BULLCHECK® Veterinary Bull Breeding Soundness Evaluation – 4th Edition

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McGowan M, Galloway D, Taylor E, Entwistle K, Johnston P. The Veterinary Examination of Bulls. Australian Association of Cattle Veterinarians, 1995.

Entwistle K, Fordyce G. Evaluating and Reporting Bull Fertility. Australian Association of Cattle Veterinarians, 2003. ISBN 0-9585654-4-9

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Declaration of interests: Dr Perry and Dr Sullivan both hold a commercial interest in morphology referral laboratories. Dr Sullivan also holds a commercial interest in the supply of the iSperm device.

Updates!

This book will be updated from time to time. To ensure you have the latest version of the book, please use this link: https://bit.ly/ACVBullBook

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2. INTRODUCTION

2.1. FOREWORD

This latest edition of the Australian Cattle Veterinarian's *BULLCHECK® Veterinary Bull Breeding Soundness Evaluation* updates the essential reference manual to include latest knowledge on cattle disease, diagnostic testing and techniques.

The standardized way of conducting a veterinary bull breeding soundness evaluation described in this publication is now known as the BULLCHECK® Exam.

The book has been reviewed by and agreed upon by experienced members of the ACV and provides clear, concise guidelines for vets to assess each bull according to the agreed BULLCHECK® standards.

The ACV's BULLCHECK's reputation is based on the use of these transparent, consistent and agreed set of standards developed by the ACV, and that the exam is carried out in a consistent and highly professional manner in accordance with these standards.

The 5 components of the BULLCHECK® Exam remain the same- scrotum, physical, semen, morphology and serving ability. The components are summarised in the standardized Bull Reporter certificate to identify risk factors for a bull's potential to be fertile in the future.

What has changed is that the *BULLCHECK® Standards* now clearly describe how to assess and report a breeding soundness evaluation. These Standards are supported by background information, which represents the views of the ACV. It is based on a combination of peer reviewed literature and collective wisdom. This book should be seen as a manual for how to conduct a BULLCHECK® examination in a standardised, ACV approved, way. It should not be seen as a textbook describing all we know about bull fertility.

The BULLCHECK® Exam is designed to encompass a pre-sale risk assessment and for annual bull risk assessment to optimise herd fertility and meet producer biosecurity and welfare objectives.

The ACV would like to thank the many members who contributed their invaluable knowledge and expertise to this book.

Tracy Sullivan (President, Australian Cattle Veterinarians)

Stacey Rae (Convenor Bull subcommittee)

2.2. STANDARDISED ASSESSMENT OF BULL FERTILITY

Veterinarians are asked to assess the fertility (or likely fertility) of bulls under several common circumstances that can be divided into two broad groups: examination of a bull after an apparent failure of fertility; and examination of a bull before it is to be used. The latter is more common, but this often puts the veterinarian in a potentially difficult position because: there may be a potential conflict of interest if the examination is being carried out for a bull seller; and the veterinarian does not want to be liable if a bull declared ok is later found to have had fertility problems. Equally, veterinarians who declare a valuable bull not to be fit for sale need to have good defensible reasons for doing so.

Thus, a veterinarian making an individual judgement about whether a particular finding, based on their own personal judgment, should preclude its use takes on a degree of risk – particularly if a client might seek an alternative opinion from a different veterinarian down the track, when things have not gone well.

The 'individual judgement risk' can be reduced significantly by having a set of standards.

A veterinarian who can make an objective assessment about whether something meets or does not meet a well described, industry accepted standard is at much less risk. This is particularly so when predicting risk, as in pre-use examinations.

This book contains a set of standards, based on evidence and collective experience, and agreed upon by experienced members of the Australian Cattle Veterinarians.

The standardized way of conducting a veterinary bull breeding soundness evaluation described in this publication is known as a BULLCHECK® examination.

A satisfactory BULLCHECK® examination is not an express guarantee of fertility, but rather an indication of the risk that a bull is likely to be "fertile" in a paddock mating situation at the time of examination and for the immediately foreseeable future, save any unforeseeable adverse events.

2.3. THE FIVE COMPONENTS OF A BULLCHECK® EXAMINATION

The BULLCHECK® examination consists of five parts, each reported separately:

Scrotum	Physical	Semen	Morphology	Serving ability
• scrotal circumference in cm	• general physical examination of the bull and a specific examination of the reproductive tract	• crush side semen assessment, including sperm motility	• high magnification microscopy of preserved sperm	• observation of the bull serving a cow

2.4. BULLREPORTER™ SOFTWARE

The Bull Reporter software, available free to ACV members, allows the examinations to be reported in a standardised format with individual certificates available, or multi-bull reports for larger numbers. The BULLCHECK® certificates produced by the Bull Reporter show each of the 5 categories above. The software allows for electronic transmission of sperm morphology results and provides a consistent way of recording and presenting BULLCHECK® examinations.

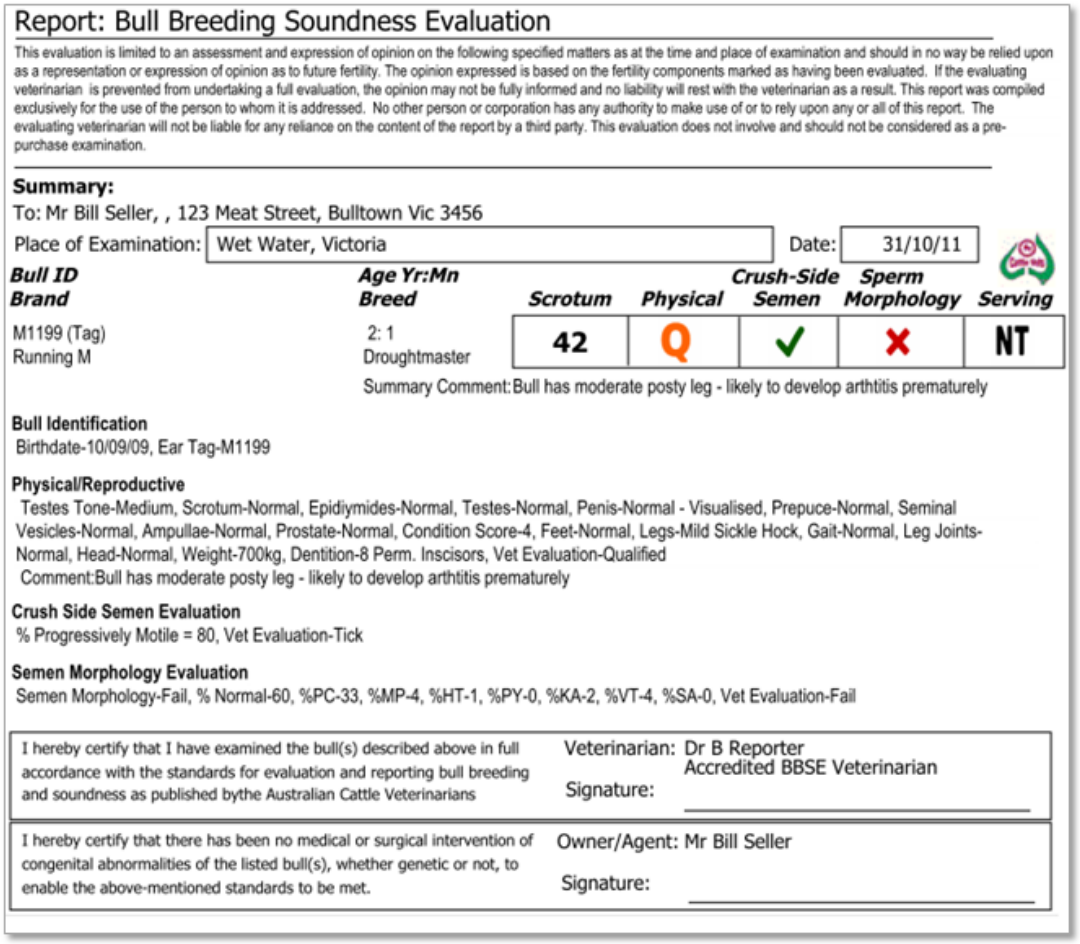
2.5. REPORTING RISK

Each of the 5 elements is reported in terms of risk to fertility. The scrotal circumference is reported in centimeters, with normal values being discussed in a later chapter. All other elements are reported as in Table 1:

Table 1 Assessment of a BULLCHECK® Exam

✓	Tick - All attributes assessed for this component were consistent with the ACV standards. No risk factors for reduced fertility were identified during this part of the BULLCHECK® Exam.
✗	Some attributes examined for this component were not consistent with ACV standards. This bull has a significant risk of reduced fertility in the short term at least. The client should seek advice from their cattle veterinarian, as some conditions may be temporary.
Q	Qualified - Not all attributes examined for this component were consistent with ACV standards but these abnormalities may not necessarily preclude the bull's use. A further comment will be provided. The client should seek advice from their cattle veterinarian as to the suitability of this bull for a particular purpose. Retesting may be recommended.
NT	This BULLCHECK® Exam component was not evaluated or not fully evaluated either at the owners request or as indicated.

An example of the certificate produced by Bull Reporter is below:



Report: Bull Breeding Soundness Evaluation

This evaluation is limited to an assessment and expression of opinion on the following specified matters as at the time and place of examination and should in no way be relied upon as a representation or expression of opinion as to future fertility. The opinion expressed is based on the fertility components marked as having been evaluated. If the evaluating veterinarian is prevented from undertaking a full evaluation, the opinion may not be fully informed and no liability will rest with the veterinarian as a result. This report was compiled exclusively for the use of the person to whom it is addressed. No other person or corporation has any authority to make use of or to rely upon any or all of this report. The evaluating veterinarian will not be liable for any reliance on the content of the report by a third party. This evaluation does not involve and should not be considered as a pre-purchase examination.

Summary:

To: Mr Bill Seller, , 123 Meat Street, Bulltown Vic 3456

Place of Examination: Wet Water, Victoria Date: 31/10/11

Bull ID / Brand	Age Yr:Mn / Breed	Scrotum	Physical	Crush-Side Semen	Sperm Morphology	Serving
M1199 (Tag) Running M	2: 1 Droughtmaster	42	Q	✓	✗	NT

Summary Comment: Bull has moderate posty leg - likely to develop arthtitis prematurely

Bull Identification
Birthdate-10/09/09, Ear Tag-M1199

Physical/Reproductive
Testes Tone-Medium, Scrotum-Normal, Epidiymides-Normal, Testes-Normal, Penis-Normal - Visualised, Prepuce-Normal, Seminal Vesicles-Normal, Ampullae-Normal, Prostate-Normal, Condition Score-4, Feet-Normal, Legs-Mild Sickle Hock, Gait-Normal, Leg Joints-Normal, Head-Normal, Weight-700kg, Dentition-8 Perm. Inscisors, Vet Evaluation-Qualified
Comment:Bull has moderate posty leg - likely to develop arthtitis prematurely

Crush Side Semen Evaluation
% Progressively Motile = 80, Vet Evaluation-Tick

Semen Morphology Evaluation
Semen Morphology-Fail, % Normal-60, %PC-33, %MP-4, %HT-1, %PY-0, %KA-2, %VT-4, %SA-0, Vet Evaluation-Fail

I hereby certify that I have examined the bull(s) described above in full accordance with the standards for evaluation and reporting bull breeding and soundness as published bythe Australian Cattle Veterinarians

Veterinarian: Dr B Reporter
Accredited BBSE Veterinarian
Signature: _____

I hereby certify that there has been no medical or surgical intervention of congenital abnormalities of the listed bull(s), whether genetic or not, to enable the above-mentioned standards to be met.

Owner/Agent: Mr Bill Seller
Signature: _____

Notice that the certificate includes:

- The identity of the client and place of examination
- The identification, breed and age of the bull
- A summary of the veterinary interpretation of each element of the examination
- A signed statement by the veterinarian that the procedures outlined in this manual have been followed
- A signed statement by the seller that there has been no surgical or medical intervention

There are, of course a virtually unlimited number of tests that could be performed and details that could be recorded. Cattle veterinarians will need to discuss with their clients which tests are appropriate for the individual situation.

A BULLCHECK® Exam certificate provides information about which tests were and were not conducted, the findings of those tests, and an assessment of the risk that is associated with these findings. It is important to stress that a BULLCHECK® Exam does not state whether a bull is fertile or infertile – it states whether or not the bull complies with an agreed set of standards, and gives an assessment of risk.

3. ACV BULLCHECK® STANDARDS

The ACV Standards in this publication have been peer reviewed and agreed to by accredited BULLCHECK® Veterinarians. They are based on the most up-to-date research, and experience of these senior members of the profession.

Having a set of agreed standards means that a veterinarian can compare a bull to the standards and state whether the bull complies.

When conducting a BULLCHECK® examination, veterinarians can objectively state whether or not a bull complies with the BULLCHECK® Standards. If the bull does not comply, the veterinarian can provide an explanation of how the non-compliance may affect the risk of fertility.

BULLCHECK® examinations provide more consistency, and mean that decisions are based on collective wisdom of ACV members rather than the opinion of an individual.

All Standards in the BULLCHECK® scheme have a consistent structure:

Recording	This is where the standard is reported on the BULLCHECK® certificate. For example, items of concern from the history, general physical exam or reproductive exam are all reported under the PHYSICAL category
Requirements NT	These are requirements for the evaluation of this standard that must be met before the standard can be reported. If any of the requirements are not met, the Standard should be reported as not assessed.
Tick 	These are the requirements for a TICK. All must be met in order to report a TICK, without any findings that would result in a Q (Qualified) or Cross being present.
Qualified 	These are the findings that would prevent a TICK being reported and result in a Q (Qualified). If **any** of these findings are present, then a Q should be reported along with a specific comment as to why. A veterinarian should exercise judgment and apply a CROSS if a condition is severe.
Cross 	These are the findings that would prevent a TICK being reported and result in a CROSS being reported.

3.1. TIMING

- Timing can be an important consideration when conducting a BULLCHECK® examination – particularly for pre-sale examinations. Closer to sale time may provide more meaningful results for the vendor (for example penile warts may develop if the period is prolonged), but other constraints such as the necessity to produce sale catalogues may require earlier testing.
- It is recommended that a Bull Reporter certificate dated up to 90 days prior to sale indicating a bull is fertile be accepted as a valid pre-sale assessment
- For bulls maintained within the same environment and management, repeatability of most traits assessed during a BULLCHECK® Exam is high to very high. A bull assessed as low risk by a BULLCHECK® Exam can acquire temporary sub-fertility if subjected to stressful conditions.
- If a bull is assessed as low risk by a BULLCHECK® Exam within 90 days before sale, there is every likelihood that, if it does not experience significant stress before sale, the risk will not change significantly. Further, if it is not relocated to management and an environment more stressful than his source, there is a high probability of being fertile 2-3 months after relocation.
- Bulls most at risk of becoming sub-fertile after relocation are those that are in very good to fat condition prior to relocation.
- Young bulls should be managed to achieve moderate growth rates (0.7-1kg/d) and be in good condition (BCS 3 out of 5) at time of sale. Feeding bulls to achieve very high growth rates and/or to be in very good to fat condition at time of sale can very adversely affect their short- and long-term fertility. Estimates of the likely performance of offspring from a given bull should be derived from estimated breeding values.
- Veterinarians should consult with their clients regarding the optimal time to conduct assessments prior to sale, taking into consideration the bulls in question, feeding and management, and the time required for follow-up testing should this be required.
- If a BULLCHECK® Exam is conducted well before a sale, the data for a bull may change, especially those aspects related to growth such as weight and scrotal circumference. Therefore, a pre-sale certificate should include weight at the time to provide context for the results reported.
- Bulls which have not reached puberty should be evaluated as Q (Qualified) rather than a “Tick” as they are at risk of reduced fertility if used immediately.
- At the time of writing, some breed society sales in Australia specify a period before specific sales in which BULLCHECK® Exam certificates must be written. If a BULLCHECK® Exam is being undertaken for eligibility to include in a sale, it is prudent to follow the sale guidelines.

4. HISTORY AND BIOSECURITY

History of the individual animal, including biosecurity aspects of the farm of origin and the individual animal can have important implications for future fertility. A detailed history should be taken for all bull evaluations. It can be helpful to document previous vaccinations, diet and recent transport of bulls and such details can be recorded on a BULLCHECK® certificate.

HISTORY includes information that is provided by the client, as well as something observed (or administered) by the veterinarian. It is important to clearly differentiate between these scenarios.

For example, if a producer advises that the bulls have been vaccinated against a particular disease, this can be recorded but it should be done so in a way that certifies the veterinarian was advised of the history rather than the veterinarian is certifying the vaccination took place (for example because they saw or administered it).

BIOSECURITY is an increasingly important consideration when farmers import animals onto a property. Producers selling bulls should have a formal biosecurity plan (such as ACV's BIOCHECK®), and, at a minimum, should have a Johne's Disease risk assessment.

4.1. TECHNIQUE

The particular biosecurity and history risks will vary with region and the type of enterprise.

4.1.1. BIOSECURITY

1. If a producer has a Biosecurity plan (for example, a BIOCHECK® plan), this should be recorded.
2. The JBAS (Johne's Biosecurity Assurance Score) may be recorded. Although not technically a reproductive disease, it may reduce longevity and may be of interest to buyers.

4.1.2. HISTORY

It is assumed that History is given to the veterinarian in good faith, and on a BULLCHECK® Certificate it is assumed that history is provided by the producer and is not verified by the veterinarian. If part of the history is personally observed by the veterinarian (for example a lab test), this should be noted in the comments.

1. Date of birth of the bull must be recorded - even if it is an estimate.
2. Any history of clinical illness, pyrexia, lameness, significant weight or body condition changes and all data available relating to previous fertility (number of females, time joined, pregnancy rate and owner's observations) should be recorded.
3. If bulls have been transported to the current location in the past 2 months, this should be recorded.

4.1.3. LABORATORY TESTING

Laboratory testing for reproductive or other important diseases should be recorded. This should include:

- Enzootic bovine leucosis - mandatory if a bull is being moved to a dairy farm
- BVDV (Bovine pestivirus) antigen - highly recommended where bulls may be sold to farms where pestivirus is not endemic
- Botulism - depending on regional circumstances
- Vibriosis – highly recommended in most cases
- Bovine Ephemeral Fever - depending on regional circumstances
- Tick Fever - depending on regional circumstances
- Trichomoniasis- depending on regional circumstances
- Any genetic diseases or traits that may be indicated by breed and history (e.g. poll gene testing)

4.1.4. VACCINATION HISTORY

Vaccination history (including dates of primary and booster vaccinations) should be recorded - particularly for:

- Vibriosis
- Pestivirus
- Clostridial disease
- Leptospirosis
- Tick fever
- Bovine respiratory disease (BRD)
- Johne's disease
- Bovine ephemeral fever (BEF)

4.1.4.1. CATTLE HEALTH DECLARATIONS

Veterinarians should include vaccination status within their BULLCHECK history. Vendor should produce a Cattle Health Declaration to declare vaccination to be current. The Cattle Health Declaration is a legal document, and the producer has the responsibility to understand and complete it accurately before signing.

Cattle Heath Declarations are a way for producers to provide information about the health status of the bulls they are selling and their vaccination status. Buyers should ask vendors for a declaration and use the information provided to determine the health risks associated with the animals on offer.

To be able to complete the current vaccinations section on the declaration vendors must have followed the manufacturer's recommendation for vaccination and the time between the last vaccination and the date the declaration is made cannot be greater than 12 months.

4.1.4.2. BULL INSURANCE POLICIES

Considering many insurance policies exclude coverage for diseases that are preventable by vaccination, well considered vaccine programs implemented according to the label and utilizing veterinary advisors are recommended.

4.1.4.3. VACCINATION SCHEDULE RECOMMENDED FOR BULLS

ACV has a separate Publication - ImmuneReady™ which describes vaccination protocols generally recommended in cattle. The following is a guide to recommended vaccines for breeding bulls:

	Pestivirus	Clostridial	Leptospirosis	Vibriosis	Botulism	BEF	BRD (MH)	IBR	Tick Fever
Sale Bulls	✓	✓	✓	✓	✓		✓	✓	
Herd bulls	✓	✓	✓	✓	✓		✓	✓	

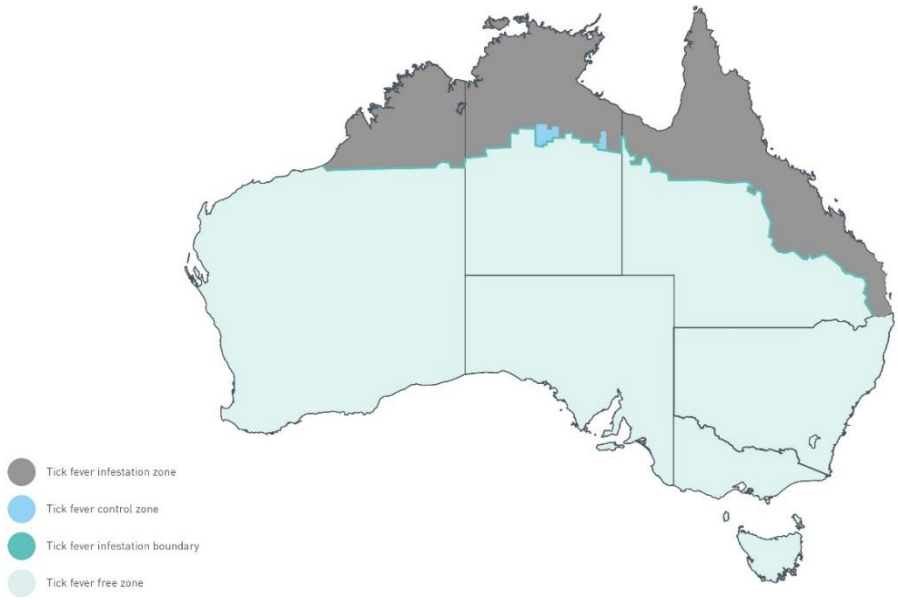
✓	Core vaccine
✓	Important diseases in certain areas and production systems
	Important in certain geographies (see maps below)

Geographies where BEF and Tick Fever vaccine may be important are described below.

Distribution of bovine ephemeral fever virus in Australia, 2007-2008 to 2019-2020.
Source: National Arbovirus Monitoring Program, Animal Health Australia

[a] Köppen climate classification

animalhealth AUSTRALIA



Tick fever zones as of 31 December 2020.
Source: *Animal Health in Australia Annual Report 2019–2020*, Animal Health Australia

animalhealth AUSTRALIA

4.1.5. SAMPLING FOR VENEREAL DISEASES

Campylobacteriosis (vibriosis) and trichomoniasis occur in Australian beef and dairy cattle herds and should always be considered when investigating poor reproductive outcomes where bulls are used for breeding.

Bovine genital campylobacteriosis, more commonly referred to as vibriosis, is a venereal disease caused by the bacterium *Campylobacter* (Vibrio) *fetus* subspecies *venerealis*. Vibriosis is characterised by infertility and abortion in female cattle as a result of a subacute diffuse inflammation of the reproductive tract. Infected bulls show no clinical signs, but many become persistently infected (carriers) and subsequently infect susceptible female cattle during mating.

Bovine trichomoniasis is a disease caused by the protozoan parasite *Tritrichomonas fetus.* Bulls are again the vector of the organism with the major impact being in the female reproductive tract. In cows, infection leads to embryonic and early foetal death, abortion, foetal maceration, pyometra and transient or permanent infertility. As with vibriosis, bulls show no sign of infection and can become persistent carriers and the main reservoir of infection.

4.1.5.1. TECHNIQUE

Campylobacter is diagnosed by either culture or PCR, Trichomonas by direct smear, culture or PCR. The collection technique is the same for each but the media differs. Sampling procedures for collection of preputial samples from bulls and correct transport to laboratories are provided by diagnostic laboratories. There are minor variations between labs in transport media and other recommendations.

Collection: The correct sampling procedures are important with trichomonosis. Because T. foetus is in highest numbers on the glans penis, it is imperative that this area is scraped well when collecting sheath samples. A Canadian study documented that the likelihood of successfully isolating T. foetus from a bull was 4 times higher if the bull was sampled from the right side versus the left side, most likely due to the location of the penis within the sheath. Given that most facilities in Australia are set up for handling cattle from the left side this should be considered when sampling bulls.

The Tricamper™ preputial sampling device, developed by the Queensland DPI is now the generally accepted means of collecting samples from bulls. Tricampers are available from Gribbles Veterinary Pathology and Queensland Department of Agriculture & Fisheries Tick Fever Centre.

