**Title of Paper**

Peritoneal fluid accumulation in the femoral canal as a result of a post traumatic femoral hydrocele in a mature warmblood stallion.

**Short running title**

Post traumatic femoral hydrocele

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**Summary**

The following case report documents the clinical presentation, ultrasonographic appearance, surgical management and outcome of a horse with a traumatic tear extending from the superficial and deep inguinal rings, across the aponeurosis of the external abdominal oblique muscle and inguinal ligament, disrupting the femoral ring, vascular lacuna and peritoneum. This subsequently resulted in fluid accumulation within the femoral canal. This unusual injury and presentation gives rise to discussion of the aetiology and nomenclature that should be used to properly describe this injury.

**Keywords:**

Horse, hernia, hydrocoele, inguinal, femoral canal

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**Introduction**

The medial thigh and inguinal region of the horse is an anatomically complex area composed of a junction between abdominal musculature and medial thigh muscles. The blending of both external and internal abdominal oblique aponeuroses is termed the external rectus sheath (Sisson, et. al. 1975). The aponeurosis of the external abdominal oblique muscle is divided into the abdominal and pubic tendons creating the slit-like superficial inguinal ring (Budras, et. al. 2009, Sisson, et. al. 1975). The deep inguinal ring is bordered cranially by the caudal edge of the internal abdominal oblique muscle, the ventromedial border is formed by the rectus abdominis muscle and the prepubic tendon, and the caudolateral border is formed by the inguinal ligament, which is actually the thickened caudal boarder of the external abdominal oblique muscle (Dyce, et. al. 2009). The inguinal canal is the oblique space between the superficial and deep inguinal rings through which the spermatic cord, genitofemoral nerve, external pudendal vasculature and inguinal lymphatics traverse. In the male equid, the peritoneum forms the vaginal tunic (parietal tunic) which descends through the deep inguinal ring through the inguinal canal to line the interior of the scrotum, in which the testes eventually reside (Sisson, et. al. 1975).

Medial to the deep inguinal ring and cranial to the inguinal ligament is an opening, closed from the abdomen by peritoneum and fascia, termed the femoral triangle. The femoral triangle is a pyramidal space that gives rise to the femoral canal and contains the femoral vessels, saphenous nerve, and deep inguinal lymph nodes. The base of the femoral triangle is dorsal and bound caudally by the gracilis and pectineus muscles, cranially by the sartorius muscle and medially by the external abdominal oblique aponeurosis formed by the vascular lacuna. The vascular lacuna is an elliptical space between the inguinal ligament and the shaft of the ilium and permits the external iliac vessels to leave the abdominal cavity in order to enter the thigh, the caudomedial aspect of the vascular lacuna is also termed the femoral ring. As soon as the vessels have passed through the vascular lacuna they occupy the femoral triangle and become the femoral vessels. In the intact state, the femoral triangle and ring is closed on the abdominal side by peritoneum and transverse fascia. The apex of the femoral triangle is ventral and gives rise to the femoral canal. The femoral canal is located on the medial aspect of the thigh, bound by the medial muscles of the thigh, the pectineus and adductor muscles caudally, the sartorius muscle cranially, iliac muscle laterally, and vastus medialis muscle distally. The femoral canal extends from the femoral ring distally to the level of insertion of the pectineus muscle (Budras, et. al. 2009, Dyce, et. al. 2009 and Sisson, et. al. 1975).

Given the complexity of the anatomy and difficulty examining these structures in the standing horse, lesions in this area can be difficult to fully assess. We document an unusual case of fluid accumulation within the medial aspect of the thigh (within the femoral canal) in a mature stallion secondary to a tear in the external rectus sheathand superficial inguinal ring. To our knowledge this type of injury and presentation is unreported in equine veterinary literature.

**Case Description**

**History**

A 14-year-old, 600kg Warmblood stallion, was initially evaluated at the owner’s premises for a swelling on the proximal medial aspect of the left thigh. On examination, an external skin abrasion and emphysema were noted in the region of the swelling. The horse showed signs of discomfort on palpation of the swelling, but the horse was sound at the walk. The referring veterinarian suspected either an insect bite or trauma and so administered 0.1mg/kg body weight (BW) dexamethasone (Colvasone)1 intravenously (IV) and 5mg/kg BW IV oxytetracycline (Engemycin)2. Box rest was advised and doxycycline (Karidox)3 10mg/kg BW per os (PO) and phenylbutazone (Equipalazone)4 2.2mg/kg BW twice daily PO were prescribed for ten days.

