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# Surgical management of marginal tears/avulsions of the suspensory ligament branches in 29 Thoroughbred racehorses

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**Keywords:** horse; suspensory ligament branch; tears; avulsions; surgery

**Summary**

**Background**: Suspensory ligament branch injuries are common in horses. Most of these injuries are grouped together and considered as a single pathologic entity.

**Objectives:** To report a specific injury of the abaxial margin of the suspensory ligament branches and to report its surgical management and outcome.

**Study design:** Retrospective case series.

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**Methods:** All horses with suspensory ligament branch injuries over a nine-year period (2007-2015) were identified. Horses with injuries which, on ultrasonographic examination, appeared to have defects in the abaxial margin of the suspensory ligament branch, that were subsequently confirmed during surgery were selected.

**Results:** Twenty-nine cases fulfilled the inclusion criteria with a specific lesion location on the abaxial margin of the suspensory ligament branch. Nineteen horses raced successfully after surgery, 9 returned to training but failed to race and one was lost to follow up.

**Main limitations:** The absence of a comparable population of non-surgically managed horses in this study means that the contribution of removing torn tissue cannot confidently be assessed.

**Conclusions:** The location and morphology of injuries described in this study is consistent, which suggests aetiopathogenic commonality. This case series suggests this type of injury has an identity of its own, differs from other types of suspensory ligament branch injuries and represents a previously undescribed subgroup.

## Introduction

Injuries to the branches of insertion of the suspensory ligaments (SLB) are common and are seen in all types of horses. In Thoroughbred racehorses SLB lesions are associated with reduced performance [1] and are an important cause of wastage [2,3]. Apart from a description of avulsion injuries of the dorsal (articular) surface of the SLB [4], most injuries and lesions of the SLB are grouped together and considered as a single pathologic entity. Specific treatment of intra-articular tears of the SLB has been described [4] however, a plethora of nonspecific treatment modalities are recorded in the literature for all other lesions of the SLB. These are similar to those employed for desmitis of the body and include rest, farriery techniques, supportive bandaging, varying forms and durations of controlled exercise, systemic and oral polysulphated glycosaminoglycans, intra-lesional injection of autologous platelet concentrates, mesenchymal stem cells, bone marrow aspirates, β aminopropionitrile fumarate, shockwave therapy and ligament splitting techniques [1,5-9]. Despite current concepts associated with regenerative therapies, it is generally accepted that horses cannot recreate the exact structure of the insertion of the suspensory branch following injury [10]. Healing consists of scar tissue and it is improbable that any type of scar tissue will be able to function in a similar fashion to the undamaged suspensory ligament branch [10]. Prognoses associated with clinical SLB injuries have been poorly documented in the literature and are mostly subjective. The prognosis for fast athletic function has been considered as guarded [5] or very guarded [11] and in racehorses as poor [12]. The presence of periligamentous fibrosis was considered to carry a poor prognosis [8,9]. In one report a degree of objectivity was introduced for juvenile injuries in Thoroughbreds. The study demonstrated that horses with juvenile SLB lesions raced significantly less as 2- and 3-year-olds (27% and 62% respectively) compared to unaffected horses (58% and 82%) [1]. This paper reports a subgroup of SLB injuries with a consistent, abaxial marginal location and their treatment by surgical removal of the disrupted tissue.

## Materials and methods

### *Inclusion criteria*

The medical records of all horses with lesions of the SLB diagnosed at Newmarket Equine Hospital between 2007 and 2015 were reviewed and 32 horses with abaxial marginal tears/avulsions were identified. Twenty-nine horses in which this was confirmed by surgical exploration were included in the study. Three cases had similar ultrasonographic findings but did not undergo and therefore were not confirmed by surgery. These were not therefore included.

### *Diagnostic procedures*

All horses were examined clinically by 2 authors (G.J.M. and I.M.W.) and a grade of lameness on a scale of 0 to 10 was recorded [13]. All affected and contralateral metacarpo/metatarsophalangeal joints were evaluated radiographically using dorsopalmar/plantar, dorsal45°lateral–palmaro/plantaromedial oblique, lateromedial, and dorsal45°medial–palmaro/plantarolateral oblique projections. In 24 cases additional oblique views were acquired (lateral45°proximal-medial distal oblique and medial45°proximal-lateral distal oblique projections) to profile the abaxial surface of respectively the medial or the lateral proximal sesamoid bone [14]. All radiographs were evaluated by 2 authors (G.J.M. and I.M.W.). Both SLBs of affected limbs were examined ultrasonographically in transverse and longitudinal planes with a linear transducer[a] (frequency optimised between 8.5 and 13 MHz) and standoff pad using both on and off incidence imaging following routine clipping and skin preparation. The thickness of layered echogenic material (fibrosis) adjacent to affected SLB was measured and graded as mild (<2.5 mm), moderate (2.5-5 mm) and marked (>5 mm). Ultrasonography, interpretation and measurements were all made by one author (G.J.M.).