1. Collect preputial samples using a fresh Tricamper for each diagnostic test you want done.
2. To reduce the risk of being kicked whilst collecting samples either get an assistant to place a gloved arm in the rectum before attempting sample collection, or collect your sample immediately after collecting a semen sample by massage or electroejaculation.
3. Leaning over the partially opened bottom crush gate grasp the ventral edge of the preputial orifice and slide the tip of Tricamper into the preputial cavity along to the preputial reflection
4. Slide the Tricamper back and forward, so that it scrapes across the preputial mucosa and surface of the penis. Block the end of the Tricamper (e.g. with a finger) to prevent any of the collected material being suctioned out and remove the Tricamper from the prepuce.
5. Hold the Tricamper just off horizontal, insert the tip into the tube of saline or transport media and remove the block from the end of the Tricamper. Cut the black head off the Tricamper with side-cutters. Leave the Tricamper head in the tube and replace the lid securely.

Handling: Optimising transport to the lab is critical to achieving good results. Testing can be done by culture, PCR, or a combination, and each has specific sample quality requirements. It is important to consult with the laboratory regarding which test will be performed and their preferred transport media for each.

4.1.6. COMMON FINDINGS AND INTERPRETATIONS

Risk factors for fertility include:

1. Recent prolonged transport (within 60 days)
2. Essential vaccinations missing
3. Essential tests missing

4.2. STANDARDS AND GUIDELINES – HISTORY AND BIOSECURITY

Standard	History and Biosecurity
Recording	This Standard is recorded as part of the HISTORY/PHYSICAL EXAM
Requirements	Reason for the evaluation / intended use of the bull Primary identification shall be ear tag, brand, tattoo, or NLIS identification. Date of birth recorded or estimated Breed History of relocation within previous 2 months recorded Vet advises whether any vaccinations or disease testing are essential based on risk analysis and sale requirements. Vaccination history (by owner or vet) may be recorded Disease testing history may be recorded
Tick	No history of long-distance travel in past 60 days History of good health Birth date recorded and consistent with bull appearance Vaccinations and tests are appropriate
Qualified	Bull has traveled long distances in past 60 days - may need to be retested History of injury or disease in last 60 days Essential vaccinations missing Essential testing missing
Cross	The year of birth cannot be determined Fail disease testing

5. GENERAL PHYSICAL EXAMINATION

Physical evaluation needs to be sufficiently detailed to make the statement that the bull is in good general health and body condition. If an abnormality present is likely to impact on short- and long-term fertility, the examination should be sufficient to provide a diagnosis, with comments on prognosis.

The guidelines set out below identify characteristics that reflect high reproductive efficiency and define abnormalities that reduce reproductive efficiency. A structural fault is important where, on the balance of probabilities, it will interfere with function and measurably reduce fertility or reduce the working life of a bull below that expected for the bulls breed, age, and environmental conditions.

The purpose of the physical exam is to identify whether a bull can, without difficulty, seek and successfully mate with females under paddock conditions over an extended period. Therefore, conditions that do not limit this outcome are NOT related to a BULLCHECK® Exam.

5.1. TECHNIQUE

5.1.1. IDENTIFICATION

The animal should first be identified. It is essential that a permanent method of identification is recorded for each bull examined. Whilst Bull Reporter allows for a multitude of identification attributes to be recorded, the ACV standard states that the primary identification shall be either an Ear Tag, Brand, Tattoo or NLIS Identification (NLIS is the Australian National Livestock Identification system – by law all cattle sold must wear an ear tag with a unique microchip ID and outside written identification. Either of these is an acceptable form of identification). In addition, the Breed and birthdate (which may be approximated) of the bull must be recorded. The figure below shows the identification options in Bull Reporter (with the compulsory ones in bold).

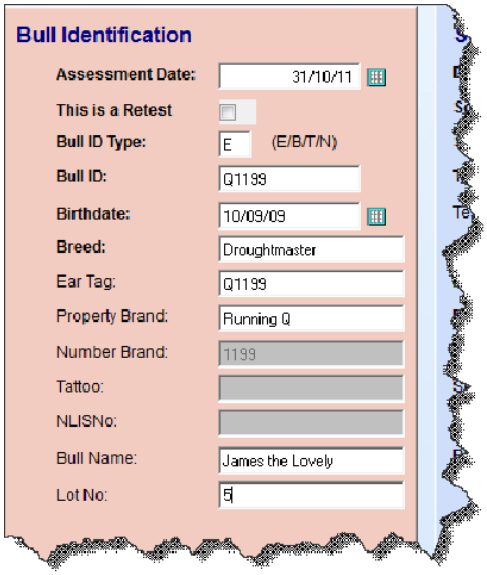


Figure 1 Bull Reporter Identification Screen

In cases where the identity of the bull might be queried, it is suggested that a sample of at least 20 tail hairs (including the roots) be obtained and securely stored by the veterinarian. DNA from such samples will be stable for long periods if the samples are kept dry. Preservation of such a sample should be recorded.

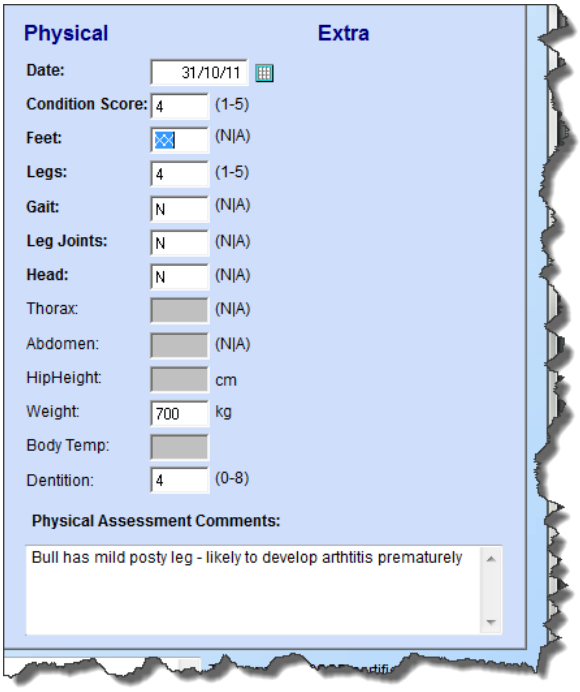
The Allflex Tissue Sampling Unit (TSU) also provides a quick and easy DNA sampling method that is reliable, easy to transport, user-friendly and most efficient way labs can process DNA samples in a lab.

5.1.2. EXAMINATION

The animal should be examined systematically by hand and eye from the head, along the neck and shoulders, down the forelimbs, along the thorax and abdomen to the lumbar region and over the hindquarters and down the hind limbs. Particular note should be taken of the feet, legs, eyes and jaw.

It is not necessary to perform a complete physical examination (for example listening to the heart, taking temperature) in clinically normal animals with no concerning history. The producer should be consulted as to the depth of the clinical examination required, as these findings can be included on a BULLCHECK® Certificate, but they will take time and cost money.

The Bull Reporter data entry screen is shown below:



Essential aspects of the general physical examination are:

1. Condition score
2. Foot conformation
3. Leg conformation
4. Gait
5. Leg Joints
6. Head

Non-essential aspects of the general physical examination include:

1. Thorax
2. Abdomen
3. Hip Height
4. Weight
5. Body Temperature
6. Dentition
   (Note that dentition may be essential for some breed society sales)

5.1.3. CONDITION SCORE

Body Condition score should be recorded as should body weight, if available. The following system of recording body condition is recommended for consistency:

Condition score	Description
1 - “Poor”	Individual lumbar transverse processes are sharp to touch and no tail head fat can be felt. A bull in this body condition is not considered sound for breeding.
2 - “Backward”	Individual lumbar transverse processes can be felt but are rounded rather than sharp
3 - “Moderate”	Lumbar transverse processes can only be felt with firm pressure. Detectable fat cover either side of the tail head
4 - “Forward”	Lumbar transverse processes cannot be felt and fat cover around the tail is easily seen as slight mounds. Folds of fat beginning to develop over ribs and thighs of animal
5 - “Fat”	The bone structure of the animal is no longer noticeable, and the tail head is almost completely buried in fatty tissue. Folds of fat are apparent over the ribs and thighs

5.2. CONDITIONS IDENTIFIED BY GENERAL PHYSICAL EXAMINATION

5.2.1. LEG CONFORMATION

Evaluation of the musculoskeletal system and gait is a critical component of the physical evaluation.

Bull Reporter makes provision for objectivity in evaluating legs and feet. For hind leg structure a 1-5 scoring system (side and rear views) should be used.

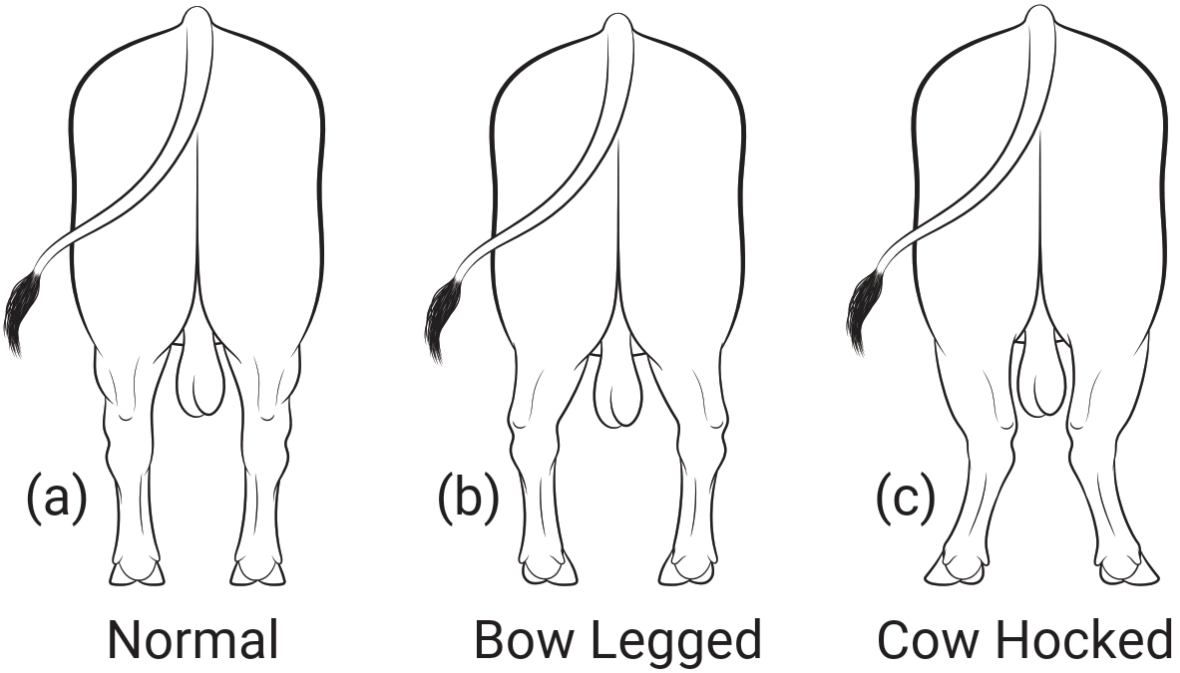


Figure 2 Hind limb conformation from rear

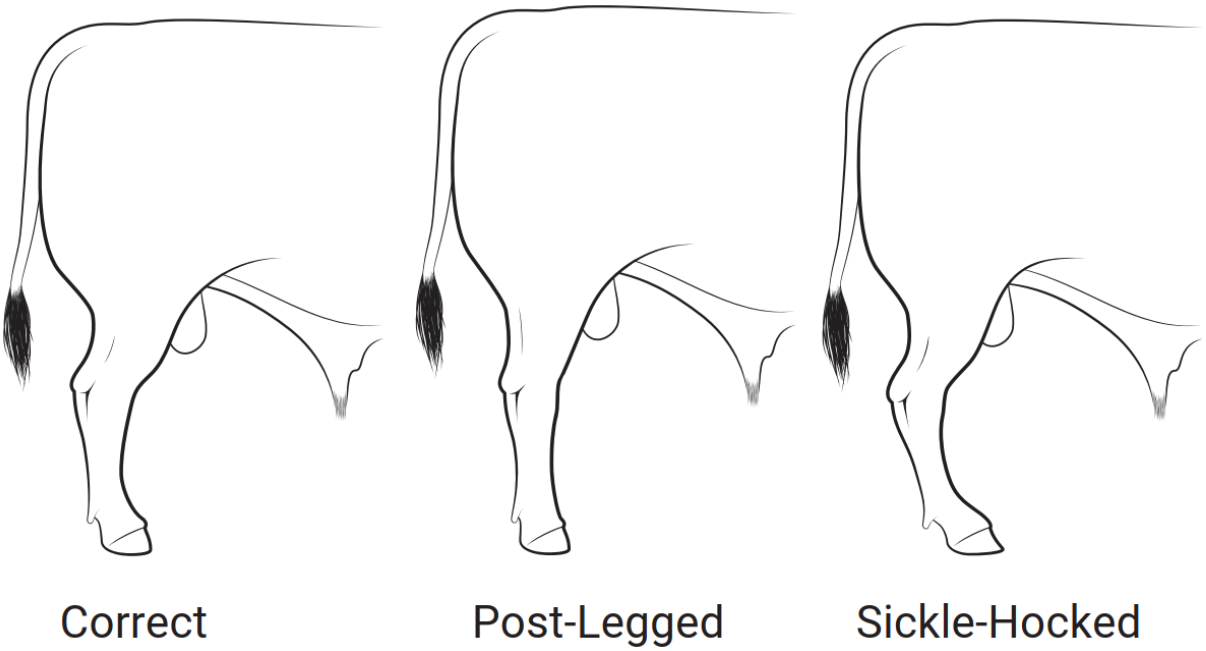
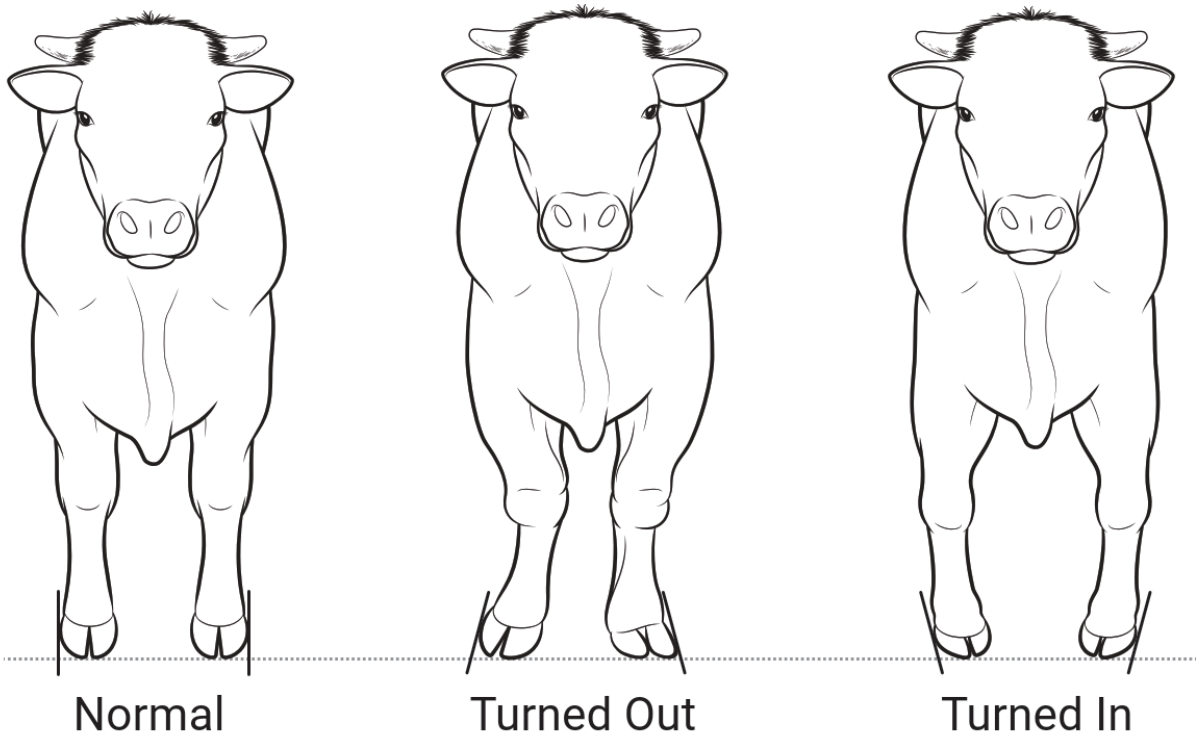


Figure 3 Figure Hind limb conformation from side

Leg Conformation Score	Description
1	Pronounced sickle hocks
2	Moderate sickle hocks
3	Normal no sickle hocks
4	Moderate post leg
5	Pronounced post leg

Common foreleg faults include buck knees, calf knees, knock knees and bow legs. Common hind leg faults include sickle hocks, posty legs, bow legs and cow hocks. While limb conformation defects are sometimes regarded only as blemishes, in some bulls such blemishes lead to dysfunction with increasing age. Mild expression of conditions such as posty legs may resolve, especially as bulls reach maturity.



Limb conformation defects may be primary or acquired. For example, a posty leg - considered by many as a major cause of hind limb disease in bulls - may become evident (usually bilaterally) at 1 to 3 years of age or it may develop as a result of degenerative arthritis of the stifle joint. Posty leg bulls generally walk short and have worn 'boxy' toes. They are predisposed to arthritis in the hips, stifle and hocks.

Bulls with 'sickle hocks' (increased angulation at the hock joint) frequently overstep, develop long overgrown claws, predisposing them to lameness.

Mild, moderate or severe degenerative joint disease will interfere with a bull's reproductive efficiency. Where there is fluid filling of the joints, especially the hock joint, but no associated lameness or pain, mild cases may be reported as Q (Qualified), but severe cases of fluid distension of the joints or any sign of lameness should be reported as X (Cross). Mild to moderate swelling of the joints, especially the radial bursa of the hock joint, appears to be a management problem in grain fed bulls and advice should be given accordingly. In herd bulls examined prior to joining, the significance of joint swelling(s) is determined by examination of the bull's age, recent clinical history, gait and serving behaviour.

5.2.2. FOOT CONFORMATION

Some examples of abnormal foot conditions are shown below. There are four feet, and they may present with different abnormalities. Thus, in Bull Reporter, feet are simply classified as normal or abnormal and it is expected that the examining veterinarian will describe the findings in the comment section.

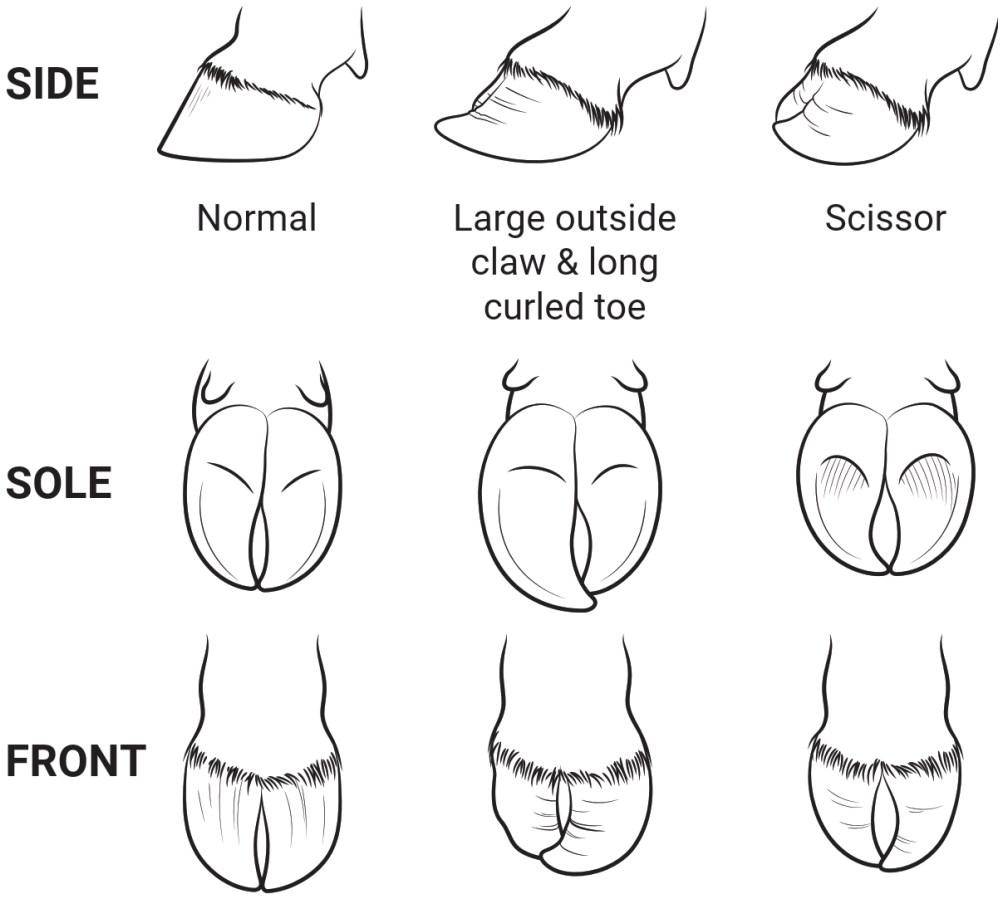


Figure 4 Front and rear feet claw structure: (a) normal (b) corkscrew curl claw (c) scissor claws (d) spread claws

Hooves should be of a normal size, with the claws of approximately equal size and symmetry. The gait of bulls with excessively straight or sloping hooves should be examined carefully. Claws worn flat across the front may provide evidence of dragging the hoof, associated with abnormal gait.

Sometimes it is not possible to assess claw conformation problems if the feet have been recently trimmed. It is suggested that a comment be made on a BULLCHECK® Exam report in cases where recent trimming might disguise poor conformation.

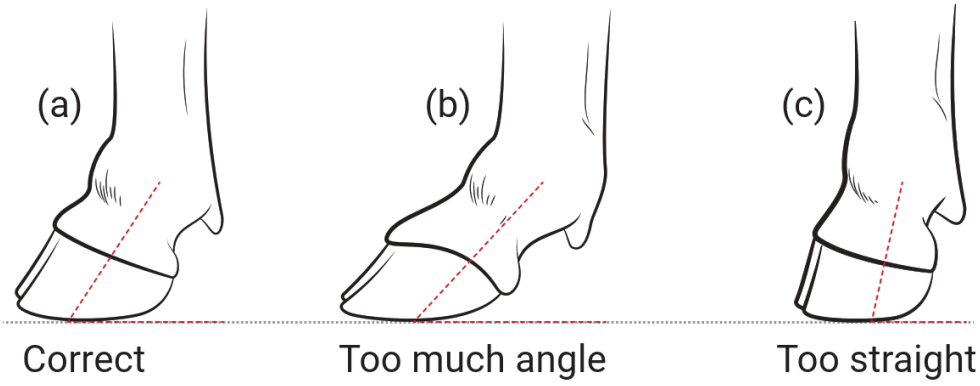


Figure 5 Angle of pasterns in front and hind legs: (a) weak, flat pastern (b) correct angle (c) too straight

Foot Angle Reference Point: Angle at the front of the rear hoof measured from the floor to the hairline at the right hoof. 1 - Very low angle 5 - Intermediate 9 - Very steep

If the foot angle is different, the most extreme one should be scored.

5.2.3. INTERDIGITAL FIBROMA

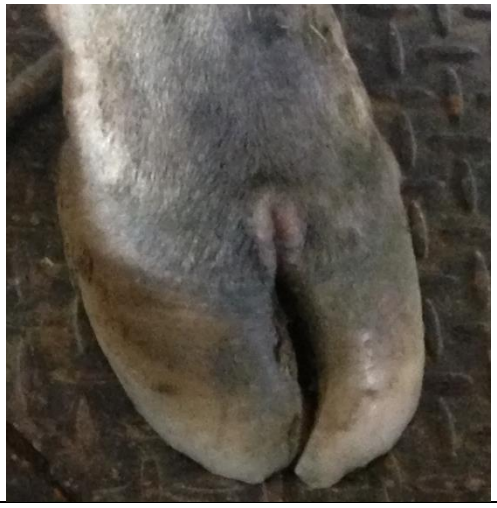
Figure 6 Severe interdigital hyperplasia – note that it is bilateral in this bull.

Interdigital fibromas with proliferative lesions (with or without evidence of acute inflammation) present a high risk of reduced fertility and are often associated with open claws. They should be reported as X (Cross). Mild keratosis without clear proliferative lesions is not considered sufficient to make a diagnosis of interdigital fibroma.