At the time of re-examination, the swelling had not decreased in size but had become soft and fluid-filled. The horse no longer exhibited signs of discomfort when the swelling was palpated and the external abrasion had healed. The swelling continued to increase in size and thirty-five days after initial evaluation (Figure 1), the referring veterinarian lanced what was suspected to be a haematoma or seroma. Approximately 750mL of serous fluid drained from the site and the horse was prescribed sulfadiazine and trimethoprim (Trimediazine)5 30mg/kg BW twice daily PO to provide broad-spectrum antimicrobial cover to reduce the likelihood of infection within the surgical site. The surgical wound, which functioned as a drainage hole, was cleaned twice daily and fluid manually expressed. As the surgical wound healed, drainage decreased and the swelling reformed. The horse was referred to the Sussex Equine Hospital for ultrasonographic evaluation and surgical consultation.

**Ultrasonography**

Ultrasonographic evaluation using a GE Logiq S7 veterinary ultrasound scanner6 with a 9-15Hz linear transducer revealed a well-demarcated and encapsulated cavity containing anechoic fluid with fibrinous loculations surrounding the periphery of the cavity (Figure 2). No other significant abnormalities were identified on ultrasonographic examination. Due to the size (approximately 25cmx20cm), location and rate of reoccurrence, surgical exploration, debridement and wound reconstruction under general anaesthesia was advised.

**Surgery**

An intravenous catheter was placed in the left jugular vein and gentamicin (Genta-Equine)4 6.6mg/kg BW IV, procaine penicillin, (Depocillin)2 22,000IU/kg BW intramuscularly (IM) and phenylbutazone 4.4mg/kg BW IV were administered preoperatively. The horse was sedated with romifidine (Sedivet)7 0.08mg/kg BW IV, prior to induction with ketamine (Narketan)5 2.2mg/kg BW IV and diazepam (Diazepam)8 0.06mg/kg BW IV. The horse was positioned in dorsal recumbency and maintained on isoflurane (Isoflo)9 and oxygen through positive pressure ventilation.

Once positioned in dorsal recumbency, the fluid filled sac on the medial aspect of the left thigh reduced in size and a progressive swelling was noted in the left scrotum. Ultrasonographic examination of the scrotum revealed anechoic fluid between the parietal and visceral tunic of the left testicle. The left testicle appeared diffusely hyperechoic when compared to the right testicle and there was a moderate soft tissue swelling of the scrotal fascia.

The left inner thigh, scrotum and inguinal region was clipped, aseptically prepared and draped routinely. A 5-cm skin incision was made perpendicular to the long axis of the limb at the distal extent of the seroma with a No. 10 scalpel blade. The incision was continued through subcutaneous tissue and into the seroma. Approximately 2L of serous fluid and fibrin was removed from the seroma by active suction. A second incision, approximately 10cm in length, was made coursing dorsally along the medial aspect of the left inner thigh, medial to the medial patellar ligament and parallel with the long axis of the limb. The second incision originated from the middle of the first incision to create an inverted ‘T’ shaped incision. A thick capsule lining the fluid filled cavity was identified grossly and resected. As the second incision was extended dorsally, it became evident that the fluid communicated directly with the inguinal canal. An approximately 10cm tear was identified in the aponeurosis of the external abdominal oblique muscle, extending caudally from the superficial and deep inguinal rings (**Fig 3**). This tear allowed direct communication between the left scrotum and the fluid filled sac. The spermatic cord was not located within the superficial inguinal ring but located within the rent in the external rectus sheath as both deep and superficial inguinal rings were torn. Due to concern of increased risk of herniation of abdominal viscera secondary to the trauma present at the level of the left inguinal ring and scrotum, the owner was contacted intra-operatively and castration of the left testicle was advised to allow repair of the tear present in the external rectus sheath and closure of the left superficial inguinal ring. The owner consented to bilateral orchiectomy and wound reconstruction.

Whilst the first surgeon (M.M) continued to debride the wound, a second surgeon (C.M.B) performed a bilateral orchiectomy through two scrotal incisions. A scrotal approach was chosen for orchiectomy over an inguinal approach given the degree of trauma to the left inguinal region. Scrotal fascia of the left testicle was moderately oedematous and the left testicle was subjectively firmer and variable in its palpable consistency (**Fig 4**). A semi-closed castration was performed to allow evaluation of the interior of the parietal tunic for abdominal viscera, of which none was identified, and to remove the left testicle. The left spermatic cord was rotated in a clockwise direction prior to placement of a transfixation and circumferential ligatures using 1 polyglactin 910 (Vicryl).10 Emasculation was performed with a Ratchet-handle Hauptner Serra Emasculator (Eickemeyer)11. The left superficial inguinal ring and rent in the external rectus sheath were sutured closed with 1 polydioxanone (PDS)10 in a simple interrupted suture pattern. The right testicle was removed via a routine closed approach as the testicle and spermatic cord appeared unremarkable on gross examination. Similar to the left testicle, the right spermatic cord was ligated with a transfixation and circumferential ligature using 1 polyglactin 910 (Vicryl)10 prior to emasculation with a Ratchet-handle Hauptner Serra Emasculator (Eickemeyer)11. Scrotal incisions were sutured closed in multiple layers using 2-0 polyglactin 910 (Vicryl)10 in a simple continuous suture pattern.