*Surgical treatment*

Surgery was performed under general anaesthesia. All horses received phenylbutazone (4 mg/kg iv; Equipalazone[b]) pre-operatively. This continued for 0-33 (mean 9.8) days at 2 mg/kg i.v. or p.o. q24h post operatively. Sodium benzyl penicillin (22,000 iu/kg i.v.; Crystapen[c]) and gentamicin sulphate (6.6 mg/kg i.v.; Genta-Equine[d]) were administered pre-operatively to 18 (62%) horses and this was continued post operatively for 1-6 (mean 3) days (sodium benzyl penicillin q8h and gentamicin sulphate q24h). Eleven (38%) horses received enrofloxacin (5 mg/kg i.v.; Baytril[e]) pre-operatively and for 2-4 (mean 3) days post operatively q24h. Two horses that had received peri-operative sodium benzyl penicillin and gentamicin sulphate had a subsequent course of enrofloxacin for 14 days and 5 days following identification of a moist incision (6 days post operatively) and a seroma (7 days post operatively) respectively.

Unilaterally afflicted horses were positioned in lateral recumbency with the affected SLB upper most. Horses with bilateral injuries were positioned in dorsal recumbency. An Esmarch bandage and tourniquet were applied to a proximal metacarpal/metatarsal level. Following pre-operative skin preparation and application of drapes, an approximately 50 mm proximodistal linear incision was made at the dorsal margin of the palmar/plantar neurovascular bundle. The underlying metacarpal/metatarsal fascia was similarly divided and together with the attached neurovascular bundle separated from the SLB. These were then reflected palmar/plantar sufficiently to expose the palmar/plantar abaxial margin of the SLB.

Treatment consisted of isolation of the torn SLB fibres and removal by sharp dissection. Margins of the defect were then debrided with a motorised surgical resector[f] to visibly intact fibrillar arrangement. The metacarpal/metatarsal fascia and subcutis were closed with continuous sutures of 3 and 3.5 mm Polyglactin 910 (Vicryl[g]) respectively followed by stainless steel staples in the skin (Precise Vista[h]). A multi-layered counter pressure bandage was then applied.

*Post-operative care*

Bandaging with progressively decreasing bulk was maintained for 17-32 (mean 23) days post surgery. Skin staples were removed after 11-15 (mean 13) days post surgery. Horses were discharged from the hospital between 3 and 20 (mean 8) days post operatively. All were kept on box rest for 2 to 4 weeks followed by gradually increasing periods of walking exercise for 6 to 8 weeks. Thereafter the exercise was determined by individual case progress and horse requirement including the time of year and its relationship to racing seasons.

*Follow-up information*

Follow-up information was obtained by an evaluation of the race records from a publically available database[i].

## Results

The 29 horses included in the study consisted of 22 males, 5 females and 2 geldings; all were Thoroughbreds in flat race training. The ages were 1-8 (mean 2.4) years old. In 14 cases the time of injury was not recognised or reported by referring veterinary surgeons. Two cases were documented as acute. Four were reported to have occurred 1-6 (mean 4) weeks and five 2-16 (mean 5.2) months prior to referral. Two horses' injuries were recorded as >4, one as >5 and one as several months before referral. At presentation 24 horses were lame ranging from 1 to 5 out of 10. Five horses were not lame at admission but had been reported to be lame by the referring veterinary surgeon when the injury was identified. Twenty-two (75.8%) horses had forelimb, 6 (20.7%) had hindlimb injuries and one (3.4%) horse had injuries to both a forelimb and a hindlimb. There were 26 (81.1%) lateral SLBs and 6 (18.8%) medial SLBs. In 26 horses one SLB was involved and 3 cases involved 2 branches. Eleven cases involved only the right fore (RF), 9 only the left fore (LF), 4 only the left hind (LH) and 2 only the right hind limb (RH). In 2 cases the LF as well as the RF were affected and in one case there was injury to the LF and the LH. In the forelimbs 23 lateral and 2 medial branches were affected. In the hindlimbs 3 lateral and 4 medial branches were affected. Injury to the lateral suspensory branch was most common (79.3%) of which 92% were identified in the forelimbs. There was palpable thickening of and/or adjacent to all affected SLBs. This was greatest on the abaxial and palmar/plantar margins with loss in palmar/plantar definition of the SLB insertion (Fig 1). Digital pressure on the affected SLB elicited a withdrawal response in 10 cases and there was an increase in surface temperature in 4 cases. None of the affected limbs had distension of the metacarpo/metatarsophalangeal joint. Response to flexion was not assessed.