Figure 7 Bilateral moderate scissor claw, along with mild keratosis in the interdigital area.

5.2.4. SCISSOR CLAW

Scissor claw can be scored as:

1. Mild: some turning inwards of toes of one or more claws of the fore- and/or hind-hooves.	
2. Moderate: very distinct turning inwards of toes of one or more claws of the fore- and/or hind-hooves.	
3. Severe: marked turning inwards of the toes of one or more claws of the fore- and/or hind-hooves with, in some cases, toes touching each other, and in very severe cases one toe crossed over the other.	

Mild scissor claw is unlikely to interfere with reproductive efficiency, but can be exaggerated by overfeeding of grain and soft ground. There is a risk that it could develop to a more severe form or that the bull may become lame. It should be noted in the comments as it is a heritable trait.

Overgrown, uneven claws are usually indications of poor limb structure or possible degenerative joint disease. They may also be temporary changes induced by feedlot conditions. Moderate and severe cases of cork-screw claws, grossly over-grown claws or severe cases of scissor claws are unacceptable. A comment should be recorded for all bulls with mild scissor claw. Bulls with moderate scissor claw should be reported as Q (Qualified).

5.2.5. CRACKS

Cracks in the hoof, either vertical or horizontal should be reported as Q (Qualified) or X (Cross- high risk).

Figure 8 A crack, possibly associated with the associated with scissor claw conformation

An assessment of Q (Qualified) or X (Cross- high risk) needs to be made by the treating veterinarian depending on the severity of the condition. At worst, such bulls will have a higher risk of lameness. It is likely that, at best, that the bull would have reduced longevity in the herd.

5.2.6. GAIT

On many occasions the owner having observed the animals over a longer period of time, will have noted stance and gait abnormalities, and have a good appreciation of any potential problems. Such observations should also be noted. When evaluating groups of bulls, it is recommended that gait of each bull be assessed while it is in a group of no more than 6 bulls either immediately before or after crush evaluation. As they walk, bulls should ideally be viewed from each side and behind with special attention to lameness associated with hip, hock, stifle or pastern joints. Bulls may need to be observed at the trot to be confident of detecting some gait problems.

A structurally-normal bull is one which allows all the forces of weight bearing and locomotion to be symmetrically directed along the limbs, minimising wear and tear on the bones, joints and hooves, and therefore minimising the incidence of lameness. The "tracking" of the bull's feet and the arc of the foot travel should be observed at both the walk and trot. The gait of the animal should be smooth with an even arc of the hooves, the rear hoof landing in the imprint of the front hoof and the imprint of the bearing surface of the hoof being even.

Over-stepping or under-stepping are indications of structural problems and may be associated with reduced ability to serve. Bulls that under-step often have very straight hocks (posty-leg defect) and have increased problems in completing the final ejaculatory thrust. Dragging of the hind toe(s), often in association with excessive wearing of the toes, is suggestive of arthritis affecting the hock, or stifle or hip joints or degenerative joint disease affecting the lumbosacral spine.

In summary, the more common gait abnormalities encountered include:

- Under-stepping, over-stepping and abnormalities of tracking. These may be of a conformational, nutritional or heritable cause, the severity of which varies and which can compromise serving ability. Individual judgement will be needed in classification to meet satisfactory standards.
- Ataxia, usually reflecting neural tissue damage from a variety of causes and more pronounced when mounting or at the trot. Such bulls would be assessed as "Cross- high risk" for the purposes of a BULLCHECK® Exam.
- Paresis often occurs concurrently with ataxia, and is shown by a short, stilted gait often with limb dragging and stumbling. Common causes include spinal trauma and degenerative spinal changes resulting in moderate to severe impediment of serving ability with poor prognosis for full recovery. These bulls would be assessed as "Cross- high risk" for the purposes of a BULLCHECK® Exam.
- Overt lameness, caused by a wide variety of painful conditions. These may involve both hoof and leg structures and joint, pelvis and spine, and range in severity from mild to severe. These conditions will impact on serving ability and fertility and affected animals would be classed as unsound at that time. Future prognosis ranges from poor to good, depending on the type and severity of the lesion.
- Upward fixation of the patella ("stringhalt") causes a stilted, unilateral or bilateral gait and exaggerated advance of the hind leg(s). It is very likely to be heritable, as it appears to be due to anatomical aberration. The condition is more dramatically expressed when bulls are in low body condition, presumably because of reduced musculature that normally helps the animal prevent the upward fixation. Such bulls should be assessed as "Cross- high risk".

5.2.7. SPINE AND LIMB DEFECTS

The most common spine and limb defects include:

- Hip dysplasia, a heritable defect, and uncommon
- Osteochondrosis involving hoofs, hips
- Degenerative hip disease, usually bilateral in older bulls
- Stifle injuries and defects including medial patella luxation, probably a heritable defect
- Degenerative joint disease particularly in stifle and hock joints, usually in older bulls.

Unfortunately, good scientific studies on the relationship between body conformation and skeletal disease resulting in clinical lameness are lacking in beef cattle. However, basic anatomical principles, the desirable angulation of joints and the mechanics of locomotion suggest that leg structural defects are often reflected

in foot and claw defects. However, the converse is also likely true, in that hoof diseases affecting hoof shape and wear may be the cause of stance and gait problems rather than the result of them.

5.2.8. THE HEAD

The head should be examined from the front and both sides to assess jaw setting, symmetry, absence of swellings (e.g. lumpy jaw) and normality of eyes. If, on these observations, there is apparent normality, then further examination is probably not justified, given the often-found difficulties of bull restraint to examine the eyes and mouth, and the additional time and costs associated with these examinations.

Severely overshot or undershot jaws may impede a bull's ability to eat and should be recorded as a X (Cross).

The eyes should be examined for lesions which may cause a significant impairment of vision. Common ocular conditions noted such as entropion (which may be heritable), corneal scarring following infectious bovine keratoconjunctivitis (IBK) and squamous cell carcinoma SCC may vary in prognosis depending on disease severity. Severe lesions may interfere with visual function, but it is possible that mild non-progressive lesions may even be beneficial in that the bull may have some immunity against the causative agent.

In squamous cell carcinoma, mild precursor lesions (seen as young as 2 years in some bulls) would be reasons for rejection because of the heritable nature of the condition.

Figure 9 Hereford bulls with active spreading squamous cell carcinomas

5.2.9. DENTITION

Whilst it is important for bull health and fertility that they have a normal bite and full set of functional teeth, dentition may also be assessed for insurance claims or for the purposes of allowing entry of bulls into some breed society sales (where dentition is used as proof of age).
Where young bulls are in satisfactory condition, the risk of poor dentition is low and the risks associated with careful assessment of the teeth may outweigh the likely benefit. When testing herd bulls older than 8 years of age, checking dentition is recommended.

Bull Reporter allows for recording of dentition using the following scale:

Dentition Score	Requirements
0	Milk teeth only
2	Two permanent incisors present
4	Four permanent incisors present
6	Six permanent incisors present
8	Eight permanent incisors present

5.3. STANDARDS AND GUIDELINES – GENERAL PHYSICAL

Standard	General physical examination
Recording	This Standard is recorded as part of the HISTORY/PHYSICAL EXAM. The value for the worst affected leg or foot is recorded.
Requirements	Assessment of condition score, feet, legs, leg joints, gait and head is compulsory.
Tick	All components evaluated fall within normal limits for the age and purpose of animal.
Qualified	Any defect that is heritable or non-heritable but present in a mild form Condition score backward or fat Mild posty-leg, sickle hock, cow hock, knock knee, bow leg Any other mild leg/foot conformation defect Mild scissor claw, or other treatable foot condition Mild swelling of joints in bulls being fed grain, where gait is normal Mild corneal scarring or entropion.
Cross	An abnormality(s) was detected that is likely to significantly reduce the fertility of the bull in the short-term and/or long-term including but not limited to: Poor or fat body condition (<2 or >4.5 on a 1-5 scale) Any severe leg conformation defect Gait abnormality or overt lameness Severe foot defect Interdigital fibroma Cancer eye Entropion Lumpy jaw Dental or jaw abnormalities that may reduce the ability to eat

6. EXAMINATION OF THE REPRODUCTIVE ORGANS

Measuring scrotal circumference by a standard repeatable method can indicate the likelihood that a bull has reached puberty, and whether testicular development is within the normal range.

Scrotal circumference is:

- A good indicator of daily sperm production especially in young bulls, which is fairly constant per gram of testis
- A highly repeatable measure (with appropriate technique) and highly heritable (30-45%)
- Correlated with sperm motility and morphology. However, these are independently assessed as part of a routine BULLCHECK® Exam
- Genetically correlated with earlier age at puberty in female relatives
- Genetically correlated with earlier return to cyclicity after calving in female relatives within tropically-adapted cattle, and especially Bos indicus cattle

The terms “scrotal circumference” and “scrotal size” are both in common use in Australia. Scrotal size is the term used by some breed societies to describe the breeding value for scrotal circumference, measured in centimeters. The term scrotal circumference is preferred in the context of the BULLCHECK® Exam to avoid misinterpretation and possible ambiguity.

6.1. SCROTAL CIRCUMFERENCE

Measurement of scrotal circumference first requires that the bull is restrained such that he is unable to harm either himself or the veterinarian, and that the scrotum is readily accessible. It is highly advisable that:

- All materials used for bull restraint are adequate to hold the bull
- All restraining facility latches are securely closed
- Bulls are restrained with a backing bar or chain at approximately the level of the scrotal attachment
- The bull is unable to move significantly forward from this bar and side to side movement is significantly restricted
- There is at least 300 mm of space behind the backing bar or chain and a further 700 mm standing room from which to safely approach the animal. A 700-800 mm high barrier in front of the standing area to work over increases safety

Further information and suggestions regarding bull restraint can be found in chapter 10.

Systematic visual inspection before palpation may reveal abnormalities which can be further investigated by direct palpation. These may include cryptorchidism, testicular asymmetry, scrotal lesions, and unusual swellings. Standards to use in assessing normality of the scrotum and contents by palpation and other methods are detailed in a subsequent section. If the scrotum, testes, epididymis and blood supply are considered normal, then scrotal circumference should be measured and recorded on a BULLCHECK® Exam.

A ReliaBull™ tape (Figure 9) is the preferred instrument recommended by the ACV as this will increase consistency between operators compared with other means.

Figure 10 ReliaBull tapes provide greater consistency in scrotal circumference measurement than other methods https://www.reliabull.ca/

The correct tension is achieved by placing the thumb against the piston and then firmly drawing the tape in contact with the entire circumference. The reading is taken at the edge of the measurement block when approximately 2 mm of green piston is showing; appearance of red indicates excessive tension. Repeat the measurement at least once to ensure accuracy to the nearest 0.5 cm.

6.1.1. BEEF BREEDS - PUBERTY

In young growing bulls measurement of scrotal circumference provides a relatively accurate guide as to whether a bull has reached puberty or not. As a general guide bulls are likely to have reached puberty when they achieve a scrotal circumference of 26 to 28cm. However, although a bull may have 'technically' reached puberty it may not yet be producing at least 70% morphologically normal sperm. This is why it is particularly important to assess sperm morphology in young bulls.

Screening young bulls prior to sale presents a special case when performing a BULLCHECK® Exam. Ethical issues arising because the veterinarian is examining the bull on behalf of the seller rather than the purchaser can be overcome by having simple clear guidelines that are based on science.

Scrotal circumference depends on both weight and breed, which can present difficulties for veterinarians and producers in circumstances where accurate weights are not available. The following guidelines are based on age rather than weight, but they take weight into account because a bull would need to have satisfactory nutrition in order to achieve the recommended thresholds.

It is recommended that young sale bulls be evaluated as Q (Qualified) if their scrotal circumference is less than those in Table 2 due to the risk of not achieving puberty. Table 3 below should be consulted to determine the minimum circumference based on bodyweight.

If sperm morphology has not been used to establish that puberty has been reached, young sale bulls with a scrotal circumference of less than 30 cm (28 cm for *Bos indicus*) should be assessed as Q (Qualified) with a comment such as "Puberty not confirmed in this bull".

Table 2 Guidelines for minimum scrotal circumference thresholds for young bulls prior to sale.

Age	Brahman	Droughtmaster, Limousin, Belmont Red, Santa Gertrudis	Wagyu	Simmental Angus Murray Grey	Hereford Brangus Shorthorn
12 months	20 cm	21 cm	23 cm	24 cm	23 cm
15 months	23 cm	24 cm	25 cm	28 cm	26 cm
18 months	25 cm	27 cm	27 cm	30 cm	29 cm
21 months	27 cm	29 cm	29 cm	32 cm	31 cm
24 months	29 cm	31 cm	30 cm	34 cm	32 cm
27 months	30 cm	32 cm	31 cm	35 cm	33 cm

6.1.2. BEEF BREEDS – LIVEWEIGHT AND BREED

BULLCHECK® Exams can be performed on bulls of any age and breed, and it is helpful to understand what the "normal" scrotal circumference for a bull might be. This section describes our current understanding of what constitutes normal scrotal circumference in the Australian herd based on the "Bull Power" project which involved analysis of about 260,000 bulls (Holroyd et al 2005, Fordyce et al 2014).

Amongst the findings was that live weight appears to be a superior reference point than age as a measure for assessing acceptable scrotal circumference in young bulls. This is because nutrition directly affects both scrotal circumference and weight.

There is no clear point at which a scrotal circumference indicates an increased risk to fertility, but as a general principle it is recommended that if the scrotal circumference is in the bottom 5% for the bull's weight and breed, it is outside the normal range, and should be reported as a X (Cross- high risk).

6.1.3. BEEF BREEDS - GUIDELINES FOR NORMAL SCROTAL CIRCUMFERENCE

Bulls should be assessed on the basis of having greater than the recommended **minimum threshold** value for **scrotal circumference** that is mostly influenced by live weight and breed. Table 5 provides a guide for recommended minimum scrotal circumference and normal range by age and plane of nutrition within breed group. Interpolation may be required to use this table. Table 5 below gives a summarised version that could be used as a ready reckoner.

Table 3 shows the minimum acceptable scrotal circumference (cm) for the various breeds at given liveweights (Kg) for each breed.

Table 3. Minimum scrotal circumference by weight and breed.

	300	400	500	600	700	800	900
Angus	*27.5*	*31.0*	33.5	35.0	36.0	36.5	37.0
Murray Grey	*25.5*	*30.0*	33.0	35.0	36.5	37.0	38.0
Hereford	*25.5*	*30.0*	32.5	34.0	35.5	36.0	36.5
Shorthorn	*25.0*	*29.5*	32.0	34.0	35.0	36.0	36.5
Charolais	*23.5*	*28.0*	31.0	33.0	34.5	35.5	36.5
Limousin	*24.5*	*28.0*	30.5	32.5	33.5	34.0	34.5
Simmental	*27.0*	*31.0*	34.0	35.5	37.0	37.5	38.0
Waygu	24.5	27.5	29.5	31.0	31.5	32.0	32.0
Brangus	*25.0*	*29.0*	31.5	33.5	34.5	35.5	36.0
Belmont Red	*23.5*	*27.5*	*30.0*	32.0	33.0	34.0	34.5
Santa Gertrudis	*22.5*	*27.0*	*30.0*	32.0	34.0	35.0	35.5
Droughtmaster	*21.5*	*26.0*	*29.5*	32.0	34.0	35.5	36.5
Brahman	*21.5*	*25.5*	*28.5*	30.5	32.0	33.0	34.0

Bulls with both testes the same size but a smaller scrotal circumference than the minimum threshold indicated above, should be considered as having abnormal testicular development. If scrotal circumference is above the 90 percentile for a bull at that weight, then further investigations are indicated to ensure there are no pathological changes present for example - orchitis or testicular degeneration associated with bruising of large testes suspended in a pendulous scrotum. Crush-side semen assessment and sperm morphology will assist in diagnosis of testicular pathology.

If the scrotum does not meet the above minimum thresholds, the scrotal circumference should still be recorded, but the Physical examination section should be recorded as X (Cross- high risk) with the appropriate comment (e.g., Scrotal circumference is not within the normal range).

Bull breeders and breed societies may impose higher thresholds where breeding objectives require increasing scrotal circumference.

The above standards do not indicate that either puberty or sexual maturity has been reached; rather, they indicate normal minimum levels of testicular development as reflected in scrotal circumference. Evaluation of sperm morphology is required to confirm attainment of puberty and sexual maturity.

6.1.4. BEEF BREEDS – SUMMARY AND RECOMMENDATIONS

Scrotal circumference should be measured and reported in all cases where the scrotum and its contents have no other pathology upon physical examination.

There is no "cut off" below which the risk of immaturity or infertility changes dramatically. Thus, scrotal circumference needs to be interpreted along with other elements of the physical examination, and with crush side semen and morphology results if available.

Bulls with a scrotal circumference that is not within "normal limits" should be viewed with suspicion unless it can be shown by other means that this does not pose a risk.

In general terms, there are some rules of thumb that might help identify bulls for which the scrotal circumference does not indicate an additional risk – these bulls would not have their physical evaluation downgraded from a tick on the basis of their scrotal circumference.

Some general guidelines:

- For young bulls where accurate weights are unavailable the minimum thresholds in Table 2 should be applied;
- For all other bulls the cut-off for the bottom 5% based on breed and weight should be applied (Table 3)
- For all bulls (except Wagyu's, Brahmans and Droughtmasters) 400 Kg and above, a scrotal circumference of > 27 cm would be within normal range.

It is recognised that it will not always be possible to weigh bulls, and that even when bulls are weighed, their weight can change by approximately 2.5%-7.5% per day (depending on environment and access to water). It is recommended that bulls that are close to the thresholds recommended in this chapter – which are the bottom 5% - should be recorded as Q (Qualified) if there is doubt – doubt is synonymous with increased risk. This could be upgraded to a T (Tick) if further tests (such as weighing, or semen evaluation) were carried out, and this could be noted in the comments.

6.1.5. DAIRY BREEDS

In dairy bulls (Holsteins, Jerseys etc) the relationship between scrotal circumference and weight has not been defined in as much detail as for the beef breeds. In Australia, dairy bulls do not tend to be sold in large breed society sales as are beef bulls. Also, dairy bulls tend to be used at much higher bull:cow ratios than beef bulls as it is necessary to rest and rotate bulls on a regular basis. It is likely that factors other than the ability to produce sufficient sperm are more commonly limiting to a bull's fertility.

Waite et al (2019) reported that in a group of 124 Holstein bulls and 84 Jersey bulls evaluated over a 12 month period:

- More than 98% of Holstein bulls with a scrotal circumference of more than 27cm and a bodyweight over 350kg had more than 70% normal sperm
- More than 88% of Holstein bulls with a scrotal circumference of more than 29cm and a bodyweight over 260kg had more than 70% normal sperm

6.2. SCROTAL BODY & SHAPE

The testicles should be freely moveable within the scrotum. The head, body and tail of the epididymides should be palpated and at the same time, testicular tone can be determined. Because of the varied anatomical shapes of the scrotum and its contents, palpation is the only way to determine the existence of many pathological abnormalities.

There is considerable variation in the size and conformation of the scrotum. Some of these variations reflect breed differences in testicular size and shape, may be normal anatomical variations, may reflect lesions on or within the scrotum, or may be due to ambient temperatures or whether or not the bull is relaxed. Other conformations can be seen as defects that can influence scrotal thermoregulation.

The testicles of *Bos indicus* and derived bulls are usually longer and narrower than those of *Bos taurus* bulls, which accounts for some of the breed differences in scrotal circumference mentioned earlier.

6.2.1. LATERAL ROTATION

Moderate lateral rotation of the testicular axis does not interfere with testicular function but bull buyers tend to discriminate against these bulls

6.2.2. CLEAVED SCROTUM

Minor incomplete fusion of the scrotal septum, which results in the appearance of a distinct cleavage between the tails of the epididymides is considered a blemish rather than of functional importance.

6.2.3. SHORT SCROTAL NECK

Bulls having a short scrotal neck tend to hold testicles close to the abdominal wall, which may occur in normal bulls on a cold day or may be associated with smaller or hypoplastic testicles. These bulls may have poor semen quality due to impaired testicular thermoregulation, and should be considered suspect for use particularly in hot environments.

Caution is also recommended where the scrotum is very pendulous. There is evidence that this predisposes the testes to trauma and ensuing degeneration.

A scrotal frenulum or “tie” is a fold of skin located on the caudal aspect of the scrotum and extending from the scrotal neck to the region of the tail of the epididymides. This frenulum results in varying degrees of rotation and elevation of the scrotum and severe cases where the testes are held towards the horizontal should be viewed with suspicion.

6.3. CONDITIONS OF THE TESTES/SCROTUM

The cardinal rule in examination of the testicles is that left should approximate right (symmetry). Unilateral testicular hypoplasia/degeneration is not uncommon, mostly on the left side that may be 20-50% smaller than the other, the prevalence ranging from 4-25% in some herds.

Testicular tone or consistency is a subjective assessment of the composition of the testicular parenchyma and the enclosing tunics. It tends to reduce with age. Testicular tone or consistency is a subjective measure of the health and function of the testis. Although it is correlated with semen quality in young bulls, this relationship weakens as bulls age. If all or the majority of seminiferous tubules are functioning normally the testes will be palpably firm and ‘springy’. However, if there is significant degeneration of most tubules the testis will be soft and the springiness’ will be markedly reduced.

Testicular tone is measured with the fingers and thumb on the anterior and posterior surfaces of the testicle, which is lightly steadied at the upper pole by the other hand. Tone has 2 components; firmness - the degree of compression of the testicle using firm pressure; and resilience - the degree of springiness or return to shape of the testicle. Scores range from pathological to normal, from very soft to hard.

Good testicular tone is firm and resilient (springy). There is marked increase in firmness with testicular fibrosis and calcification that is commonly associated with increasing age, systemic illness and trauma. Mild testicular degeneration will not normally be detectable on palpation.

It is recommended that for consistency in evaluation, a single testicular tone scoring system of 1-5 be used where 1 is very soft and 5 is very hard, a normal testicle being in the 2-4 score range. The subjective nature of this assessment and the lack of good data relating this measure to individual bull fertility is re-emphasised. The value of measuring testicular tone by palpation may be in determining gross changes (very soft or very hard) rather than in detecting subtle differences in testicular function or differences associated with fertility variations.

6.3.1. TESTICULAR DEGENERATION

Testicular degeneration is an acquired condition in which normal testicles undergo changes that usually result in reduced size and abnormal function. Mild degeneration of some seminiferous tubules has been reported in up to 90% of beef bulls, indicating that almost all young bulls have some testicular degeneration. However, these mild changes have little effect on semen quality. The increasing prevalence of atrophic seminiferous tubules as bulls age, suggests that the process is continuous and intensifies as the bull gets older.

There are many possible causes of testicular degeneration recorded. These include thermal injury, stress, infectious agents, dietary deficiencies and toxicoses, and the administration of drugs such as corticosteroids and zeranol implants. High grain diets are a common cause.

Diagnosis by palpation can be problematic as changes in size and tone can be subtle. Crush-side semen evaluation and sperm morphology is a more sensitive way to diagnose testicular degeneration than palpation later in the disease and is strongly recommended in cases where there is clinical uncertainty based on palpation. It should be remembered that there can be up to an 8-week lag phase between the time at which an insult to the testes takes place and the appearance of abnormal sperm in the ejaculate. It is strongly suggested that clinically suspicious testicles found during a BULLCHECK® Exam be recorded as a Q (Qualified) and a retest in 8 weeks recommended in the comment.

It is unusual for resolution to start less than 60 days after the onset of semen changes, and when it does occur, it is common for bulls to display lower semen density or higher proportions of abnormal sperm than prior to the disease.

If the degeneration is severe or the initiating cause is present for a prolonged period, the changes may be irreversible. It is important to note that the prognosis depends on the degree of damage present in the seminiferous tubules and that it is unrelated to the numerical severity of initial changes in the semen.

Bulls diagnosed with testicular degeneration during a BULLCHECK® Exam should not be used for mating in that season and should be reported as “Cross – high risk of reduced fertility”. However, the majority of bulls with mild degeneration do return to normal with time and valuable animals may be worth keeping and retesting. A comment to this effect would be appropriate.