Following closure of the superficial inguinal ring and the tear in the rectus sheath, excess skin was removed from the dorsal and medial aspect of the incisions and the dead space minimized using 0 polydioxanone (PDS)10 in a simple interrupted walking suture pattern. Skin was closed using 0 polydioxanone (PDS)10 in a vertical mattress pattern, interspersed with simple interrupted sutures. A Jackson–Pratt drain (MILA Multipurpose Drain 10fr with introducer & bulb (DK1090))12 was placed at the most distal aspect of the incision to facilitate post-operative drainage. A sterile bandage was applied over the incision for anaesthetic recovery; the horse recovered from general anaesthesia uneventfully using a rope assisted recovery system.

**Aftercare**

Post-operatively, the horse continued to receive procaine penicillin G and phenylbutazone for 10 days. Analgesia was supplemented with 0.1mg/kg of morphine sulphate (Morphine Sulphate Injection)13 administered IV and IM for 48 hours post-operatively. A sterile bandage was applied to the surgical site and changed as required for 28 days. The surgical site drained approximately 500mL in the first 24 hours and the volume of discharge decreased over the following four days so the drain was removed five days after surgery.

Ten days after surgery the surgical site was considerably more swollen and approximately 500mL of serous exudate was drained from the surgical site following sterile opening of the most distal aspect of the incision. The exudate was cloudy yellow and contained 22.1x109/L WBC (96% neutrophils), 0.06x109/L RBC and TP of 38g/L. The horse displayed no clinical signs of a systemic infection. Haematology and biochemistry revealed hyperfibrinogenaemia and an elevated serum amyloid A. The exudate was considered to be associated with a local infection, not an accumulation of peritoneal fluid from the repaired tear in the external rectus sheath and inguinal ring. Bacterial culture of the fluid isolated a predominant growth of *Escherichia coli*, sensitive only to enrofloxacin. Penicillin was discontinued and enrofloxacin (Baytril)14 10mg/kg BID orally was started and continued until the wound ceased to discharge. The volume of exudative discharge from the wound decreased over the following 14 days.

**Outcome**

The horse was discharged from the hospital 19 days after surgery. Sutures were removed 25 days post-operatively. Fifty days after surgery the horse was turned out in a small grass paddock. No other significant abnormalities were noted during re-examination at 71 and 133 days after surgery. The horse made a full recovery and ridden work was introduced. Communication with the owner 2 years after surgery confirmed the owner was happy with both the cosmetic and functional outcome of the horse and the swelling had not returned.

**Discussion**

This case highlights a unique trauma to the superficial and deep inguinal rings, the inguinal canal, the aponeurosis of the external abdominal oblique and its inguinal ligament and the related femoral ring anatomy resulting in what was presumed to be an accumulation of peritoneal fluid along the medial aspect of the left thigh, within the femoral canal.

Classification of this trauma is somewhat difficult. Neither the definition of a hernia, seroma or hydrocele adequately and accurately describe this lesion. A hernia consists of three portions, a ring, sac and contents (Withers and Mair 2008). In the current case, there was a palpable opening into the abdominal cavity and a defined sac lining an accumulation of fluid but there was no abdominal viscera or omentum within the sac. The lack of viscera and or omentum casts doubt as to whether this lesion can be accurately termed a true, acquired direct hernia. A recent equine case report describes herniation of small intestine through the femoral canal following closed castration with ligature of the spermatic cord (Torre et. al. 2013). This bears similarities to the current case, however, no abdominal viscera or omentum was involved in the current case.

The swelling on the medial aspect of the left thigh in this horse was originally suspected to be a seroma. A seroma is the sterile accumulation of serum within a dead space (Janis et. al. 2016) however, if the fluid was an extra-abdominal out-pouching of peritoneal fluid secondary to a tear in the superficial inguinal ring and external rectus sheath then it would not be accurate to describe the fluid accumulation as a seroma. Femoral hydroceles are a collection of serous fluid within the vaginal tunic and are rarely reported in the human literature (Abantanga and Lakhoo 2010, McCorkle and Bell 1941, Rives 1934). Femoral hydroceles form thin walled fluid-filled masses confirmed to communicate with the peritoneal cavity through the femoral ring and result in swellings in the groin region (Rives 1934). Hydroceles are formed through normal physiological openings in the abdomen but in the described case fluid did not accumulate within the vaginal tunic because the tear in the external rectus sheath and superficial inguinal ring allowed fluid accumulation within the femoral canal resulting in the swelling on the medial aspect of the thigh, therefore this fluid accumulation may best be classified as an acquired post trauma femoral hydrocele.