6.3.2. TESTICULAR HYPOPLASIA VS. TESTICULAR DEGENERATION

Testicular hypoplasia is a term sometimes used when one or both testes are smaller than normal for a bull’s age or weight. Technically, in contrast to testicular degeneration, hypoplastic testes have never developed to normal size. It is preferable to use the term “hypoplasia” alone only when it is confirmed histologically as the genetic connotations and associated stigma have in the past attracted the attention of lawyers. It is better to state that the testicle(s) is smaller than acceptable. Caution should be used when making a diagnosis before 2 years of age as further growth is still possible. If unsure, it is recommended that the term “testicular hypoplasia/degeneration” be used.

6.3.3. UNILATERAL HYPOPLASIA/DEGENERATION

The general rule is that one testicle should not differ from the other in size by more than 20%. Often the smaller testicle is abnormal in tone – it can be either abnormally hard or soft.

Diagnosing marginal cases of unilateral hypoplasia/degeneration sometimes presents some difficulties for veterinarians. It is difficult to differentiate size differences less than about 20%. One approach if in doubt about the relative size of the smaller testicle is to palpate using the other hand. Alternatively, measurement of the circumference of each individual testis can be performed. Bulls with unilateral hypoplasia/degeneration are at a high risk of subfertility or infertility, and the condition is unlikely to resolve.

This condition is not uncommon in tropical bulls. When unilateral hypoplasia/degeneration is an inherited or congenital defect, it is almost always the left testis. If the right testis is smaller, even slightly, it is an indicator that careful examination should be conducted to ensure degeneration is not in progress or that there is not some other pathology present.

Figure 11 Examples of testicular hypoplasia/degeneration

6.3.4. BILATERAL TESTICULAR HYPOPLASIA/DEGENERATION

Figure 12 Bilateral hypoplasia/degeneration

Characterised by two small testicles with a scrotal circumference of less than the standards listed in the previous chapter. These conditions have been identified in a number of breeds, are heritable, and have been shown to be an autosomal recessive trait. They are associated with low concentrations of spermatozoa, poor motility and elevated levels of abnormal spermatozoa. Bulls with these conditions are likely to be infertile or sub-fertile.

Bulls with a scrotal circumference that is below the standards but where this is likely to be due to immaturity (i.e. testicles are “normal” for the body weight or age of the animal, but where the bull is too immature for immediate use) should be reported as Q (Qualified) with a comment that the bull should be re-tested prior to use.

6.3.5. ORCHITIS

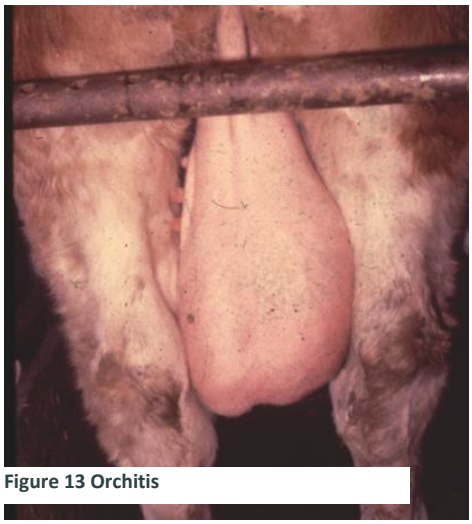


Figure 13 Orchitis

Characterised by testicular enlargement and hardness, orchitis is an infrequent diagnosis in Australian bulls. Orchitis can be a result of haematogenous spread, direct penetration or "ascending" infection.

Brucella abortus and tuberculosis are both known to cause orchitis but have been eradicated from Australia. Except when caused by *B. abortus*, orchitis is generally unilateral. Orchitis presents a serious risk of reduced fertility as the adjacent testicle may suffer thermal injury, and healing, when it occurs, involves fibrosis and calcification. It is not normally possible to salvage a testis that exhibits obvious signs of orchitis. Bulls with orchitis are not suitable for use and should be recorded as X (Cross - high risk).

6.3.6. INGUINAL HERNIA

Figure 14 Inguinal hernia

Inguinal hernias are rare, and easily diagnosed either visually or by palpation. Bulls with inguinal hernias are not suitable for use and should be recorded as X (Cross - high risk).

6.3.7. HAEMATOMA

Figure 15 Hematoma

Haematomas secondary to trauma are an unusual occurrence. They interfere with semen production through thermoregulatory interference and these bulls should be recorded as X (Cross - high risk).

6.3.8. HYDROCOELE

The presence of a distinctly palpable layer of free fluid in the cavity surrounding the testes is not normal and has been associated with internal parasites, inflammation, and other abnormalities. However, a cause is not always identified and it is not invariably associated with poor reproductive outcomes. Hydocoeles may occur unilaterally, most commonly surrounding the left testicle, presumably due to anatomical differences in venous return between the left and right testes. Anecdotally, ACV members have reported reduced sperm quality with hydrocoeles. If all other findings, including sperm morphology, are normal a Q (Qualified) finding is probably appropriate.

6.3.9. CRYPTORCHIDISM

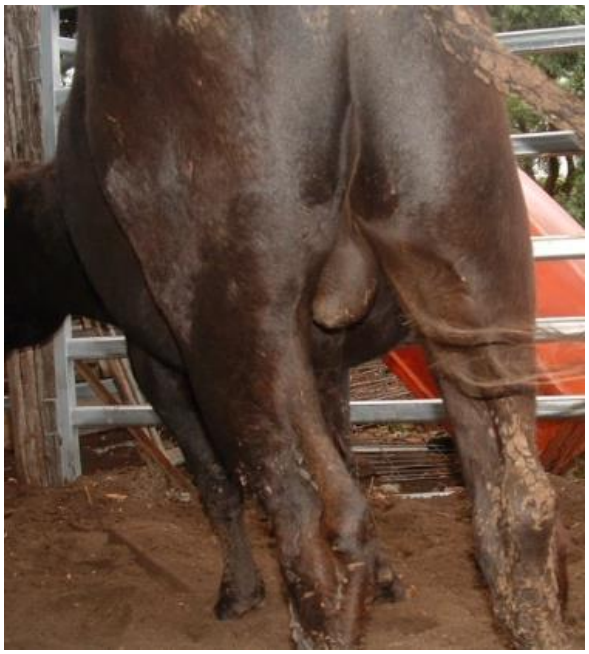


Figure 16 Cryptorchidism

Cryptorchidism is easily diagnosed either visually or by palpation. Cryptorchid bulls are not suitable for use and should be recorded as X (Cross - high risk).

6.4. CONDITIONS OF THE EPIDIDYMIS

6.4.1. EPIDIDYMITIS

Epididymitis, most often unilateral with head or tail involvement, results in varying degrees of fibrosis of the epididymis with loss of function. The condition is often associated with seminal vesiculitis. Lesions can be small and diagnosis requires careful palpation.

Except in the early stages of the disease, antibiotics are likely to be of little value. Bulls with epididymitis should be reported as “cross - high risk” and given a very guarded prognosis.

6.4.2. FAILURE OF DEVELOPMENT

Segmental aplasia of the mesonephric ducts can result in failure to develop all or part of the epididymis. Whilst aplasia of the tail is relatively easy to palpate, it can be more difficult to appreciate problems in the head or body. Bulls show oligospermia if the condition is unilateral or azoospermia if it is bilateral. It should be noted that if sperm are present, they may well be quite normal morphologically, but the bull is likely to have reduced ability to serve large numbers of cows.

6.4.3. SPERMATOCOELE/ SPERM GRANULOMA

Figure 17 Sperm granuloma in the head of the epididymis

A cyst in the epididymis containing sperm (spermatocoele) or a lump where the body has reacted to sperm that has leaked into the tissue (sperm granuloma). Both present as abnormal asymmetric lumps on palpation. These conditions do not respond to treatment and bulls should be reported as “X cross- high risk”.

6.5. CONDITIONS OF SCROTAL SKIN

6.5.1. THICKENING OF SCROTAL SKIN

The scrotal skin should be thin and pliable, although there can be a great variation in consistency of the skin of healthy bulls. Inflammation of the scrotal skin or thickening from past inflammation will interfere with thermoregulation. In many older bulls, thickening of the scrotal skin is not uncommon and is often associated with inflammatory responses as a sequel to conditions such as tick infestation or scrotal mange. Bulls that have been on high-energy diets for prolonged periods may have increased deposition of sub-cutaneous fat, leading to apparent thickening of the scrotal skin that can impair scrotal thermoregulatory capacity and thus testicular function.

6.6. CONDITIONS OF SCROTAL NECK

The scrotal neck should be palpated for enlargements. Possible findings include:

6.6.1. VARICOCELE

Figure 18 Varicocele

A varicocele is dilation and tortuosity of the veins of the pampiniform plexus and cremaster veins. Not uncommon in merino rams, it is unusual in the bull. Affected animals are sterile or severely subfertile due to abnormally high temperatures within the testis and possibly because of the presence of an arterial pulse in the abnormal testicular artery interfering with normal spermatogenesis.

6.6.2. FAT DEPOSITION

Figure 19 Excessive fat deposition

Deposition of excessive fat in overfed bulls: Bulls fed high energy rations during the 'fattening' phase lay down fat in the neck of the scrotum. These bulls may suffer disturbances in sperm development because of increased temperature within the testes.

6.7. STANDARDS AND GUIDELINES – SCROTAL SAC AND CONTENTS

Standard	Scrotal sac & its contents
Recording	Scrotal circumference in cm, measured by a Reliabull tape is recorded as Scrotal circumference Other findings are recorded under HISTORY/PHYSICAL EXAM
Requirements	Scrotal sac and contents shall be assessed by careful palpation of the scrotal sac, testes, epididymis and measurement of the scrotal circumference with a Reliabull tape.
Tick	Scrotum and contents clinically normal Scrotal circumference falls within the normal range OR borderline scrotal circumference with sperm morphology assessed as normal
Qualified	Borderline scrotal circumference without sperm morphology Bull is pre-pubertal Hydrocoele with normal sperm morphology
Cross	An abnormality(s) was detected that is likely to significantly reduce the fertility of the bull in the short-term and/or long-term including but not limited to: Presence of varicocele Excessive fat in scrotal neck Difference in testicular size > 20% Tone score 1 or 5 Testes outside normal range of SC, Orchitis, inguinal hernia, haematoma, cryptorchidism, epididymitis, spermatocele, varicocoele, hydrocoele without normal sperm morphology

6.8. EVALUATION OF THE PENIS AND PREPUCE

Examination of the penis is an essential element of the BULLCHECK® Exam. There are three methods of examining the penis and prepuce:

6.8.1. PALPATION OF THE PENIS AND PREPUCE THROUGH THE SKIN

This examination can be performed by examining the bull from behind (forward to backward movement completely restricted by means of a kick gate or rail placed behind the bull's upper thighs) and palpating forward from the sigmoid flexure along the entire length of the sheath to the preputial orifice. Gross lesions such as penile haematoma will be detected, but many other lesions such as persistent frenulum and penile deviations will not be detected on palpation.

6.8.2. PROTRUSION OF THE PENIS AND INSPECTING IT IN THE EXTENDED POSITION

Protrusion of the penis can be induced in the great majority of bulls if an assistant passes a gloved hand and forearm into the rectum. Relaxation of the retractor penis muscles generally occurs. This facilitates a two-handed action by the operator, pushing the preputial skin back, grasping the penile shaft through the skin between the preputial opening and the scrotum and pulling the shaft forward. While the shaft is then held firmly in that position, the skin of the sheath close to the preputial orifice is pushed back and the protruding glans penis is grasped with the other hand (using cotton gauze to prevent slipping). Protrusion of the penis can also be achieved in some bulls by pushing forward (when positioned behind the bull) on the sigmoid flexure (usually located at the base of the scrotum). While acepromazine administered I.V. is effective in relaxing the penis, routine use other than for fractious bulls is not recommended. Protrusion of the penis frequently occurs during electroejaculation or rectal massage, though this is not consistent, particularly with *Bos indicus* bulls.

For this reason, a diagnosis of erectile dysfunction should not be based purely on the failure to achieve a full erection during electro-ejaculation. The use of an electro-ejaculator to stimulate prolonged exposure of the penis is not recommended.

A pudendal nerve block can be used for cases requiring detailed examination of the penis and minor procedures. Most lesions of the penis and prepuce will be detected but not deviations that are manifest only in the erect state.

6.8.3. EVALUATION OF THE ERECT PENIS DURING SERVING

This allows the structure and function of the penis to be assessed and is the preferred level of examination, since it allows a range of abnormalities to be detected. This method of examination would normally be recorded separately from the physical examination, as part of the serving ability examination.

Bull Reporter allows recording of the penis exam as "Normal Visual", "Normal Palpated" or abnormal. Whilst visual examination is preferred, palpation is acceptable provided this is recorded as such.

The penis can be examined during several elements of a BULLCHECK® Exam including the physical examination, crush side semen evaluation and serving ability testing. For the sake of consistency, common conditions of the penis will be described in this chapter.

6.9. CONDITIONS OF THE PENIS AND PREPUCE

6.9.1. PENILE HEMATOMA (BROKEN PENIS)

Also known as rupture of the corpus cavernosum penis (CCP) and fractured penis, this is the most common injury to the penis of the bull. A rupture of the CCP typically occurs due to a sudden shearing force being applied to the penis during mating. Such injury might occur when a bull with a fully extended penis thrusts without completing intromission, when a cow collapses at the point of ejaculation when the penis is most fully extended and enlarged; or when a bull is charged by another bull at this point. Whilst the rupture is typically as far back as the sigmoid flexure, there is a pooling of blood as a hematoma in a characteristic pre-scrotal position.

Figure 20 Penile hematoma

Figure 21 penile hematoma dissected

Spontaneous healing occurs in some bulls (estimates vary between 10 and 50%). Various authors recommend conservative and surgical techniques. There is general agreement that bulls with this condition will require at least 60 days sexual rest. Bulls with this condition should be reported as high risk, with a guarded prognosis.

6.9.2. FAILURE TO ACHIEVE ERECTION

Figure 22 Failure of erection due to vascular shunts

The CCP needs to be closed system in order for an erection to occur. In pre-pubertal bulls, there are many small veins that drain the CCP into the dorsal vein of the penis. In some bulls these veins do not disappear at puberty. This condition (abnormal venous drainage of the CCP) need to be differentiated from simple immaturity.

There are other rare congenital and acquired conditions, most if not all of which are untreatable. Inability to form an erection in a post pubertal bull is very likely to indicate lifelong infertility.

If there is doubt about the diagnosis, retest the bull. Virgin yearling or two-year-old bulls should not be diagnosed with this condition on the basis of a single serving assessment and they should always be retested. Apparent failure of erection may simply be due to immaturity or lack of experience.

6.9.3. PENILE DEVIATIONS

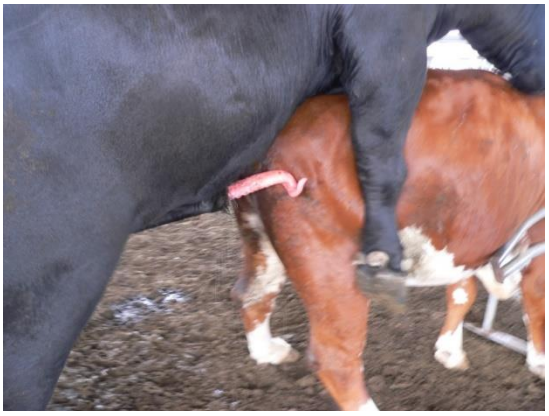


Figure 23 Premature spiral deviation of the penis makes intromission impossible

The two most common types of penile deviations are spiral deviation of the penis (SDP) or corkscrew penis, and ventral deviation of the penis, the latter condition being rare. With ventral deviation of the penis, the free part of the penis curves downwards and prevents intromission occurring. Both conditions are caused by insufficiency of the dorsal apical ligament of the penis and trauma is very rarely involved in their aetiology.

The term PSDP (premature spiral deviation of the penis) has been used commonly to describe this condition but there is no real evidence within the literature that the penis spirals normally within the vagina. This doctrine was based on a single study involving eight related Friesian bulls and using an artificial vagina. Even in this study, spiraling of the penis within the vagina only occurred in approximately 50% of services thus the term spiral deviation of the penis (SDP) is preferred.

SDP has been recorded in most beef and dairy breeds. The condition has been associated with moderate to marked reductions in pregnancy rates, particularly in single-sire mating of affected bulls.

Prior to the development of SDP, (the spiral configuration always being on the right side), some bulls may show poor mating dexterity and mount several times with a straight penis and make repeated short thrusting movements without achieving intromission. In the early stages of the defect, the affected bull may develop premature spiral deviation of the penis intermittently interspersed with normal services. After mounting, SDP may occur within the sheath or on contact with the hindquarters of the female, or most commonly when there is no contact with the female. It is difficult to predict the progression of the condition that may occur either during or over several mating seasons.

Affected bulls invariably develop from mild (where <25% or services exhibit SDP) to moderate (30-70%) to severe (>75%) stages of the disease. This may occur within one mating season or over several seasons. It is uncommon for virgin bulls to have SDP, however, a small percentage of bulls develop it during their first mating season. Most affected bulls develop the defect between 3 and 6 years of age but it is also possible for bulls to first develop it at 7-8 years of age.

Spiraling of the penis is often observed when inducing erection with an electro-ejaculator. Documentary evidence of this being a reliable indicator of spiraling during natural mating is lacking. For this reason, confirmation by serving ability testing is recommended where this is observed.

Culling is recommended for affected bulls as this is believed to be a heritable condition. SDP tends to be a progressive disease and as such bulls with this condition should be reported as X (Cross – High Risk).

6.9.4. PERSISTENT PENILE FRENULUM

Figure 24 Persistent frenulum

Persistent penile frenulum is recorded in some breeds more than others and is regarded as an inherited defect. Affected bulls are unable to fully protrude their penis from the sheath and in most cases cannot achieve intromission. Because of the inherited nature of the defect, surgical correction should not be done in seed-stock bulls. Bulls that have undergone surgical correction should be assessed as Q (Qualified) with a comment noting that the bull is suitable as a terminal sire only.

6.9.5. SHORT RETRACTOR PENIS MUSCLE

The syndrome of short retractor penis muscle is rare. It may occur congenitally as an inherited condition, or may result from atrophy of the retractor penis muscles following injury to the penis or prepuce. Affected bulls have normal libido but during attempted service, the penis is only partially protruded and an ejaculatory thrust is not completed, despite active seeking movements.

Whether due to inadequate length of the RP muscles or the penis itself, inadequate penile protrusion causes inability to mate. As a guide to identification of the condition, a study by Bellinger (1971) indicated that in apparently-normal bulls, the length of the extruded penis measured from the tip of the glans penis to the preputial orifice, ranged from 43 to 58cm while Gilbert RO (1984) found that a presumptive diagnosis could be made if penile protrusion of less than 25 cm could be obtained in an adult bull with a pudendal nerve block.

6.9.6. TRAUMA OF PENIS AND PREPUCE

Figure 25 Hair strangulation of the penis – a good example of the importance of visualising the penis

Traumatic injury to the penis and prepuce is common, particularly in younger bulls. The injuries are varied and can range from slash injuries due to barbed wire or complete amputation of the free end of the penis due to an encircling hair ring.

Preputial lacerations frequently occur in association with mating and usually occur in a longitudinal manner on the ventral aspect of the prepuce (see later). Bulls with traumatic injury to the penis are often detected in a serving assessment because of an obvious painful lesion, haemorrhage from the penis or failure to achieve intromission. Injuries to the prepuce are associated with swelling of the sheath (particularly near the preputial orifice) and/or prolapse of the prepuce.

Injured bulls should be confined in a crush, the penis extended (if possible) and carefully examined. Digital palpation of the preputial cavity may enable detection of tears of the prepuce. Deep injuries involving the dorsal penile nerves and the corpus cavernosum have a grave prognosis.

Penile lesions can affect fertility through functional inability to serve, behavioural effects on libido due to pain, through secondary sperm problems, and through contamination of ejaculate with blood. Bulls with penile or preputial trauma should be reported as Q (Qualified) or X (Cross - high risk) depending on the judgement of the attending veterinarian and a retest recommended. Serving ability testing is strongly recommended in bulls that have a history of penile lesions. Secondary stenosis lesions and damage to the sensory nerves on the dorsal aspect of the penis resulting in an inability to seek and achieve intromission are potential serious consequences.

As a general rule, lacerations that involve only the preputial epithelium and which do not extend into elastic layers may often heal with medical treatment and 30 days sexual rest. More chronic lesions will tend to require surgery and at least 90 days sexual rest.

6.9.7. DORSAL ANALGESIA OF THE PENIS

Figure 26 Bull with dorsal analgesia of the penis, resulting from a previous penile haematoma. Bull failed to achieve intromission when evaluated in two separate tests

Analgesia or loss of sensation of the free part of the penis usually secondary to damage to the dorsal nerves of the penis following laceration or injury to the dorsal area of the free part of the penis. It can also occur as a sequel to surgical removal of a papilloma/frenulum or haematoma of the penis.

After mounting a female in oestrus, affected bulls have an erect penis but fail to locate the vulva. They consistently thrust over the rump or to one side of the rear leg and do not achieve intromission despite repeated mounting activity. Recovery of normal function has occurred after 10 months or more, however, the value of most bulls precludes waiting that long on the off chance that they may recover.

6.9.8. PENILE WARTS

Penile fibropapillomas or warts are common in bulls between 1 and 2 years of age, but rare in bulls 3 years of age and older. The lesions, often multiple in number, are confined to the free part of the penis, particularly the glans penis and may be pedunculated or diffuse. In the latter case a mass of wart tissue usually encircles the glans penis resulting in analgesia of the penis and failure to achieve intromission.

Penile warts are detected by manual examination of the penis or during a serving assessment. The prognosis for penile warts is good and many cases will recover spontaneously. When surgical treatment is used, treated bulls should be monitored and closely examined prior to the next mating season or prior to sale as warts can re-occur within 1-2 months of treatment.

As warts are a viral disease that can be spread sexually, bulls should be considered unsuitable for mating (and a biosecurity risk) until they are healed.

Figure 27 Penile warts

6.9.9. BALANITIS, POSTHITIS AND BALANOPOSTHITIS

Balanitis refers to inflammation of the penis; posthitis to inflammation of the prepuce; and balanoposthitis to inflammation of both penis and prepuce. Very commonly inflammation is associated with infection in these conditions. Penile infections are relatively common, particularly in young bulls. A range of bacterial, viral and other organisms can be involved, the most common being the genital form of bovine herpesvirus type 1 (BoHV-1) virus.

Mild cases may heal spontaneously but there is considerable risk of penile or preputial scarring in more severe cases, leading to adhesions. The effectiveness of the respiratory herpesvirus vaccines against the genital forms of the disease is at the time of writing not understood. Given the potential infectious nature of balanoposthitis, and the risk of spread to other bulls and cows (particularly in naïve herds) it is recommended that this condition be reported as X (Cross - high risk).

Figure 28 Acute balanitis

Figure 29 Penile ulcers that may lead to adhesions

Figure 30 Ulcerative posthitis, caused by C. renale is occasionally seen in bulls and is often associated with high protein diets

6.9.10. PREPUCE STENOSIS (PHIMOSIS)

Prepuce stenosis is common in all breeds of bulls. It has a high prevalence in *Bos indicus* and polled *Bos taurus* bulls because of the predisposing factors noted in the previous sections, and follows injury and infection of the internal lamina of the prepuce at mating.

Figure 31 Early ulcerated injury on the internal lamina of the prepuce in a 2-year-old Angus bull as a result of mating activity

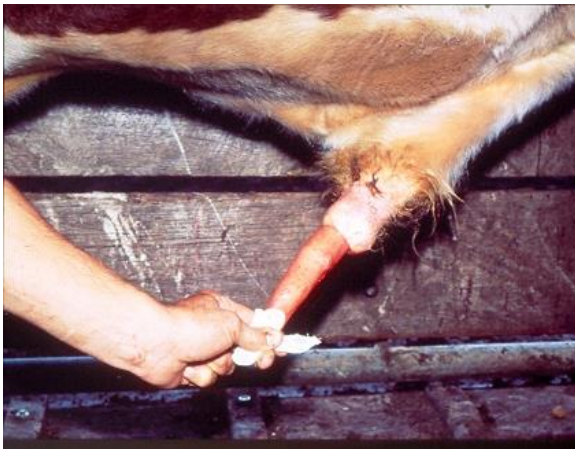


Figure 32 Long term ring stenosis of the prepuce which now prevents full extrusion of the penis. The defect was first noticed during a serving assessment test.

Avulsion or tearing of the prepuce usually starts at the ventral raphe where the internal lamina of the prepuce forms the fornix as it reflects onto the free portion of the penis. In severe cases, the inflammation and infection causes the penis to contract into a granulosed spiral configuration, often call a 'club penis' which may result in paraphimosis of the penis, leading to a very poor prognosis.

Figure 33 Aftermath of avulsion of the prepuce.
The free portion of the penis has contracted into a granulosed spiral configuration or "club" penis

6.10. EVALUATION OF THE SHEATH AND UMBILICUS

6.10.1. DEFINITIONS

The following definitions are used in the BULLCHECK® Sheath Scoring Method:

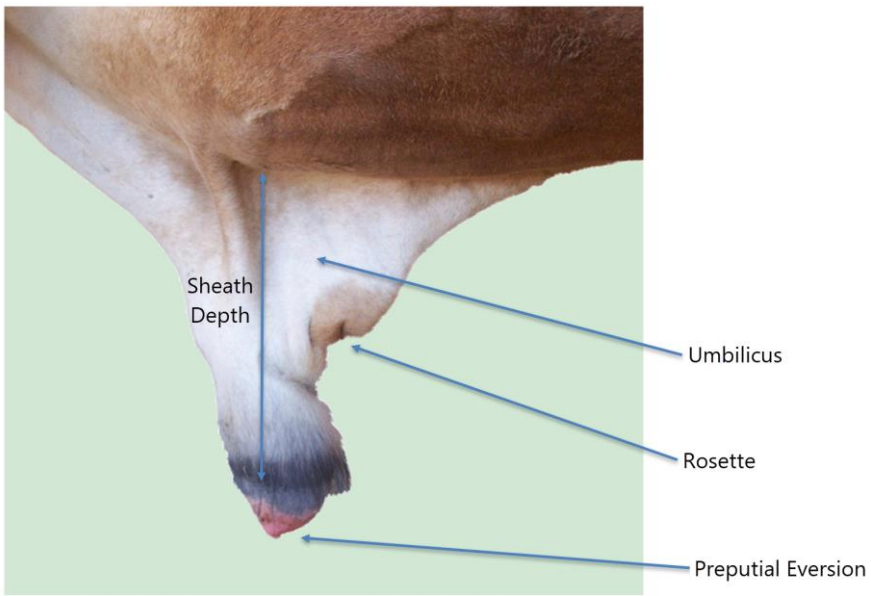


Figure 34 Illustration of sheath structures and measurements

Sheath: external hair covered appendage between the scrotum and umbilicus.

Prepuce: mucosa within the sheath

Umbilicus / Umbilical cord: remnant of the umbilical blood vessels surrounded by the skin through which it passes to the abdominal wall and the external umbilical scar or navel.

Evaluation of the prepuce is particularly important in *Bos indicus* and *Bos indicus*-derived bulls, where poor sheath structure is often associated with trauma and preputial pathology.

6.10.2. A REVISED SCORING SYSTEM FOR 2021

Several methods of sheath scoring have been described, based mostly on sheath depth and angle. Some confusion has existed because the ACV method of sheath scoring (1-5 scale, where 1 indicates a tight sheath) and the Breedplan method (1-9 scale, where 9 indicates a tight sheath) used scores which ran in different directions.

After some consideration, ACV has elected to introduce a new scoring scheme, developed by Michael McGowan and John Bertram which separately assess the sheath depth, umbilicus and preputial eversion to be known as the DUE Sheath Score (Depth, Umbilicus, Eversion).

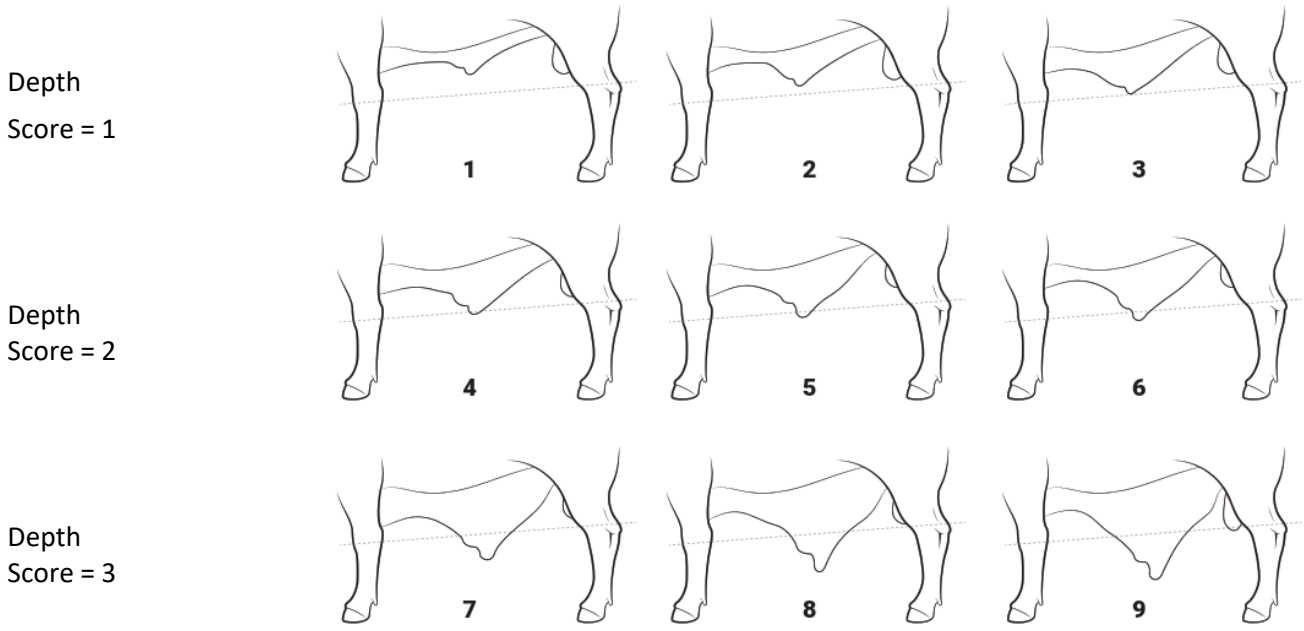
This assessment should be done when the bull is standing freely in the race leading up to the crush, or in a small holding yard and by palpation during the clinical examination in the crush. It consists of visual assessment of sheath depth and conformation, conformation and size of the umbilicus and degree of preputial eversion.

Previously used sheath scores did not take into account the latter two components of the examination which have been shown to affect mating ability, risk of preputial prolapse, and risk of umbilical hernias in progeny.

Further, it should be noted that in Brahman and tropical composite bulls both sheath score and estimated length of everted prepuce at 18 months of age are moderately heritable (heritability of 0.23 to 0.35).

6.10.3. SHEATH DEPTH

The below scoring system is an adaptation of the original Breedplan and ACV scoring systems:



1 = Breedplan (reversed) score 1, 2, 3 i.e. tight to small sheaths all above the 'knee-hock' line The sheath depth (vertical distance from the abdominal wall to the preputial orifice) is estimated to be less than 15cm with sheath angle less than 30° to the horizontal. Bulls with this sheath score are considered to have good to satisfactory sheath conformation.

2 = Breedplan (reversed) score 4, 5, 6 i.e. moderate size sheaths with the preputial orifice either on or just below the 'knee-hock' line up to level of the umbilicus. The sheath depth is estimated to be 15cm to 20cm with sheath angle 30° to 45° to the horizontal. Bulls with a sheath depth of 20cm and sheath angle of 45° are considered to have questionable sheath conformation.

3 = Breedplan (reversed) score 7, 8, 9 i.e. excessively pendulous sheaths with the preputial orifice very obviously below the 'knee-hock' line. The sheath depth is estimated to be >20cm with sheath angle >45° to the horizontal. Bulls with this sheath score are considered to have unacceptable sheath conformation due

to increased risk of preputial prolapse, particularly for bulls that also have a score of 3 for preputial eversion (see below).

Assessing sheath depth

Actual

Knee-hock line

6.10.4. UMBILICUS

The umbilicus is located immediately in front of the preputial orifice and is best visually assessed immediately after semen collection or while the bull is standing freely in the race before the crush or in a holding yard. If required the umbilicus can be palpated while the electroejaculator probe is in position with application of low-level stimulus. Excessive thickening of the umbilical cord and surrounding tissue ('rosette'), collectively known as the umbilicus or 'navel' are indicative of either a resolved umbilical hernia or umbilical infection; both are associated and the former is heritable. The umbilical cord and rosette are scored as follows:

1 = not detectable or small rosette (< 2cm in width i.e less than one finger width) and thin umbilical cord (<1cm in diameter). These bulls are considered to have a normal umbilicus.

2 = moderate size rosette (2 – 6cm in width, one to two finger width), umbilical cord 1-2cm in diameter. Bulls with a rosette estimated to be 5-6cm in width and an umbilical cord estimated to be 2cm in diameter are considered to have questionable umbilicus conformation.

3 = large rosette (>6cm in width i.e greater than 2 finger width) and umbilical cord >2cm. These bulls are considered to have unacceptable umbilicus conformation due to likely negative impact on mating ability (increased mass of tissue immediately in front of the preputial orifice interferes with intromission).

6.10.5. PREPUTIAL EVERSION

Eversion refers to preputial membrane which hangs from the preputial opening involuntarily but is readily pulled back into the sheath when the bull is walking or in response to a tactile stimulus. The degree of eversion of the prepuce should only be assessed while the bull is standing freely in the race before the crush or in a holding yard. The length of everted prepuce is only estimated for those bulls in which it is persistently everted. The length everted can be estimated in hand-widths (i.e 10cm) and is scored as follows:

1 = no eversion. These bulls are considered to have a low risk of preputial injury except in bulls with a sheath depth score of 3 (see above).

2 = prepuce everted less than one hand-width. Bulls estimated to have one hand-width of prepuce persistently everted are considered to have a marginally increased risk of preputial injury.

3 = prepuce everted greater than one hand-width. Bulls with this score are considered to be at increased risk of preputial injury and hence increased risk of preputial prolapse.

Figure 35 Brahman bull with mild eversion

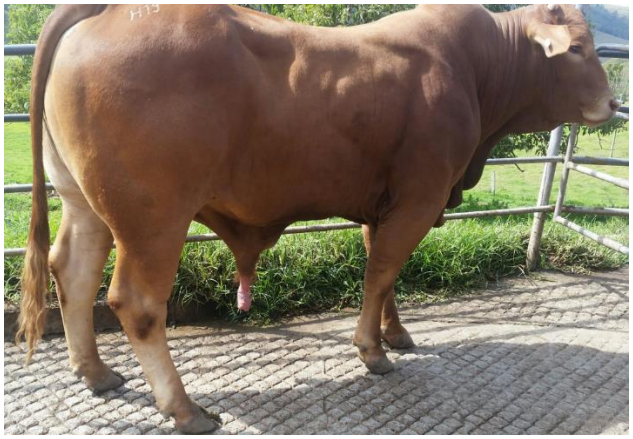


Figure 36 Severe eversion – more than a hand width

Figure 37 Prolapse of the prepuce can progress to the point where it prevents mating

6.10.6. REPORTING THE DUE SHEATH SCORE

The score is reported as D/U/E where D=sheath depth, U=Umbilicus size, E=Preputial eversion, and all are numbers 1-3 representing a Normal, Mild, or Severe effect as described above.

Sheath score 1, 1, 1

Sheath score 2, 2, 2

6.10.7. PREPUTIAL INJURIES

The sheath, particularly the prepuce, is prone to injuries and inflammation as a consequence of insults to itself or surrounding structures such as the penis. The risk of injury is increased when the anatomical factors listed above are present but morbidity is not limited to bulls with poor conformation.

The common pathologies are:

Infection - The sheath is prone to infection as a sequel to injuries, haemorrhage or other insults. The most common causes are penetrating injuries at the sheath opening as a result of eversion, penetrating injuries along the length of the lamina as it is stretched over the erect penis during breeding, and tearing away of the remnants of the attachment between the penis and lamina interna during breeding attempts, most commonly associated with semen collection using an artificial vagina.

Unless identified and treated early, infection commonly results in chronic-active inflammation which can result in excessive scar tissue formation, adhesions or abscessation.

Prolapse – Preputial prolapse is a common sequel to infection, injuries and urethral rupture. Unless treated effectively, fibrous tissue formation can result in permanent damage, requiring surgery.

Stenosis - Narrowing of the cavity can result from injuries and uncontrolled inflammation, preventing extrusion of the penis and, when severe, causing damming back of urine and further inflammation. By the time this is diagnosed surgery is generally inevitable.

Adhesions - Inflammation stretching across layers of loose connective tissue underlying the lamina interna can result in the formation of inflexible scar tissue which limits the mobility of the penis and sheath. Once formed, the prognosis is poor.

Any history of surgery must be noted on the certificate.

6.11. EVALUATION OF THE ACCESSORY GLANDS

These include the vesicular glands (commonly referred to as seminal vesicles), prostate, bulbourethral glands and ampullae – the enlarged dorsal termination of the ductus deferens.

The vesicular glands, prostate and ampullae can be assessed by per-rectal palpation, noting size, symmetry and consistency.

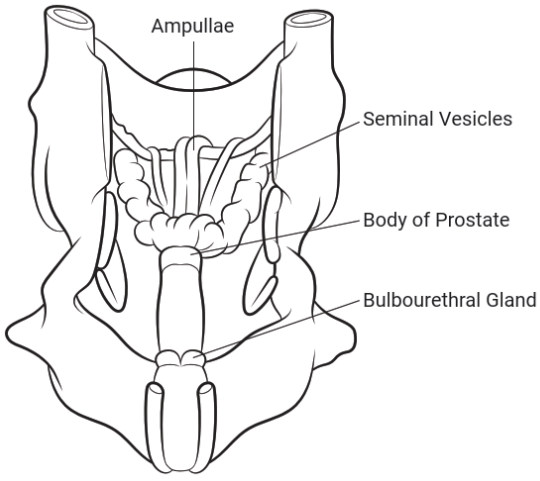


Figure 38 Dorsal view of accessory glands in the bull

In the bull, the most common abnormalities diagnosed involve the vesicular glands and to a lesser degree the ampullae. These disorders may be congenital, and possibly inherited as in the case of so-called segmental aplasia of mesonephric duct derivatives, or be inflammatory such as in accessory genital disease (eg. seminal vesiculitis).

6.11.1. SEMINAL VESICULITIS

Seminal vesiculitis usually presents as an acute condition in young bulls with swelling of the glands, loss of lobulation, pain responses on palpation or insertion of the electroejaculator probe, and pus cells or flocculant material in the ejaculate commonly noted. In older bulls, a chronic syndrome of sclerosing inflammation with gland enlargement, loss of mobility due to adhesions and loss of lobulation is most often seen. In a north Australian study the overall incidence of seminal vesiculitis was 9% with the chronic and sclerosing infection of older bulls the main manifestation. Reports from North American herds suggest a range of 0.85% to 10%. However, an individual herd prevalence as high as 49% has been reported.

Various infectious agents including viruses, chlamydia, a range of bacterial agents, fungi, and even *T. foetus* have been isolated from inflamed vesicular glands but the pathogenesis is unclear. Chronic cases are often bacterially negative. Infection of the vesicular glands may occur by ascending or descending infection and is often seen as an acute syndrome in young bulls on feed exhibiting mounting behaviour. Seminal vesiculitis can cause a reduction in semen quality, but effects on fertility appear variable. Depending on the causative agent, treatment results may not be satisfactory. Affected bulls are often culled prematurely when in fact recovery is common. In recent times, a single injection of long acting tulathromycin (Draxxin® Pfizer) has been reported as useful by some veterinarians.

In the case of pre-sale examinations or examinations for insurance purposes, it is recommended that examination of the accessory glands be undertaken and recorded. Cases where there are large number of pus cells in the semen, changes in sperm morphology, or where there is obvious acute infection that may progress (as evidenced by pain on palpation) should be assessed as Q (Qualified) or X (Cross-high risk), along with appropriate comments.

6.12. STANDARDS AND GUIDELINES – REPRODUCTIVE ORGANS

Standard	Evaluation of the penis, prepuce, sheath & accessory sex glands
Recording	This Standard is recorded as part of the HISTORY/PHYSICAL EXAM.
Requirements	The penis and prepuce shall be carefully examined by visualisation. If visualisation of the extended penis is not possible, palpation is acceptable but this must be recorded on the certificate. Accessory sex glands must be evaluated by gentle palpation. Sheath scoring is non-essential but strongly recommended in Bos indicus breeds.
Tick	Penis, prepuce and accessory sex glands are anatomically normal.
Qualified	Previous penile/preputial injury that has healed and determined functional Presence of mild disease in the accessory sex glands DUE Sheath Score of 2 for Depth, Umbilicus or Eversion
Cross	An abnormality(s) was detected that is likely to significantly reduce the fertility of the bull in the short-term and/or long-term including but not limited to: Penile haematoma, penile deviation, short retractor penis muscle, irreparable penile or preputial trauma, penile warts, balanoposthitis, phimosis, failure to achieve erection and significant or progressive disease of the accessory sex glands. Presence of a persistent frenulum, even if surgically corrected. DUE Sheath Score of 3 for Depth, Umbilicus or Eversion

7. SERVING ABILITY ASSESSMENT

A critical component of reproductive efficiency of a bull is libido and serving ability.

Serving ability testing has not been shown to be useful for genetic improvement based on the number of serves undertaken in a test, but may be useful to identify bulls where there are potential mating ability problems or in the investigation of bull fertility problems.

7.1.1. WELFARE

Serving ability testing presents animal welfare and ethical challenges because of the use of restrained females. There are also risks associated with potential transmission of venereal disease. The best way to ensure that bulls are serving cows effectively is for producers to observe this during the mating period. As such, it is recommended that serving ability testing be undertaken only when there are identified increased risks that serving ability may be affected, or where it is not possible (for example because of farm size) to adequately observe bulls during the mating period.

7.1.2. REQUIREMENTS FOR SERVING ASSESSMENT

7.1.2.1. INFRASTRUCTURE

The restraint of females in crates results in more mounts and serves by bulls. In addition, restricting movement of females improves opportunity for closer observation of bulls for penile and musculoskeletal abnormalities.

An appropriate test yard has sound yard construction, the opportunity for multiple crates to be used, and access to the crush and race, as well as entry and exit gates for bulls. Pre-assessment, bulls should have clear vision of the females and bulls in the test yard to enable adequate sexual stimulation and to enable the person responsible for the assessment to identify and select adequately stimulated bulls. An adjacent yard is required in which to place re-test bulls and should be easily accessible to recall bulls as required.

The service crates used for the assessment must be designed to restrain previously unhandled females. An appropriate design and dimensions are shown in Figure 47. The ground surface must be firm and not slippery, and females must be standing at the same level as the bulls. Slippery concrete, deep mud, or soft sand are unsuitable. The crates must be firmly secured to the yard structure and placed 5-7 metres apart to minimise between-bull interactions.

Crates should not be sited directly opposite each other in a narrow test yard. Experience indicates that a series of up to 4 crates along one or two sides of the yard is ideal. Bull interference can be minimised if sufficient space is provided for the bulls. Conversely, using an excessively large yard often results in ineffective recording of mating behaviours and difficulty for positioning by the recorder to observe penile structure and musculoskeletal adequacies.

7.1.2.2. SUITABLE FEMALES

The oestrous status of restrained females generally has no significant effect on bull mating behaviour in either tropically-adapted or British-bred bulls, though it is suggested that yearling bulls may mate more readily with oestrous females. When using unrestrained females it is essential to have oestrous females for the duration of the test.

Females used in the test should have a quiet temperament, be non-pregnant or early pregnant, preferably not smaller than 75% of the weight of the bulls being assessed, and in at least body Condition score 3 to 4 (out of 5). Females that have been trained to a halter, and which can be tethered and lead are superior to untrained females. Using females vaccinated against campylobacterosis (vibriosis) is also recommended.

7.1.2.3. NUMBERS OF FEMALES

The number of females available for use during the test should be equal to about half the number of bulls; less females may be required for use with yearling age bulls. Preference has been expressed for polled or dehorned females. All females are not usually required but it reduces the possibility of over-usage of females. Some females are served more frequently than others and when this occurs they should be replaced as soon as practical if showing signs of stress.

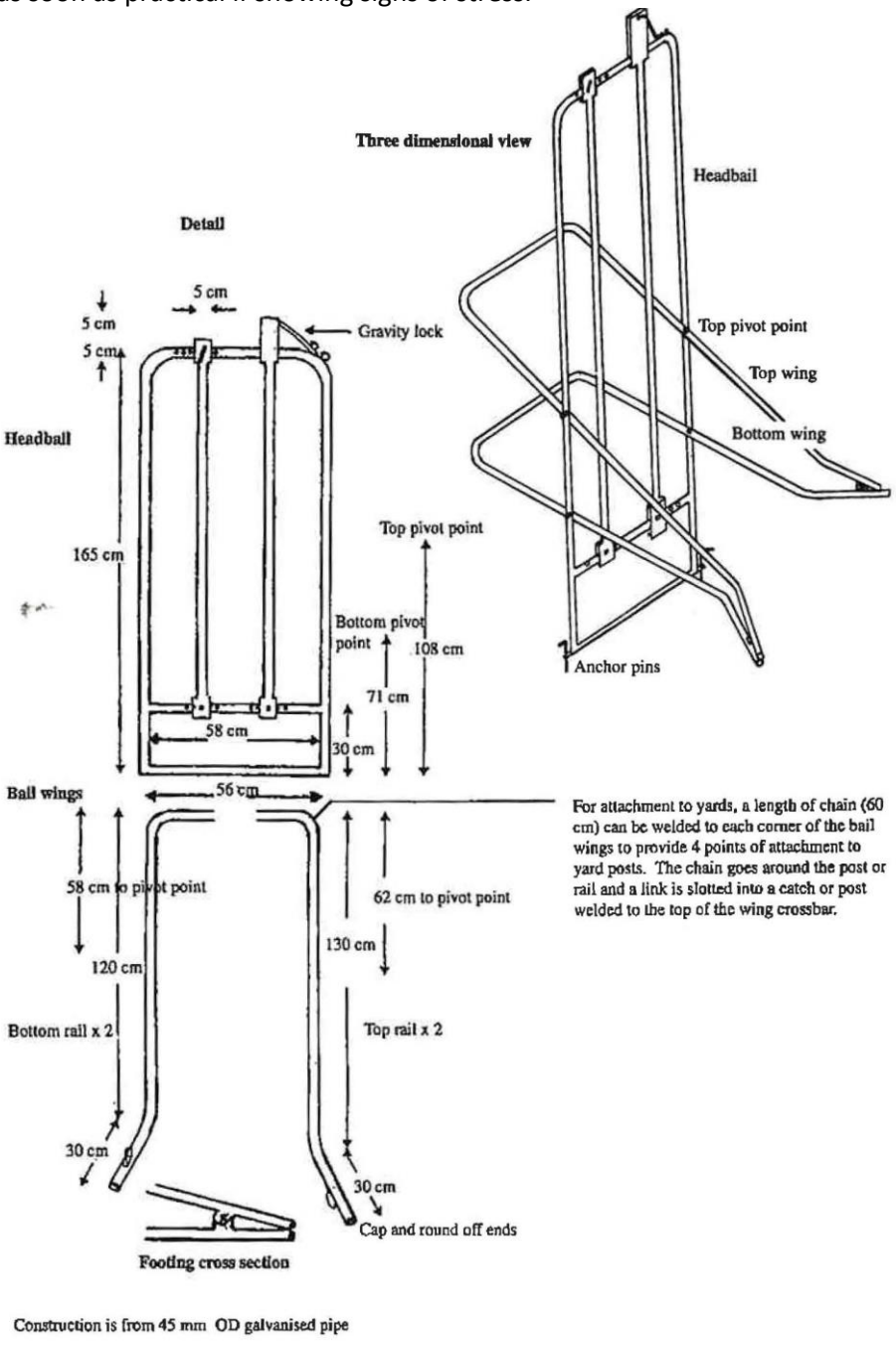


Figure 39 Design for a Serving Assessment crate

7.1.3. STANDARD PROCEDURES

Consistent method should be used so that interpretations are minimally influenced by site, bull origin, time and date of test and other factors, thus enabling valid comparisons to be made. Young *Bos indicus*-content bulls with no mating experience need to be held with cyclic females (e.g., as few as one female per two bulls) for at least 24 hours prior to assessment. The following is a guide to conducting a standard assessment:

- Place females in a yard adjacent to the bulls about to enter the test yard.
- Place an experienced bull or bulls with the females to initiate mounting activity and identify potential oestrous females that will be marked with seminal fluid on the hindquarters in readiness for use in the assessment. This tends to reduce inconsistencies during the assessment. An alternative to this is to use experienced bulls to serve each heifer after crating, or to smear a few mls of semen collected during crush side evaluation over the perineum of each female.
- Keep the pre-assessment bulls in close proximity to test females to maximise stimulation.
- When crating females, halter them in a crush or race, attach an extra longer rope (e.g., up to 15m) to the halter and allow her to move freely to the test yard. Pass the free end of the rope through the head bail and draw the female into the bail.
- Once in the bail, disconnect the long rope and tie the short halter rope to the yard rail to restrict the female from either lying down or lurching forward. This may not be required for *Bos taurus* females.
- For bulls about 2 years of age, use up to one more bull than the number of females during assessment. For older bulls use the same number or less bulls than females.
- Assess bulls together which are of a similar age and that have been grazed in an established social group to minimise fighting and other antagonistic behaviour.
- If fresh semen is available, pour 10-20 mL of diluted semen over the tail head and sacral region of each female to provide olfactory stimulation prior to the first group of bulls and encourage early commencement of mating behaviours.
- All females used in the assessment must have 20-50 mL of obstetrical lubricant (methyl cellulose with 1% chlorhexidine) applied over the vulva and infused into the vagina before the assessment is commenced.
- The recorder must be in the yard with the bulls to exert control as needed and to move bulls in/out, progressively around the females and maintain a close monitor of bull and female welfare.
- Move the first group of bulls into the test yard; these are used to stimulate the remainder of the bulls. If mounting does not start within 10-15 minutes, replace these bulls or add more bulls. If the first group of bulls do not demonstrate mating behaviour, return these to the group awaiting assessment.
- Once mounting of the females has commenced, start assessment using bulls that are 'obviously stimulated' and eager to enter the test yard.
- Move the bulls from one female to another following a mount or service.
- Keep fighting to a minimum by separating bulls that show any signs of aggression toward others.
- Any bull displaying poor temperament should either be not tested or removed from the test group as soon as this is evident to avoid injury to both assessor and test females. These bulls can be retested on their own at the end of the test, if the information is considered vital.
- Remove each bull from the assessment when a bull has served a maximum of 3 times or if the set time for assessment (10 min for *Bos taurus,* 20 min for others) has elapsed, whichever is sooner; start timing from when each bull mounts (*Bos indicus*) and or serves (*Bos taurus*) a female.
- Yearling *Bos taurus* bulls may be allowed to serve up to 5 times, and the assessment period may be extended to a maximum of 20 minutes if data is required to rank them for genetic merit analyses.
- Monitor females and replace any that are distressed, straining, or will not stand in the crate, even prior to commencing the assessment. Replace females after they have received a maximum of 20 serves.
- If any female is injured, administer veterinary treatment as needed and the animal must then be removed from the crate and excluded from further assessments.
- Avoid replacing more than a half of the females at each change.