Despite ultrasonography performed prior to surgery, injury to the superficial inguinal ring and external rectus sheath was not identified until surgery. To the authors knowledge there are no publications or descriptions of ultrasonographic evaluation of the inguinal rings or abdominal wall other than during assessment of other conditions such as cryptorchidism or herniation where the main focus is on the testis. Further work into the ultrasonographic appearance of the superficial and deep inguinal rings may allow more accurate early diagnosis of such conditions in the future.

Given the trauma to the superficial inguinal ring identified at surgery the risk of herniation was high if the defect in the abdominal wall and inguinal ring was not closed. Closure of the inguinal ring has been described by open (Van der Velden 1988) and laparoscopic techniques (Rossignol et al. 2007). Given the abnormalities on gross examination of the left testicle, orchiectomy of the left testicle was advised. There was no pathological reason to remove the right testicle, but the owner elected for a bilateral orchiectomy.

This case presents an interesting discussion concerning the correct description of the lesion identified and also reports the unusual presentation of an inguinal lesion. This case has given the authors pause when considering the surgical approach to swellings located within the region of the femoral canal.

**Authorship**

C. M. Baldwin and M. McMaster were involved in the clinical management of case and contributed to preparation of the manuscript. S. Priestnall contributed to clinical discussion and manuscript preparation. All authors gave their final approval of the manuscript.

**Authors’ declaration of interests**

No conflict of interests have been declared.

**Ethical animal research**

Not applicable.

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None

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**Manufactures Details**

1Norbrook Laboratories, Newry, Down, UK.

2MSD, Milton Keynes, Buckinghamshire, UK.

3Nimrod Veterinary Products Ltd, Moreton-in-Marsh Gloucestershire, UK

4Dechra Veterinary Products, Hadnall, Shrewsbury, Shropshire, UK.

5Vetoquinol UK Ltd, Buckingham, Buckinghamshire, UK.

6GE Healthcare, Chalfont St. Giles, Buckinghamshire, UK.

7Boehringer Ingelheim, Bracknell, Berkshire, UK.

8Diazepam CP Pharmaceuticals, Wrexham, Wales, UK.

9Zoetis UK Limited, Leatherhead, Surrey, UK

10National Veterinary Services Limited, Stoke-on-Trent, UK

11Eickemeyer Veterinary Equipment Ltd, Sunbury-on-Thames, Surrey, UK

12DMS Plus Limited, Alton, UK

13Martindale Pharmaceuticals, High Wycombe, Buckinghamshire, UK

14Bayer plc, Reading, Berkshire, UK

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**Figure Legend**

Figure 1: A fluid-filled mass on the medial aspect of the left thigh of a 14-year-old Warmblood stallion thirty-five days after initial evaluation.

Figure 2: Transverse ultrasonographic image of a hypoechoic fluid-filled mass located on the medial aspect of the left thigh in a 14-year-old Warmblood stallion. No abdominal viscera was identified but a hyperechoic poorly organised lining of the fluid filled sac could be visualised, which was later evident during surgery. Medial is to the left.

Figure 3a and 3b: Anatomical depiction of location of tear through the superficial inguinal ring and external rectus sheath resulting in a rent between the peritoneal cavity and femoral canal (red line). 3a demonstrates the proximal and distal extent of the femoral canal on the medial aspect of the left thigh. Adapted from Budras, et. al. (2009) and Sisson et. al. (1975). A. Adductor; A.E.R.S. Aponeurosis of external rectus sheath; F.C Femoral canal; F.L Facia latae; F.T Femoral triangle; G Gracilis; I Iliacus; L.A Linea alba; NVB yellow tube denotes the passage of the major femoral and saphenous neurovascular bundle and lymph nodes; O.I Obturator internus; P. Pectineus; P.M Pasoas major; R.F. Rectus femoris; S. Sartorius; S.I.R Superficial inguinal ring; S.M Semimembranosus; T.F Tensor faciae latae; V.M. Vastus medialis. Fig 3b is a caudoventral view of the inguinal region, dorsal is to the right and the left hind limb is abducted at the bottom of the image. A left sided tear in the aponeurosis of the external rectus sheath is indicated by the red line and the vascular lacuna is indicated by the purple line between the superficial inguinal ring and the femoral triangle.

Figure 4: The left testis of a 14-year-old Warmblood stallion with an identified external rectus sheath tear. Note the oedematous intact parietal tunic (triangle) and the markedly swollen external spermatic facia (stared).