- Observe all bulls closely during each service from the right (off) side if possible to observe for spiral deviations of the penis.
- Dominant bulls should be sufficiently removed from the test yard so that they are unable to influence the behaviour of other bulls during assessment.
- Bulls that have been assessed should be moved well away from the test yard.
- If oestrous females are used in the assessment and are needed for subsequent assessments, any potential pregnancy should be terminated.
- Monitor heifers for several days after use and administer veterinary care for any injuries. Do not sell these heifers for at least 4 weeks after use.

Figure 40 a restrained heifer

7.1.4. RECORDING

Standard recording includes:

- I: Interest - number of times a bull expressed sexual interest, e.g., nose curling, licking, and false mount of a restrained female.
- M: Mounts - number of full mounts by a bull, but not including those when a serve occurs. The penis may not be observed in some tropically-adapted bulls.
- S: Serves - number of effective mounts with intromission, ejaculatory thrust, and dismount with an erect penis.

An example serving assessment recording for a bull may be: [Bull ID] [Start time] I M I S I I M M M S. A bull that qualifies for a re-test or that may be considered sub-fertile could be described as: I I I I M.

Observed abnormalities are recorded in comments. The bull should be observed for penile erection, direction, protrusion, shape, and rigidity along with focus and ejaculatory thrust. Simultaneously, observe the musculo-skeletal function of the bull with particular attention to the back, and to stifle and hock weaknesses that limit the effective mating behaviour of the bull. During the test, abbreviations often used to expedite the procedure include:

- C: Spiral deviation of the penis (SDP or Corkscrew penis)
- V: Ventral deviation of the free end of the penis
- RF: Retained Frenulum
- A: Other abnormalities

SDP is frequently identified when using the electroejaculator for semen evaluation. Any evidence of a SDP at this stage should be complemented with a mating behaviour test. However, age of the bull will frequently influence the evidence of this abnormality. Recent studies of penile abnormalities suggest that SDP was by far and away the most common abnormality affecting the mating ability/capacity of bulls detected by veterinarians and researchers. It was rarely detected in young bulls (1- to 2-year olds) but across breeds 8.2% (n=939) of 3- to 6-year old and 18.4% (n=179) of >6-year old bulls were diagnosed with SDP.

7.1.5. INTERPRETATION

A bull showing no or little interest in the test females may be insufficiently stimulated, be inhibited by external factors such as a dominant bull, suffering a physical condition (such as a penile injury or systemic illness), or of low libido. Re-assessment of such bulls should be conducted with a different group of bulls or at the end of assessment.

Some penile conditions are not fully expressed in bulls until 4-5 years of age, and some bulls need up to 4 serves before demonstrating SDP. Some musculoskeletal disorders can only be defined by a thorough physical examination in association with a quantitative serving assessment when the bull is placed under a more strenuous mating load (compared with a basic mating behaviour assessment).

There is wide variation in behaviours expressed during serving ability assessment. Average trends for mating behaviour that have been noted during research include:

- Young, sexually inexperienced bulls may achieve fewer serves than sexually-mature bulls in a quantitative assessment.
- As bulls increase in age up to 3 years, the number of serves achieved will tend to increase whilst the relative number of mounts will tend to decrease.
- At the same age, British-breed bulls serve more than Belmont Red bulls which in turn serve more than *Bos indicus* bulls.
- Expression of mating behaviours is more repeatable when using restrained rather than unrestrained females. Repeatability appears high in *Bos taurus* bulls; *in Bos indicus*-content bulls it is higher if the interval between tests is short.

Yearling tropically adapted genotypes frequently demonstrate similar and more mounts than 2yr-old bulls, but achieve relatively fewer serves. As they increase in age, the numbers of mounts often decrease and are complimented by an increase in the number of serves.

One system for quantitative assessment used for *Bos taurus* bulls is:

Table 4 A quantitative system used for serving ability assessment in *Bos taurus* bulls

Rank	Serves
Very High:	3 within 5 minutes
High:	3 within 10 minutes
Moderate:	2 within 10 minutes
Low:	1 within 10 minutes
Doubtful or Unsatisfactory (rare):	0 within 10 minutes

Within the tropically adapted genotypes, the northern studies were unable to identify any relationship between quantitative measures and mean mating to conception intervals amongst bulls of varying libido.

Bull Reporter provides for several mating ability procedures to be recorded which include:

- **Number of Interests recorded**. Details of the number of interests, flehmen displayed by the bull.
- **Number of Mounts recorded**. Details of number of mounts achieved in the test period.
- **Number of Serves recorded**. Details of the number of serves recorded.
- **Penis**. This allows for the initial recording of Normal / Abnormal penile condition. Any abnormality should be complimented with detailed comments of the observed condition.
- **Musculoskeletal Function**. This facility provided for Normal / Abnormal function of each bull. Specific attention should be paid to bulls standing both too far behind and too close to the females being mated. Attention to spinal flexibility, penile focus and mating dexterity.
- **Restrained Females**. This record enables documentation of the basis of the test – restrained or unrestrained females.
- **Oestrous Females**. This record identifies whether the females used in the test were in oestrus at the time of the test.
- **Females used in the test**. This is the number of females restrained in 'crates' in each test for the purpose of mating ability tests of bulls
- **Bulls used in each test**. This is the number of bulls used within each test group.

7.2. STANDARDS AND GUIDELINES – SERVING ABILITY

Standard	Serving ability
Recording	This is recorded under SERVING ABILITY
Requirements	The bull is assessed in facilities that enable a clear view of serving ability
Tick	Normal penis. Normal musculoskeletal function. No other observed attributes that may limit the ability of the bull to mate naturally. At least one serve within 10 minutes for Bos taurus bulls and within 20 minutes for Bos indicus bulls, respectively.
Qualified	Serving ability that falls below one serve within 10 minutes for Bos taurus bulls and within 20 minutes for Bos indicus bulls, respectively.
Cross	An abnormality(s) was detected that is likely to significantly reduce the fertility of the bull in the short-term and/or long-term including but not limited to: Presence of penile or preputial abnormality that prevent natural mating. Failure of bull to serve female, musculoskeletal/neurological problem.

8. CRUSH-SIDE SEMEN EVALUATION

Collection of a representative sample of semen, its visual and microscopic assessment and its evaluation against a set of minimum threshold standards for several traits are integral parts of the BULLCHECK® Exam process. The following sections provide guidelines, suggestions and recommendations for the collection, handling, and crush-side evaluation of semen samples from herd bulls.

8.1. TECHNIQUE

There is general consensus on the most appropriate techniques available to collect semen from the bull:

- electroejaculation (EE)
- per-rectal massage (RM)
- artificial vagina (AV)

The choice of collection method will depend on the clinical circumstances, the background under which bulls are managed and the veterinarian's familiarity with, and confidence in the method. Electroejaculation and per rectal massage are the methods most often employed outside specialized semen collection facilities.

An accurate estimate of spermatozoa concentration and total number of spermatozoa in an ejaculate can be determined for bulls which have undergone routine semen collections by AV. Semen collected from bulls by EE and RM varies considerably in spermatozoal concentration and total numbers due to differences in response of individual bulls and variations in semen collection technique. However, if a bull is regularly collected and a complete ejaculate is obtained with EE, total sperm per ejaculate can be similar to that collected with an AV. Where a sample collected by EE or RM has, irrespective of volume and density, good motility and satisfactory levels of morphologically normal spermatozoa this is good evidence for normal testicular and epididymal function.

8.1.1. ARTIFICIAL VAGINA

AV semen collection is used commonly in artificial insemination centres. It is recognised that collection using an AV allows evaluation of a natural and usually good quality ejaculate, and also has the advantage of enabling an assessment of mating ability to be made. AV collections are generally much denser than samples collected by other methods. However, the practical reality is that for the vast majority of naturally mated (and usually unhandled) beef and dairy bulls, AV collection is not a feasible or safe option.

8.1.2. ELECTROEJACULATION

In most field situations semen collection is usually only possible using either EE or RM techniques. Where large numbers of bulls are to be collected, unless the operator is very skilled in the technique, RM becomes impractical, but is a useful adjunct to EE.

The technique of EE involves the application of low-level electrical stimulation in the form of a modified sine wave to selectively stimulate the nerves responsible for emission and ejaculation. Voltage is increased in a rhythmic and stepwise fashion until the ejaculatory threshold level is reached.

In a very high proportion (>95%) of bulls examined, a satisfactory semen sample can be collected by EE with relatively little stress on the bull. Poor semen samples can be the result of poor collection technique, extended sexual inactivity (eg. testing bulls prior to the breeding season in a controlled mated herd) or contamination (especially urine). Where it is suspected that the poor semen quality is as a result of collection technique, three attempts should be made before and evaluated before a bull is awarded a X (Cross) or deferred for testing on another occasion.

Where the collection technique fails to produce an ejaculate suitable for evaluation, an additional sample may be collected within about 5 minutes by EE. Alternatively, the bull may be drafted off and a collection attempted again at the end of the run of other bulls being collected.

Ejaculates often improve on subsequent collections - particularly after periods of prolonged sexual rest. The syndrome is variously known as 'rusty load', 'stale ejaculate', or 'accumulated semen'. The ejaculate is very poorly motile, is often of dense concentration, and has a variable proportion of morphologically normal sperm.

Individual bulls vary in their response to EE. However, the following protocol is recommended:

1. Good restraint and non-slip flooring during electroejaculation is necessary.
2. The use of tranquilizers to assist restraint and/or reduce pain is not recommended, as many tranquilized bulls are more difficult to collect, or may lie down or urinate during the collection process.
3. For best results use the largest rectal probe size that the bull will comfortably accommodate.
4. Ensure the probe electrodes are free of tarnish and have been cleaned with a light scourer (If it's not shiny, it may not work).
5. A per-rectal examination and assessment of the internal genitalia should be undertaken prior to EE. The ampullae and pelvic urethra (but not the vesicular glands) can also be massaged, which assists collection.
6. Lubricate the probe well before insertion, and ensure there is no ballooning of the rectum. Lubricant is very important if the faeces are of dry consistency.
7. The probe should be held in place at least until the bull is feeling the stimulation as it can be easily ejected when the bull strains.
8. Many modern EE machines have built in pre-programmed cycles that induce ejaculation.
9. Where manual control of voltage is required, commence stimulation at the lowest power setting. Take the rate up slowly until the bull can be seen to react to the stimulation and then drop back to zero, progressively increasing the voltage. There is a great deal of individual variation in the response of bulls to electroejaculation, but as a general rule, larger bulls require larger voltages before ejaculation occurs. Bos indicus cattle tend to be more sensitive to the procedure and so both frequency of stimulation and maximum voltage reached often have to be less than with Bos taurus animals if recumbency is to be avoided. Bulls with acute seminal vesiculitis also tend to be very sensitive to the stimulation.
10. Erection is most often achieved if the frequency of stimulation is fairly high and applied in a rhythmic fashion. Again, there is a lot of variation, but the aim is to get the bull rocking back and forth (stimulation for approx. 2 sec. and then a break for approx. 1-2 sec). This technique is suitable for most British breeds.
11. Many Bos indicus bulls will not tolerate high frequency stimulation and so the objective of achieving an erection is forgone to ensure the bull remains standing. With these animals, stimulation for approx. 2 sec followed by a 3-5 sec break usually leads to a trouble-free collection although semen will receive some contamination on its passage through the prepuce. Clipping the preputial hairs prior to collection is desirable in these circumstances.
12. Heavy sheaths in some Bos indicus bulls may be retracted manually during periods of stimulation to visualise the penis.
13. Semen is collected by the operator or assistant crouching beside the bull and holding a collection vessel over the penis during ejaculation. The person collecting the semen should crouch beside the front legs of the bull since most kicks will come from the hind legs.
14. On occasions, semen ejaculated into the prepuce will not come out until all stimulation has stopped and the prepuce has been allowed to relax. This often occurs after the bull is being released from the crush. Semen can be milked out of the prepuce by squeezing the prepuce against the belly wall with your hand and then sliding the hand down toward the preputial orifice.

8.1.3. PER-RECTAL MASSAGE OF THE ACCESSORY REPRODUCTIVE ORGANS

Standard textbook descriptions of the per-rectal massage technique for semen collection emphasise the need for massage of the vesicular glands (vesicular glands) together with the ampullae and pelvic urethra. Some operators believe that best results are obtained from Brahman bulls if the SVs are not massaged. Many practitioners also find this to be true in *Bos taurus* bulls, however, a combination of massage of both the seminal vesicular glands and the ampullae has been used to successfully collect semen in *Bos taurus* bulls. In summary, regardless of the breed of the bull, the technique used should focus on massage of the ampullae.

Necessary steps in rectal massage are:

1. Locate the pelvic urethra on the floor of the pelvis and move tips of fingers forward to palpate the transverse part (or distal ridge) of the prostate gland. This is the reference point of palpation.
2. Locate the ampullae by moving the fingers 5-8cm immediately forward of the prostate gland. The ampullae are 0.5-1.0cm in diameter, 5-8cm in length and tapered, not lobulated as are the vesicular glands.
3. The most common mistakes in locating the ampullae are failing to locate the transverse part of the prostate, and palpating too deeply. For mature bulls the transverse part of the prostate is usually located just beyond wrist depth in the rectum.
4. Massage or stroke the ampullae, developing a rhythmic motion of stroking ampullae and pelvic urethra, avoiding touching the lobulated vesicular glands (particularly in Brahman bulls). As emission and ejaculation commence, strong pulsations of the pelvic urethra and the rectum will develop, and stroking of the urethra should be in synchrony with these contractions.
5. Continue massaging with external massage of the root of the penis in the perineal region above the sigmoid flexure until semen is collected. If a representative sample is not obtained then the above sequence of massaging can be repeated several times if necessary, though usually if no semen is collected within 2-3 minutes, it is unlikely that the procedure will be successful.
6. After semen is collected then palpate the vesicular glands for normality. They are located forward of the transverse part of the prostate gland diverging from the midline at an angle of approximately 20^{o}. They are irregular lobulated glands, which in young bulls 1- 2 years of age measure 6-8cm long, 1.5-3 cm wide and 1-2cm thick. In older bulls (>5 years) the vesicular glands may be up to 15cm long, 3-4cm wide and 2-3cm thick.

A majority of Brahman and *Bos taurus* bulls will partially extrude the penis on massage. Whilst the operator's hand is in the rectum an assistant can grasp the penis and partially extend it for examination without any major reaction from most bulls.

In the event of unsuccessful collection by massage, and a decision to use electroejaculation, leave the bull for several minutes to allow ballooning of the rectum to decrease if this has occurred, or alternatively expel air from the rectum by grasping a fold of rectal wall, while exerting slight backward pressure to induce a peristaltic wave. Immediate insertion of an ejaculator probe into the ballooned rectum often results in intermittent and sometimes severe stimulation of the bull.

If a good quality sample of semen is collected from these methods, then this can be accepted as a representative sample from the bull. When an unsatisfactory ejaculate is obtained, then further efforts should be made to collect another ejaculate either immediately, or preferably at the end of the examination run, to enable evaluation of the bull at that point in time.

8.2. COLLECTION AND HANDLING OF SEMEN SAMPLES

The sample is collected using a dry latex or disposable plastic funnels (as per Fig 51). These are preferred for convenience and reduction of possible disease transmission. A funnel handle can be made or purchased to allow distance from the bull. Keep a short space from the protruding penis with the funnel, as in this way one can observe the penis and note when seminal fluid discharge ceases and a collectable sample starts. Collection of the sperm rich fraction of the ejaculate only is recommended.

In cold conditions, precautions must be taken to avoid cold shocking of the sample (seen as 'shivering' movements of individual spermatozoa), and the funnel and collection tube should be kept warm prior to collection. A warm box can be used for this purpose (insulated box containing plastic bags of warm-hot

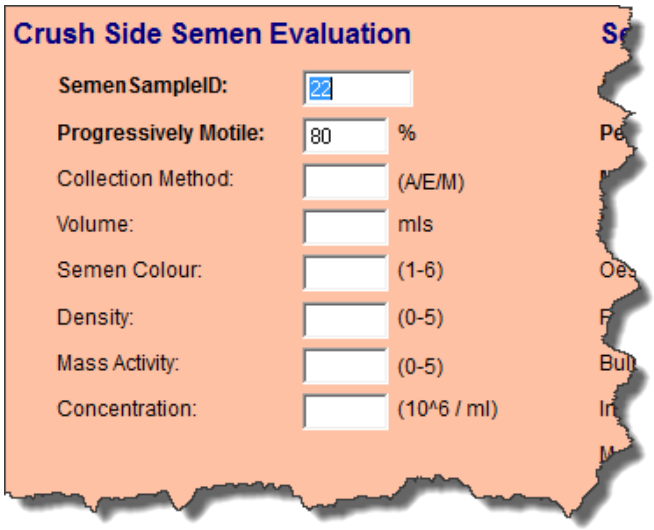
water). A plastic bag suspended from the funnel handle containing warm 37°C water is sometimes used to keep the sample warm- particularly for custom collection. In extreme conditions it may be necessary to insulate both the funnel and collecting tube.

When testing large numbers of bulls, the funnels should be washed and rinsed with PBS (Phosphate buffered Saline), citrate or normal saline between bulls and allowed to drain before re-use. A small rack for this purpose is advantageous. Alternatives include the use of a separate sterile 70 mL clear plastic vial or disposable centrifuge tube for each bull that is attached to a collection handle. This avoids any concerns over venereal disease in custom–collected samples, wetness of equipment, or poor visibility of the sample being collected.

During collection exposure to sunlight should be avoided. This can be achieved through wrapping aluminum foil around the tube or placing it in a styrofoam mould although this makes checking the quantity and quality of the sample collected difficult.

8.3. CRUSH-SIDE EVALUATION OF SEMEN

The data entry screen for the crush side evaluation of semen in Bull Reporter is displayed below:



Samples should be examined as quickly as possible. Pre-warmed (37°C ideal) clean new slides, cover slips, or iSperm chips, glass or plastic disposable pipettes or small volume, disposable tip Oxford or Ependorff pipettors are needed together with pre-warmed PBS or citrate solution. One advantage of the latter pipettors is that it is easy to keep the disposable tips warm under cold conditions and there is little risk of cross contamination of samples as the tips are changed for each sample (tips are very cheap).

It is important to remember that detergents, soap and most disinfectants are spermicidal, and even minute traces on glassware can contaminate samples, and inhibit motility, thereby resulting in false evaluations, as do diluents which are not isotonic or buffered to a neutral pH.

Good techniques are vital, particularly the avoidance of cold shock from cold glassware as incorrect motility assessments and increased numbers of sperm with abnormal morphology will be found after cold shock.

Always use a microscope warm stage set at 37° C so there is consistency both between and within days in the temperature at which samples are assessed. Glassware even at a temperature of 30^0 C can depress motility. If using iSperm ensure heater is on to maintain sample at 37^0C. Equally, hot dry conditions and hot (>40^0C) glassware can cause rapid drying of a thin semen film leading to errors of interpretation.

The first step in crush-side evaluation of semen is an important preliminary evaluation of semen density, colour and motility. It allows you to judge whether you have a representative sample, or whether you may need to collect again.

Yellowing of a sample may suggest urine contamination. Smell it to check. These samples should be examined quickly, as urine depresses motility. Urine contaminated samples should be discarded, and a

further sample taken. Some bulls also produce ejaculates with an orange coloration that is probably carotenoids which do not affect semen quality.

Initial examination usually involves an assessment of concentration (density) of sperm, volume and mass activity (gross motility), recording of abnormal colour (eg blood, urine staining) and presence of any flocculent material (pus). Subsequent motility and morphological assessments are only valid when the semen sample acquired is representative for the bull at that time. This condition is met if a minimum of about 200 spermatozoa are present per microscope field at x100 magnification of a sample under a cover slip or for iSperm when semen concentration is less than 500 million sperm/ml. This equates to a sample with a density score of 1 or more (see below).

8.3.1. PROGRESSIVELY MOTILE

Progressive motility describes the % of individual sperm progressing forward and is positively associated with fertility.

Progressive individual forward motility is a compulsory measure in assessing a semen sample to meet the Tick (low risk) standard for a BULLCHECK® Exam.

Progressive motility may be approximated:

a) Objectively in lab using CASA (Computer Assisted Semen Analysis) machine;
a) Objectively, in the lab or field using iSperm. ISperm is a recent technology using sperm recognition software and species-specific algorithms with an iPad mini camera to determine percentage of sperm motile, progressively motile and their associated velocities; or
b) Subjectively using a microscope in field at 100- 400x magnification.

If using microscopy, pre-warmed microscope slides, (36-37^{0}C ideal) pipettes and glass coverslips are required. To view progressive motility of individual sperm, a drop of diluted semen is placed on the slide, a coverslip placed on the drop, and the sample viewed at x100 - x400 magnification. Normal bull semen, with the exception of very dilute samples, needs to be diluted for an accurate assessment of individual motility. This should be done in a standard manner using warm PBS or other physiological solution. If sperm cannot be viewed individually, samples should be diluted in a standard manner with warm PBS or proprietary extender solution (approximately 1 drop semen: 5 drops diluent, though greater dilutions may be necessary.) This can be done either by mixing semen and diluent on the slide and covering a subsample with a coverslip, or alternatively semen and diluent can be mixed in a small tube and a sample of the diluted material examined under a coverslip. Sperm is extremely sensitive to temperature, pH and osmotic shock. The diluent must be 36-37^{0}C, isotonic and pH close to 7.4. If diluent pH < 6.5 and >8 results in motility of bull sperm will decrease. PBS may be stored at correct temperature in a portable straw thawer.

Motility evaluation should be done as soon as possible after collection, within several minutes for accurate results. Only sperm which move through their own propulsion are considered motile. There are various degrees and patterns of motility. Most cattle sperm will move at almost 2 entire body lengths per second, and it is therefore considered reasonable to count all those which move forward at more than one body length per second as forward progressive motile sperm. Beware in the assessment not to include sperm that move backwards or those that are motile but do not move forward. Those that move in large circles could be considered to be forward progressive motile.

It is difficult to reliably assess the proportion of sperm moving forward just by looking at 10 sperm simultaneously. This is unnecessary because the assessment of motility in a BULLCHECK® examination simply requires categorizing sperm in to < 30%, 30-60% or >60%.

A good way to do estimate motility is to repeatedly focus on areas of the slide and assess whether:

a) There are twice as many moving forward as not moving forward;
b) There are about the same number; or
c) There are twice as many sperm not moving as there are moving

Although this is technically using cutoffs of 33% and 66%, it is likely to be more repeatable than trying to look at ten sperm simultaneously and count the ones moving forward. Results from subjective assessment will be less precise than objective assessments because of the difficulty of assessing many sperm at once, but also because objective measures use specific velocities to determine that sperm are moving forward -

and the human eye cannot discern small differences in sperm velocity. Objective measures are preferred when collecting sperm for increased precision when calculating the dose of semen to be included in frozen straws.

As with other measures of semen quality, there are varying views on thresholds for progressive motility, which for natural mating are not well supported by research data. Subjective motility assessment does not have a good correlation with fertility. Experience in the USA and Australia suggests that an acceptable minimum threshold for bulls used for natural mating is more than 30% progressively motile sperm.

However, because bulls may be required to provide semen for freezing and the fact that normal healthy bulls should produce semen of >60% progressive motility and lower motility may be an indicator of pathology, ACV has adopted the semen standard (a tick) of a 60% threshold for progressively motile, though bulls which achieve at least 30% progressive motility will rate as a Q (Qualified).

Assessment of this element would normally be conditional on volume, semen colour and density being within normal limits.

8.3.2. VOLUME

Volume recording is an optional element of the BULLCHECK® Exam examination. It will be affected by factors such as operator, the efficiency and method of collection, contamination with pre-ejaculatory fluid and time since last ejaculation. There is little evidence that the numerical value of volume taken at a single test is either repeatable or related to fertility. Recording may be useful to build up a history though - repeated collection attempts that result in very low volumes may be significant. Prolonging electrical stimulation in an attempt to obtain a greater volume for evaluation purposes is not justified.

8.3.3. SEMEN COLOUR

Colour is probably more useful in assessing the quality of the sample obtained rather than the fertility of the bull. There is a wide range of normal colours possible, but contamination with urine or blood may be obvious.

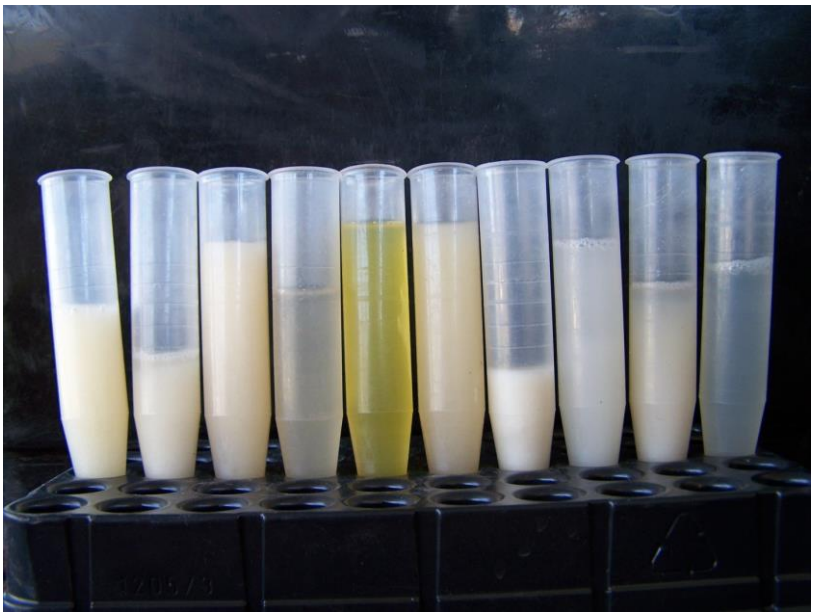


Figure 41 Variation in the colour of ejaculates.

8.3.4. DENSITY

Sperm density is a very rough estimate of concentration made based on the gross appearance of the semen sample.

The following is a useful guide to concentration of bull semen collected by transrectal massage or electroejaculation.

Table 6.1 Bull semen density scale

Scale	Gross appearance	Approx. concentration (sperm per ml)
1	clear to slightly turbid	<150 million *
2	turbid to dilute milky	150 - 300 million *
3	dilute milky to milky	300 - 600 million
4	milky to creamy	600 - 1000 million
5	creamy	1000-1500 million

* Note that white blood cells and epithelial cells can also cause the ejaculate to appear slightly turbid to milky - microscopic evaluation of sperm is necessary to demonstrate the presence or absence of these. If ejaculation occurs with the penis in the sheath and semen is collected at the preputial opening, many such cells may be present and do not make the sample unacceptable.

Subjective estimations of concentration are not highly repeatable and there is not a good relationship of density to fertility.

8.3.5. CONCENTRATION

Concentration is not an essential component of BULLCHECK® evaluation other than noting there are sufficient sperm in the sample (approximately 180-200x 10^6).

More accurate concentrations are required for ejaculates collected for custom freezing or chilling, to ensure correct dilution to achieve minimum sperm numbers per straw.

8.3.6. MASS ACTIVITY

Mass activity is assessed by placing an undiluted drop of semen onto a warmed slide (37°C) at low magnification.

While other arbitrary scales have been proposed, general Australian veterinary practice has been to use a scale of 1-5 where:

Mass activity Scale	Description
1	no swirl; generalised oscillation if individual sperm only
2	very slow distinct swirl
3	slow distinct swirl
4	moderately fast distinct swirl; dark waves seen
5	Fast distinct swirl with continuous dark waves

8.4. STANDARDS AND GUIDELINES – CRUSH SIDE SEMEN EVCALUATION

Guidelines:

- A bull with well-developed testicles and good testicular consistency usually produces a representative semen sample. Failure to obtain a sample of satisfactory quality suggests inadequate collection technique and another collection attempt is indicated. Very few bulls have "no spermatozoa".
- If the semen is of good concentration, and progressive motility on initial examination, and does not contain pus, a representative sample has been obtained.
- If a massaged or electroejaculated semen sample is of low concentration but of high progressive motility this is suggestive of normal function of the reproductive organs. Scrotal circumference data provides additional information about the potential quantitative output of the testicles.
- If a sample is of low concentration and has low progressive motility then the interpretation is more difficult. Up to three further samples should be taken on the day of examination to see if progressive motility is improved. Use techniques to avoid cold shock and take care when handling the sample.
- If a sample of 30-60% progressive motility is obtained, the bull should be recorded as Q (Qualified) and a comment made that the bull may well be suitable for paddock mating but may be higher risk in single mating situations or when semen is to be frozen.
- If a sample of semen showing 30% progressive motility or more cannot be obtained then the bull should be recorded as Cross (high risk).

Standard	Crush Side Semen Evaluation
Recording	This is recorded in CRUSH SIDE SEMEN EVALUATION
Requirements	Collection and assessment of semen using: artificial vagina, electroejaculation or rectal massage. Microscopic evaluation within minutes of collection. Adequate measures to prewarm slides and glassware and maintain temperature of samples and diluents.
Tick	A sample is collected with motility > 60%
Qualified	Motility > 30% but <60% in more than one collection Evidence of mild seminal vesiculitis (presence of inflammatory cells, but no clinical signs of pain in seminal vesicles)
Cross	An abnormality(s) was detected that is likely to significantly reduce the fertility of the bull in the short-term and/or long-term including but not limited to: Three ejaculates with progressive motility consistently below 30%, Inflammatory cells present, with painful seminal vesicles.

9. MORPHOLOGICAL EVALUATION OF SPERM

9.1. BACKGROUND

Figure 42 Disposable plastic funnel with disposable plastic vials

Morphology (anatomy) of sperm is an important predictor of fertility in the bull – particularly when significant proportions of certain abnormalities are present. There is also significant evidence that selecting for bulls with higher percentage of normal sperm has reproductive benefits in the short and longer term.

Spermatogenesis in the bull takes approximately 61 days followed by 11-13 days in the epididymis. Thus, it takes over 2 months between the first differentiation of a spermatogonium and the arrival of its sperm in the ejaculate.

A wide variety of stressors have been implicated in oxidative spermatogenic damage, including pyrexia, low testosterone level, gossypol, ethylene dibromide and glucocorticoids.

The types of abnormality observed can provide clues as to the timing and type of insult imposed. There is a consistent sequence of predominant sperm abnormalities which arises following a wide variety of stressors indicating that many morphological abnormalities may share a common pathogenic pathway.The effect of insults varies with the stage of spermiogenesis. Different phases of spermatogenesis vary in susceptibility to particular insults. Thus the specific abnormalities in a spermiogram can point to the likely prognosis for individual bulls.

9.2. TECHNIQUE

ACV recommends a standard method of collecting and examining sperm for the purposes of performing a BULLCHECK® Evaluation. Sperm morphology should be performed by a morphologist who has the correct equipment and who understands the ACV recommended standards outlined in this book. Samples should be submitted in neutral buffered formal saline. Sperm should be assessed using Differential-interference phase contrast (DIC) microscope at 1000x magnification.

Semen is collected for morphology in 10% isotonic neutral buffered formal saline (BFS). Sufficient semen is added to 1ml of BFS to see a distinct cloudiness and colour change. This may vary from 1 drop of thick concentrated semen >1000 million sperm/ml to 5 drops of watery semen <100 million sperm /ml. The vials must be leak proof. It is recommended that BFS be purchased commercially rather than made up at the veterinary clinic to ensure correct formulation, as sperm artefacts can be caused by incorrectly constituted fixatives. The sample should be agitated gently after adding the sperm to ensure mixing and avoid clumping.

For veterinarians using reference laboratories, undertaking sperm morphology on a bull is simply a matter of collecting the sample, sending it to a laboratory, and interpreting the results.

ACV does not recommend or endorse the services of particular sperm morphologists – veterinarians need to do their own research and establish that a particular laboratory or morphologist is appropriate in the same way the choose laboratories or pathologists for other samples.

9.2.1. AVOIDING MISTAKES:

Sperm morphology may be influenced by collection and handling. Collection technique may be lacking, and the sample not representative of a true ejaculate.

- Add semen to the fixative as soon as possible after collection to avoid environmental damage.
- Ensure that BFS is at the same temperature as the semen 37^{o}C
- Use permanent, unambiguous labelling.
- Transport samples at physiologic (room) temperature.
- Ensure that the BFS is properly constituted and in-date.

9.3. COMMON FINDINGS AND INTERPRETATIONS

Results are reported according to Bull Reporter's 26 defect category system based on anatomical site of defect. At least 100 sperm should be assessed. If the percentage of normal sperm is between 62 and 78 after 100 sperm are assessed, a further 100 sperm should be assessed from the same sample.

Sperm may have multiple defects and the resulting category percentages are not mutually exclusive resulting in the sum of individual defect percentages frequently exceeding 100.

Current acceptable thresholds are based having at least 70% normal sperm, and no more than 20% non-compensable defects or 30% compensable defects. Defects that are considered to be compensable if they can be compensated for by increased sperm numbers. Non-compensable defects cannot be compensated for by the addition of more sperm because they fertilize eggs, but the eggs are not viable. Some guidance is given as to acceptable levels of the different classes of abnormalities, but due to the lack of comprehensive research on some abnormalities it remains up to the examining veterinarian to evaluate the risk level.

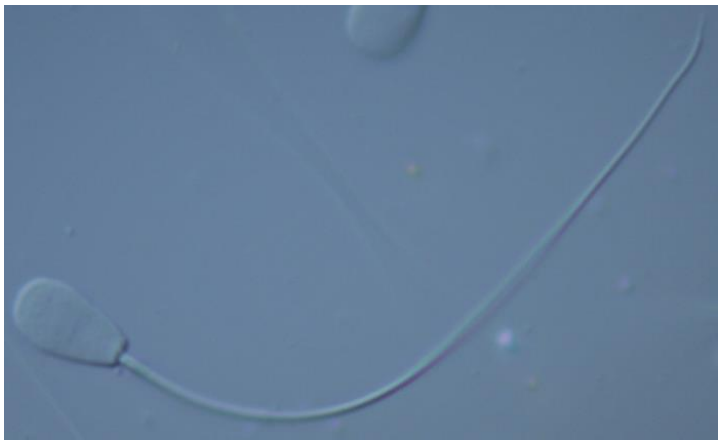
A standard BULLCHECK® spermiogram divides abnormalities into 8 categories, each consisting of one or more specific abnormalities.

Category	Defects	Notes
Normal Sperm	Normal sperm, and those with distal cytoplasmic droplets, abaxial tails, bent midpieces, segmental aplasia, slightly pyriform heads, narrow heads	These defects do not appear to affect fertility at low numbers – but high numbers of any one defect may be a cause for concern.
Proximal Cytoplasmic droplets (PC)	Proximal droplets	Significance can depend on the presence of other abnormalities. Sperm can't bind to oocytes. Epididymal dysfunction or immaturity. Non-compensable if >20%.
Mid-piece defects (MP)	Distal midpiece reflex, Dag defect, stump tails, multiple (accessory) tails	Generally considered compensable defects as sperm can't reach egg.
Head and Tail defects (HT)	Detached/loose/decapitated heads, reflex tails / bent principal pieces, coiled tails / bent principle piece	Generally considered compensable defects as sperm can't reach egg.
Pyriform heads (PY)	Pyriform heads	Often occur along with other abnormalities in the same and different sperm, indicating oxidative damage during spermiogenesis has occurred within 2-4 weeks prior to testing. Generally considered non-compensable.
Knobbed Acrosomes (KA)	Knobbed acrosomes	May be genetic in origin when high levels (>20%) present along with other abnormalities. Sperm showing the defect are likely compensable because they can't reach the egg, but there is evidence that some sub-types may be non-compensable.
Vacuoles / Teratoids (VT)	Small apical vacuoles, large confluent vacuoles, diadem defects, rolled heads, teratoid heads	Some of these are due to oxidative damage, some are potentially heritable. Considered non-compensable.
Swollen Acrosomes	Swollen acrosomes, ruffled / incomplete acrosomes	Aged sperm – especially "rusty loads". Generally considered compensable.

Bull Reporter is capable of storing individual abnormalities described. A more detailed description of the sperm abnormalities considered under BULLCHECK® follows.

[Section 8.3.1- the images in this section are taken from Perry (2021), which can be found here: https://doi.org/10.3389/fvets.2021.672058]

9.3.1. NORMAL SPERM



The ACV standardised system of analysis of the spermiogram dictates that sperm with morphological defects which do not impact fertility are included in the count of normal sperm. These include distal cytoplasmic droplets, abaxial tails, bent midpieces, segmental aplasia, slightly pyriform heads and narrow heads.

Figure 43 Normal sperm

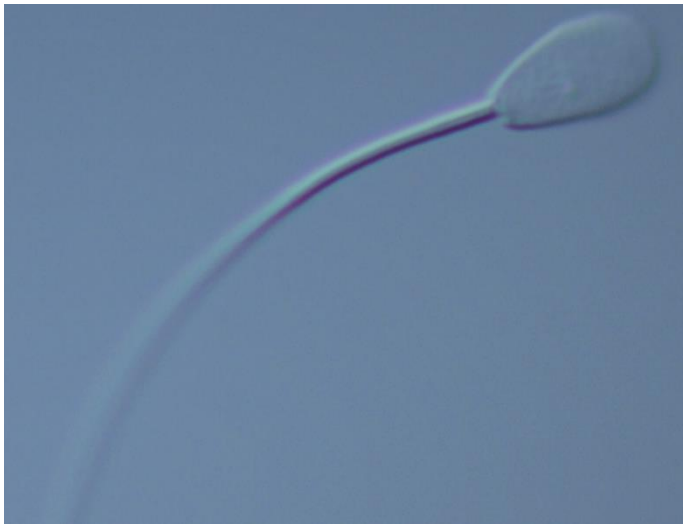
9.3.1.1. DISTAL CYTOPLASMIC DROPLETS

Most developing sperm at the cauda epididymis have a cytoplasmic droplet at the distal- midpiece position. Phospholipid Binding Protein is produced by bovine vesicular glands and has been demonstrated to bind to sperm membrane removing distal droplets. Consequently, when sperm are mixed with seminal fluid, the droplets are shed from the distal midpiece.

Distal droplets are usually present in less than 3% of bull sperm and are reported under the normal sperm count in Bull Reporter. Distal droplets are considered compensable. However, if present in high proportions >30% they should be noted in the comments and retesting of the bull and the potential unsuitability of the sample for freezing should be considered.

Figure 44 Distal cytoplasmic droplet

9.3.1.2. ABAXIAL TAILS



Abaxial tail implantation is only an abnormality of bull sperm when it is accompanied by an accessory tail. It occurs in the neck region and involving the eccentric positioning of the centriolar complex relative to the head base. Abaxial tail attachment is not considered abnormal in the stallion, boar or dog.

Figure 45 Abaxial tail

9.3.2. PROXIMAL CYTOPLASMIC DROPLETS

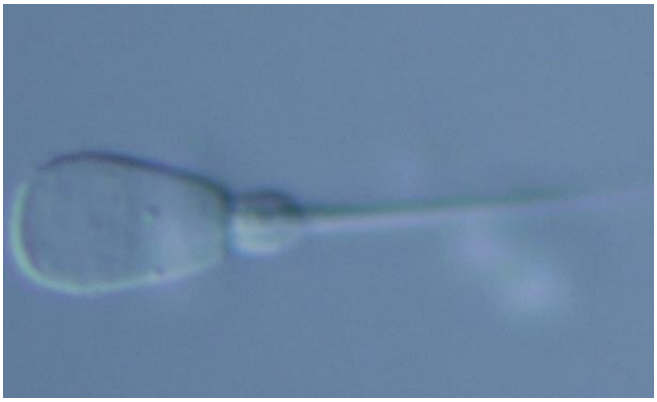


Figure 46 Proximal cytoplasmic droplet

A high percentage of sperm with proximal droplets is associated with abnormal epididymal function, spermiogenesis or sperm maturation. Bulls can recover from elevated levels of proximal droplets within a matter of weeks, although the prognosis may depend upon other types of abnormalities associated with the proximal droplets.

Peripubertal bulls often have elevated numbers of sperm with proximal droplets, these normally reduce by the time a bull is 13 to 14 months. however, cases of proximal droplets can persist well after puberty and sexual immaturity is not their only cause.

9.3.3. MID-PIECE DEFECTS (MP)

Mid-piece defects are the most common semen defects in beef bulls. They are generally considered to be compensable traits, as sperm with midpiece problems usually cannot reach the fertilization site.

9.3.3.1. DISTAL MIDPIECE DEFECTS (DMR)

Figure 47 Distal midpiece reflex

The distal midpiece reflex (DMR) is one of the most common defects encountered in bull sperm. It is differentiated from the bent tail defect by the fact that part of the midpiece is included in the bend usually trapping a cytoplasmic droplet. The affected sperm are often swimming backwards or in tight circles on motility assessment.

DMRs are due to disturbances in the cauda epididymis. Post stress, DMRs can increase rapidly within a week then regress if the stress was mild or short lived. If prolonged or severe stress the DMRs may persist.

DMRs can also be caused by problems collection and handling (e.g. cold shock, hypo-osmolality), however, these DMRs will not have the retained droplet.

9.3.3.2. DAG / DAG LIKE / TIGHTLY COILED MIDPIECE DEFECT

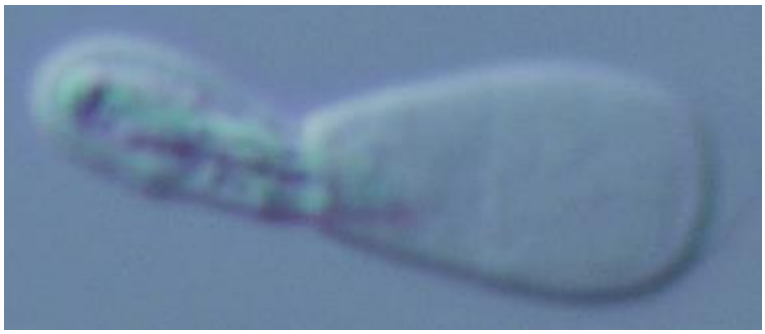
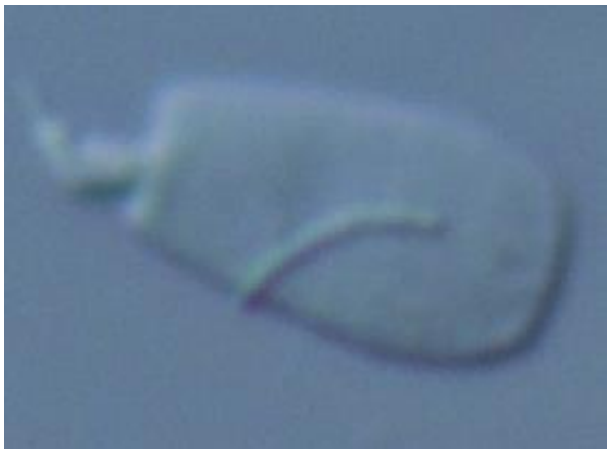


Figure 48 Dag defect

Named after the Jersey bull in which it was first identified (not because they look like a dag), this defect is characterised by strong folding, coiling and fracture of the distal part of the sperm midpiece (with or without a retained distal cytoplasmic droplet). True Dag defects generally occur at very gigh levels. Similar ("Dag-like") defects occur at lower levels.

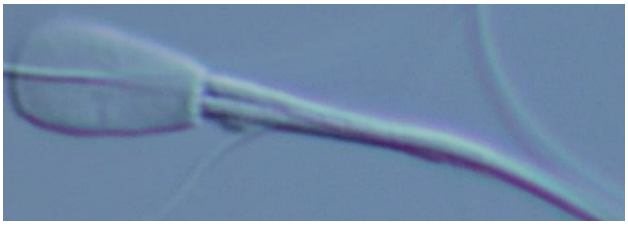
9.3.3.3. TAIL STUMP AND SHORT TAIL DEFECT



The tail stump defect is uncommon but reported in multiple breeds of cattle. Sperm affected have a short tail stump or rudimentary tail with the stump often obscured by a retained proximal droplet. Most sperm are dead and immotile and >60% of sperm are affected. Affected bulls are usually completely sterile and not expected to recover.

Figure 49 Tail stump defect

9.3.3.4. ACCESSORY TAILS/ DOUBLE TAILS



The presence of accessory tails along with abaxial tails is considered a mid-piece defect. As seen above, abaxial tails on their own can be considered as normal sperm.

Figure 50 Double tails

9.3.4. HEAD AND TAIL DEFECTS

Head and tail defects are generally considered to be compensable traits, as sperm with tail problems usually cannot reach the fertilization site.

9.3.4.1. DETACHED HEADS/ LOOSE HEADS/ DECAPITATED HEADS

Large numbers of detached normal heads can occur in association with abnormal accumulation of sperm in cauda epididymis. Peristalsis continuously moves sperm from the cauda epididymis into the urethra to ensure fresh sperm in ejaculation. Failure of this process can result in a buildup of sperm or “rusty load”.

Figure 51 Detached head

9.3.4.2. REFLEX TAILS/ BENT PRINCIPAL PIECES

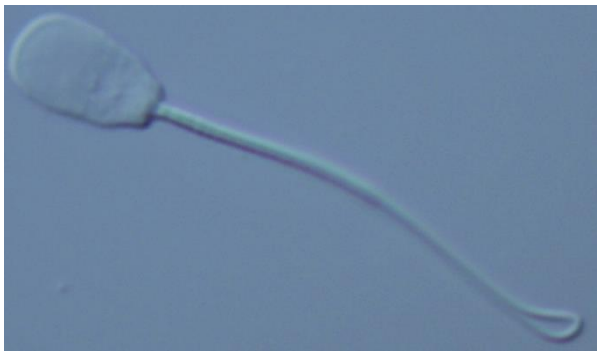


Figure 52 Reflex tail

Sperm with a reflex distal to the midpiece annulus, usually with a cytoplasmic droplet in the loop originate under the same circumstances as DMRs. Hypotonic shock may cause as similar type of bend without a trapped droplet.

9.3.4.3. COILED TAILS/ COILED PRINCIPAL PIECES

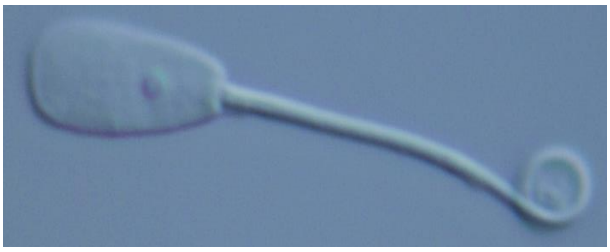


Figure 53 Coiled tail

Coiled tails are characterised by a tight coiling of the principal piece around a cytoplasmic droplet at various locations along the length of the tail. There appears to be a hereditary predisposition that some bulls are more prone to develop coiled tails secondary to season, stress, thermoregulation and/or oxidative stress. Coiled tails are often noticed with dag like defects in Bos- indicus and Bos indicus cross breeds by Australian morphologists.

9.3.5. KNOBBED ACROSOMES (KA)

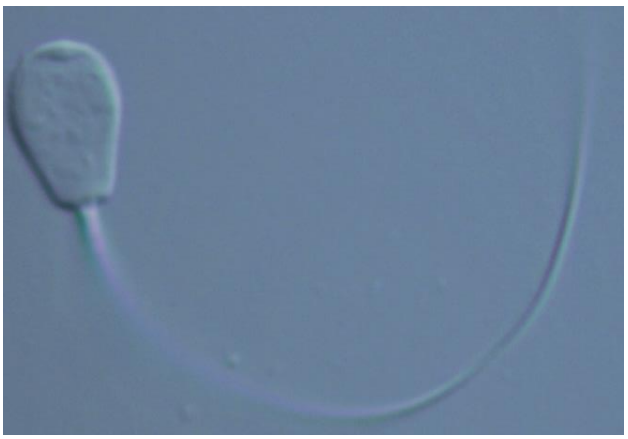
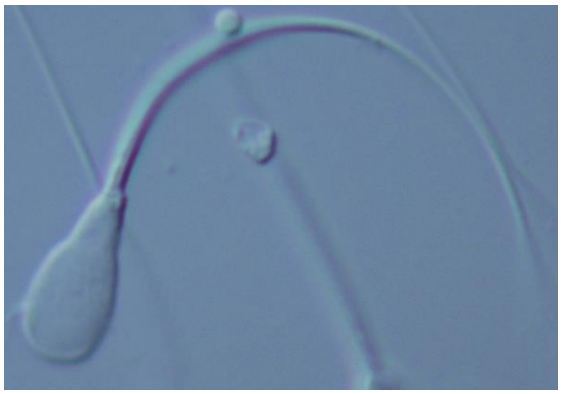


Figure 54 Knobbed acrosome

A number of acrosomal anomalies have been reported in bull sperm. The knobbed acrosome defect can be identified as an apical swelling that may protrude from, or fold over, the head and appears most often as a flattening or indention of the apex. Elevated levels of KAs in bull semen can linked with either genetic or environmental factors. With the latter, the elevated levels are usually seen in concert with other signs of spermatogenic dysfunction. A genetic cause is suspected when relatively high proportions (>20%) of sperm exhibit the KA defect in the absence of frequent numbers of other sperm abnormalities. Current evidence is that some sub-types of KA may be non-compensable but more work is needed in this area.

9.3.6. PYRIFORM HEADS



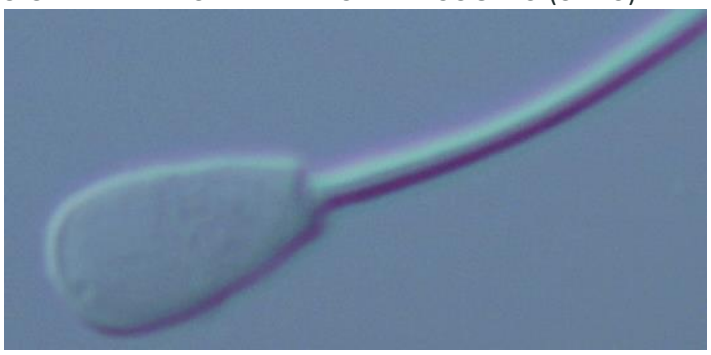
Pyriform, or pear-shaped heads, are a fairly common abnormality, usually observed with other head abnormalities such as diadem and proximal cytoplasmic droplet defects. It is not uncommon to encounter elevated levels of pyriform sperm heads in young bulls which have been over conditioned. Although such sperm are often impeded from reaching the fertilization site and zona pellucida they are generally regarded as non-compensable defects due to their potential to cause post-fertilization problems.

Figure 55 Pyriform head

9.3.7. VACUOLES

Age, heat and stress are often associated with the formation of vacuole defects. Hereditary breed predispositions have been demonstrated for some breeds.

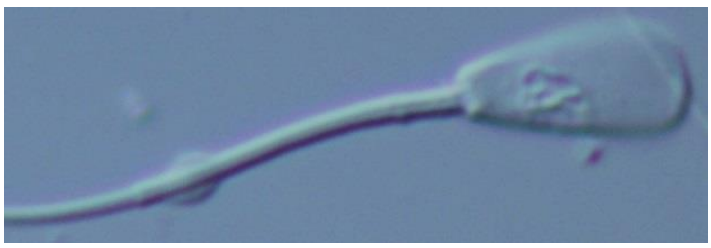
9.3.7.1. SMALL APICAL VACUOLES (SAVS)



The occurrence of small single or double vacuoles in the apex of the sperm head. The importance of this type of vacuole on fertility is unresolved.

Figure 56 Small apical vacuole

9.3.7.2. LARGE CONFLUENT VACUOLES



Very large vacuoles may occur in large numbers with or without diadems and SAVs. These have been associated with infertility.

Figure 57 Large vacuole

9.3.7.3. DIADEM DEFECT (CRATER)

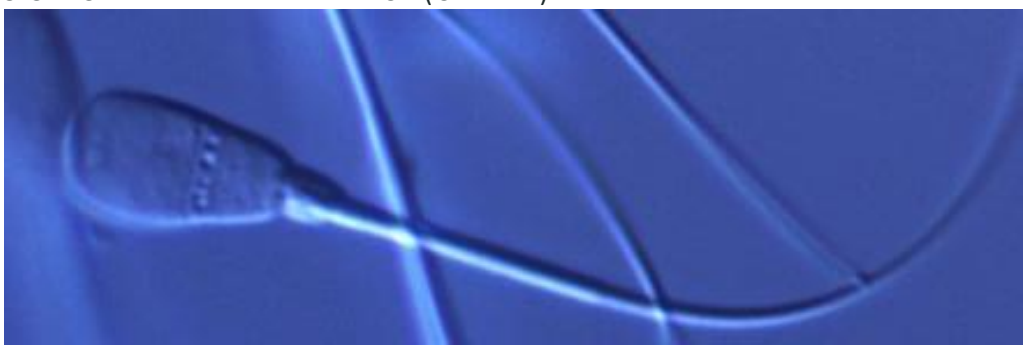
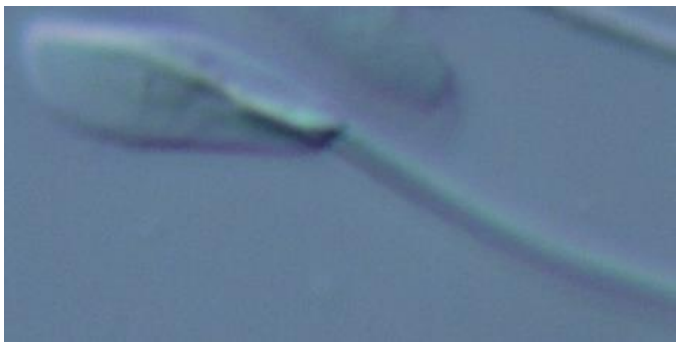


Figure 58 Diadem defect

Subtle vacuoles or craters, often seen in the equatorial region of the sperm nucleus, represent oxidative damage which occurs during the differentiation phase (spermiogenesis), resulting in abnormal chromatin condensation and binding. Such sperm may achieve fertilization. However, due to DNA/chromatin damage they can cause subsequent problems such as early embryonic death, early pregnancy loss, and possibly abortion and poor viability neonates. They are classified as non-compensable defects. Environmental (temperature-related) effects on spermatogenesis have shown to be one cause of diadems as the appearance of this sperm abnormality follows within days of the administration of dexamethasone or the application of scrotal insulation. The problem may resolve with time, treatment and/or environmental change although some bulls are more susceptible possibly due to impaired thermoregulatory mechanisms of their testes.

9.3.7.4. ROLLED HEAD- NUCLEAR CREST- GIANT HEAD SYNDROME



This abnormality is also included under the vacuole/teratoid category as it is uncommon. It is thought to be an inherited condition. The prognosis for recovery is very poor. The number tolerated in the ejaculate is at 20% because of the ability to penetrate the zona pellucida but the inability to produce a viable embryo. Reports upon its effect, when present at 20-30% of the ejaculate, on conception rates vary between 27-74%.

Figure 59 rolled head

9.3.7.5. MICROCEPHALIC AND MACROCEPHALIC HEADS

Small (microcephalic) and giant (macrocephalic) heads are categorized as compensatory defects. The variation in size of the sperm head may be due to an excess or deficiency of nuclear chromatin. They are commonly found in very small numbers in the ejaculates of bulls of normal fertility. These defects can be observed with a myriad of other defects (pyriform, vacuoles, etc.) Following a disturbance in spermatogenesis, but still rarely exceed 5–7% of the ejaculate.

Figure 60 Macrocephalic head

9.3.7.6. TERATOID HEADS

Figure 61 Teratoid head

The term teratoid means significant malformation, in this case of the sperm head region. If a significant number of sperm are so affected, then this usually reflects a severe spermatogenic insult. The defect is regarded as non-compensable.

9.3.8. SWOLLEN ACROSOMES

Figure 62 Swollen Acrosome

In general, the term swollen acrosomes refers to an evident ballooning of the acrosomal membrane(s), which is a common occurrence in ageing sperm - for example in the “rusty load” syndrome or where samples are not added to fixative in a timely manner. However, ruffled and incomplete acrosomes have been reported in sub fertile bulls.

9.3.9. DEFECTS CAUSED BY SAMPLE PREPARATION

A number of sperm problems, including those related to movement and morphology, can be caused by environmental factors which occur after the sample is collected. These can lead to errors in diagnosis and prognosis.

Common problems in this category are listed below:

Sample preparation error	Indicators in sperm
Cold Shock	Observation of particular sperm movements, such as moving backwards, circling and "shimmering" in place. Suspiciously large difference between motility and morphology. Increased distal midpiece reflexes without accompanying retained droplets.
Poor handling (temperature, contamination, rough handling, inappropriate extender)	Decreased percent intact acrosomes (PIA) Increased loose/degenerating acrosomes Presence of evident numerous bacteria Excessive clumping Increased bent and coiled tails Increased loose/detached sperm heads Evidence of crystal formation
Non-isotonic media	Increased distal midpiece reflexes (without droplets in the bend) and tail abnormalities
Poor preparation /microscopy	Sperm too concentrated or too sparse on the slide. Undetected subtle sperm defects (especially if consistent). Increased numbers of narrow heads.
Excessive motion or torsion (coverslip)	Increased loose/detached sperm heads. Evidence of disruption (broken midpieces and tails, sperm debris) of the sperm preparation.

Figure 63 Defects caused by sample preparation: 1 = DMRs caused by cold shock; 2-Hypo-osmotic effects; 3- decapitated sperm due to torsion of cover slip; 4-Bacteria adhered to sperm membranes

9.3.10. OTHER CELLS IN SEMEN.

A variety of cells may be observed in semen samples, including erythrocytes (RBC), white blood cells (WBC), epithelial cells, round cells and bacteria. Where semen appears abnormal or large numbers of cells other than sperm are seen during motility evaluation an air-dried heat-fixed thick-thin semen smear stained with eosin-nigrosin or diff-quick stain is indicated to enable accurate identification of other cells. In general, the significance attributed to them is related to their prevalence. For example, some RBC are commonly encountered in semen, and they are not regarded as problematic if they are sparse. However, if there are sufficient to cause more than a faint pink tinge in the ejaculate, then they may be inhibitory to sperm. Similarly, occasional WBC are regarded as normal. Again, a flag is raised if there are more than several encountered per microscope field, or frank pus is observed in the ejaculate.

Epithelial cells are also commonly encountered, especially in peri-pubertal bulls. Here care should be taken to ensure that they are not mistaken for sperm when gross visual estimation is made of sperm density.

Medusa cells, or formations, are rarely seen and usually receive comment when they are. They are regarded as accumulations of sloughed epithelial cells from the epididymis. They are not regarded as significant unless observed in numbers.

Round cells, however, can be indicative of problems. These usually represent sloughed cells from different regions of the spermatogenic epithelium and are often seen in concert with other signs of spermatogenic damage.

Bacteria are commonly encountered in the semen sample, as semen is a contaminated product. When seen in ejaculates of bulls undergoing the BULLCHECK® Exam, they are only noteworthy if related to other signs of infection such as pus, vesiculitis etc.
WBCs and RBCS may be contaminants form sheath. It is important to note if ejaculate was collected form exteriorised penis or from sheath for interpretataion of cells

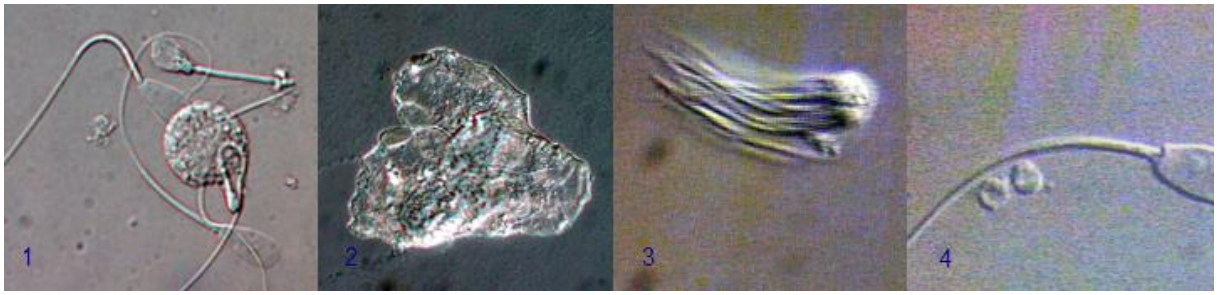


Figure 64 Other cells found in semen: 1 = round cell or spheroid ; 2-Epithelial cell, 3-Medusa formation; 4-red blood cells

9.4. STANDARDS AND GUIDELINES – SPERM MORPHOLOGY

The assessment of sperm morphology is strongly recommended for every bull examination. Sperm morphology assessment is necessary if sperm motility assessment is <60%. It is a compulsory requirement for some breed societies and bull sales.

Standard	Sperm Morphology
Recording	This is recorded under SPERM MORPHOLOGY
Requirements	Assessment of sperm using Differential-Interference Contrast (DIC) microscopy at 1000x magnification. Count 100 sperm (or 200 if Percent Normal Sperm at 100 count is marginal - between 62 and 78). Distal droplets >30% to be noted in comments.
Tick	>= 70% normal sperm
Qualified	>= 50% normal sperm <30% of any type of defect <20% of individual defects for proximal droplets, pyriform heads or vacuoles
Cross	<50% normal sperm OR >30% of any type of defect OR >20% of individual defects for proximal droplets, pyriform heads or vacuoles

10. OCCUPATIONAL HEALTH AND SAFETY

Safety is of utmost importance when examining bulls. Bulls are large, expensive and potentially dangerous animals which can put themselves and all around them at risk if not handled carefully.

Common classes of hazards that need to be taken into account when working with bulls in a crush include:

- Sudden unplanned/unforeseen movements of animals in and around the crush
- Musculo-Skeletal disorders arising from repeated activities that involve repetitive straining. Reducing manual handling is an important concept in Occupational Health and Safety
- Environmental hazards including exposure to UV light and the elements, tripping hazards, protrusions at head height, electrical hazards, and hazards due to slippery wet conditions or inadequate lighting.

This chapter is not designed to be a complete reference guide to occupational health and safety, but rather serves to provide some advice surrounding the particular risks associated with examining bulls, as many cattle crushes were not specifically designed for restraining bulls, and even fewer were designed for reproductive examination or collecting semen.

There are specific OHS responsibilities placed on the designers and manufacturers of plant that may be used in a workplace. There are also responsibilities which can vary from state to state of the owner of the site, the manager of the site (typically the farmer), the person in charge (typically the veterinarian), and all employers concerned (the farm manager and the vet practice). It is important to understand that when someone makes alterations to a crush, they bear some responsibility for injuries that occur because of those alterations. It is recommended that alterations to any equipment used in workplaces be undertaken by people with appropriate skill and qualifications.

Before restraining a bull in a crush, an assessment that the crush is well maintained and suitable for the bulls to be restrained should be carried out. Particularly on farms where the most common use of the crush is for cows, latches should be checked to ensure they are secure – especially those that might come loose with excessive force that causes pipes to bend. A gate that flies open unexpectedly can cause injury, and ropes or chains should be applied to prevent this from happening.

In dairying situations where facilities are designed to accommodate quiet, frequently handled animals it is particularly important to ensure that the crush etc. will be able to allow bull examination to be carried out safely for both the animal and persons involved.

10.1.1. TO BAIL OR NOT TO BAIL

Most bulls vigorously resist restraint of the head. A thorough examination of the head area therefore necessitates robust restraint to maintain adequate operator safety. This may reduce the possibilities of obtaining an adequate semen sample. The value of the information gained therefore needs to be carefully balanced against the safety and other considerations in deciding whether, when and how to restrain the head for examination.

As a general comment it is often better not to catch the bull's head in the bail during the examination/electroejaculation process. Certainly, some individual bulls will tolerate their heads being caught but the consequences for those that do not must be anticipated. It is very important that if bulls' heads are restrained in a crush, it is possible to release their head in a hurry, even if with the bull in a recumbent position and unable to rise. This is particularly important where the bottom of the bail tapers to a V or in crushes with guillotine style head bales.

There are several commercially available head restraints that work well when combined with walk through type crushes. These are especially recommended if special examination of the head (eg for dentition assessment) is required.

10.1.2. IMPORTANT RISKS

The crush can be a dangerous place - it is important to identify and manage safety risks before commencing work. This table lists some of the common risks that should be assessed and managed.

Source of risk	Examples of risk	Level of risk	Example management of risk
Crush facility	A large fractious bull is loaded into a light crush that is not bolted down and the crush falls over on the operator	Severe injury or death	An assessment that the crush is suitable and strong enough for the cattle to be loaded must be made.
Crush maintenance	A latch releases under pressure when an animal is struggling in the crush and a gate swings open rapidly and hits an operator	Severe injury	An assessment of the latches and locking mechanisms of the crush must be made. Doubtful latches should be re-enforced with rope.
Crush surrounds	Operators concentrating on the animal in the crush may trip over obstacles in the surrounding area or suffer trauma from projections at head height	Moderate injury	Remove as many objects and hazards as possible, and ensure that all people present are aware of any remaining hazards
	Electrocution - Water comes into contact with electricity	Serious injury or death	RCD devices are essential if electricity is used near the crush
Crush environment	Excessive UV exposure, dust, or moisture present a health risk	Serious health risk	Ensure sunscreen or other protection is used as appropriate; delay procedure
	Inadequate lighting or slippery conditions increase risk of accident	Severe injury	Manage as appropriate. Ensure floor is not slippery.
	Working in isolation	Severe injury	If working without assistance, communications and emergency procedures (eg: call base every 30 mins) are required
Sudden unplanned movement from animal in the crush causes crushing / trauma	An operator standing behind the animal is crushed when the animal escapes from the head bale and moves backwards	Severe injury or death	Vet gates open so as to provide escape route Use a suitable barrier between the animal and the operator – typically a rump bar or bottom part of the split vet gate.
	An operator's arm is crushed between an animal and a part of the crush (for example an operator reaches through the bars on the side of the crush to inject an animal and the animal jumps, crushing the operator's arm)	Severe injury	Gates should be opened so as not to put the operator at risk
	An operator's arm is crushed by a gate or bar when the bull goes down while a rectal examination is being performed	Severe injury	The height of the bar or gate should be assessed to minimize this risk.
Sudden unplanned movement from the animal in the crush causes kicking injury	An operator standing behind an animal is kicked	Severe injury	A split vet gate will help manage this risk. The bottom half of the vet gate should be solid.
	An operator examining a front leg or reproductive organs is kicked by the rear leg	Severe injury	It may be important to have sufficient personnel and a vet gate and so that a tail jack can be applied. Sedation may also be considered.
	An operator is kicked with the hind leg	Severe injury	Split side gates will help manage this risk
Crushing injury/trauma from the animal that left the crush	An animal is drafted into the same yard as the operator, and it attacks the operator	Severe injury or death	An assessment of animals temperament, suitable yard size, or a separate enclosed area for the operator is needed.
Musculoskeletal injury	An operator is at risk of repetitive strain injury from tasks that require straining and repetition	Severe injury	Warm up exercises, modification of the crush to minimize climbing over fences

Risk Assessment:

Farm:	**Date:**
Veterinarian:	**Stock Breed:**
Stock Type (circle) : Bulls Cows Steers Calves	**Estimated weight (kg):**
Stock Temperament (circle): Trained to lead Calm Nervous Unhandled Aggressive	

This document is designed as an aid to assist veterinarians in making a risk assessment of the crush and surrounding area when it is about to be used for a veterinary procedure. A table from farmsafe.com.au is provided below which considers the potential consequences and the likelihood of occurrence to determine if the level of risk is low, moderate, high or extreme. The table on the right indicates the action that should be taken once the level of risk is identified.

CONSEQUENCES How severely could it hurt someone	LIKELIHOOD — of exposure to a hazard causing injury given the frequency of exposure and consequence.				
	ALMOST CERTAIN	LIKELY	POSSIBLE	UNLIKELY	RARE
CATASTROPHIC ➢Death, permanent disablement	Extreme	Extreme	Extreme	Extreme	High
MAJOR ➢Serious bodily injury	Extreme	Extreme	Extreme	High	High
MODERATE ➢Medical Treatment	Extreme	High	High	Moderate	Moderate
MINOR ➢First Aid only	High	High	Moderate	Low	Low
INSIGNIFICANT ➢ No Injuries	High	Moderate	Low	Low	Low

OK or Not Applicable	**NO FORESEEABLE RISK OK** for now. Review if any equipment / people /materials / work methods or procedures change. **Or** this particular inspection item is **Not** Applicable to this workplace.
EXTREME (ACT NOW)	**EXTREME RISK - ACT NOW (Do something to manage these risks immediately.** Stop the task until the hazard is controlled and the risk managed.
HIGH (ASAP)	**HIGH RISK – ACT AS SOON AS POSSIBLE.** Do something to manage risks assessed as soon as possible. Consultant with Management.
MODERATE (PLAN)	**MODERATE RISK – PLAN** to manage these risks / note any suggestions on how these risks might be managed. Consultant with management or Supervisor
LOW (REVIEW)	**LOW RISK - OK** for now. Review if any equipment / people /materials / work methods or procedures change. Consult with Supervisor.

Identified Risk	**Level of risk (tick)**					**Comments / Actions required**
	N/A	Low	Moderate	High	Extreme	
General Crush						
Crush is not strong enough to hold stock						
Crush not fixed – risk of tipping/moving						
Crush maintenance – latches not secure						
Crush Maintenance – head bale not secure						
Race - Stock can be safely loaded into crush						
Head bale – stock may escape form head bale						
Injury to operator from head bale controls						
Front - injury from head of stock						
Side - crushing injury between stock and bars of crush						
Side – crushing injury from stock escaping crush						
Side – kicking injury						
Behind – crushing injury from stock moving backwards						
Behind – Kicking injury from stock in front						
Behind – Crushing / traumatic injury from stock in race behind						
Surrounds – risk of tripping						
Surrounds – risk of electrocution						
MSDs – risk of musculoskeletal disorders						

10.1.3. GENERAL CRUSH COMMENTS:

Suitability	N/A	Excellent	Adequate	Inefficient	Unsafe	Comments
Suitability for class of animal						
Suitability for job being performed						
- Head Bale						
- Side Gates						
- Vet Gate						
- Back Gate						
- Forcing area						
- Floor / roof						
- Surrounding area						

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