Radiographs demonstrated an irregular abaxial margin and radiopacity of the abaxial margin of the ipsilateral PSB in 18 limbs (56%) (Fig 2). There were widened radial lucencies in 6 (19%) bones and small mineral radiopacities proximal to the PSB in 5 (15%) limbs. Three cases had no evidence of radiological abnormalities.

Ultrasonographic evaluation (Table 1) in all cases demonstrated disruption of the palmar/plantar abaxial margin of the SLB immediately adjacent to the proximal sesamoid bone with a hypoechoic to anechoic defect and extrusion of echogenic material which was isoechoic to the SLB (Fig 3a). All affected SLBs had increased cross sectional areas compared to contra-axial branches. Layered echogenic material consistent with fibrosis was evident adjacent to all affected SLBs (Fig 3a) and was categorised as mild in 14, moderate in 10 and marked in 8 limbs respectively. There was irregularity of the hyperechoic abaxial surface of the PSB at the insertion of the SLB in 28 affected limbs (Fig 3b). Small hyperechoic foci within hypoechoic tracts which extended proximally from the SLB insertion were evident in 26 affected limbs (Fig 3b).

Surgery revealed combinations of haemosiderin deposits (consistent with previous haemorrhage), granulation tissue, fibrous adhesions and organised scar tissue adjacent to the margins of all affected SLB (Fig 4a, 5a). Granulation tissue, fibrous adhesions and periligamentous scar tissue overlying SLB defects were removed by sharp dissection. Lesions in the SLB had consistent locations and morphology consisting of palmar/plantar defects in the epidesmon containing bundles of haemorrhagic ligament fibres that had avulsed from the PSB (Fig 4b, 5b). Proximal recoil of the avulsed fibres was visible in 13 SLBs. Small mineralised fragments were attached to recoiled SLB fibres in 8 limbs. Lesion margins were identified by an intact surface to and fibrillar arrangement within the SLB (Figs 4c, 5c).

Post-operative complications occurred in 5 cases. Three horses showed mild abdominal pain post-operatively; all responded to medical management. One horse developed a moist area associated with the incision and another a seroma; the horses received additional antimicrobial drugs as previously described. These and all other surgery sites healed by first intention.

Follow-up information was available for 28 of the 29 cases. Nineteen horses raced (66%); 17 in flat and 2 in jump races. They had 1-27 (mean 9; median 4) starts for an aggregate of 10 wins and 14 places. Four horses did not win or place. Time from surgery to the first race was 6-30 (mean 15; median 15) months. Only 3 horses raced before injury so direct comparison regarding athletic capability was not possible. Of the 9 that did not race, one suffered a re-injury, 3 sustained separate injuries and 5 were sold.

**Discussion**

Injuries to the SLB are common and seen in all type of horses [8]. Subclinical ultrasonographic abnormalities have also been reported in horses which race on the flat [2,20] and over fences [3]. A post mortem study in Thoroughbred racehorses demonstrated correlation between forelimb SLB lesions and subsequent catastrophic (life ending) suspensory apparatus failure and fracture of the lateral condyle of the third metacarpal bone in the contralateral limb [15]. It has been suggested that in sports horses usually only a single SLB in a single limb is affected but both branches may be affected particularly in the hindlimbs [8]. A study of SLB injuries in sports horses found no overall difference in limb or side distribution [9]. In the current series, forelimbs were more commonly affected than hindlimbs which is in accord with previous reports of SLB injuries in racing Thoroughbreds [1,2,12]. Sidedness (left fore most common) was evident in a study of SLB lesions in Thoroughbred yearlings in the USA [1]; this may be a reflection of anticlockwise training direction as it has not been recognised in the current group or other studies of racing Thoroughbreds from the UK [2,3]. Studies of Thoroughbred racehorses have consistently identified abnormalities in medial more frequently than lateral SLB [2,3,15]. Lesions reported in the current study were more common laterally than medially but none of the previous publications made any differentiation of lesion type or location within the SLB.

Although it has been suggested that some horses with clinical signs of SLB desmitis have no ultrasonographic evidence of fibre disruption [16], in most cases this is pivotal to lesion identification [1-6,8,9,11,12]. In the cases reported, four abnormalities, increased cross sectional area, a defect in the palmar/plantar abaxial margin, extrusion of disrupted ligament fibres and adjacent layered echogenic tissue, were consistent features. Irregularity of the abaxial surface of the PSB at the insertion of the SLB (88%) and small hyperechoic foci within the SLB defects (81%) were also common findings. A 3 grade classification system based on subjective assessment of hypoechoic or anechoic areas in static recorded transverse ultrasound images was used in a study of SLB lesions of yearling Thoroughbreds [1]. However, this did not document lesion location within the SLB and was considered inappropriate for the current study.

Surgical exposure of lesions revealed a consistent lesion morphology in which the palmar/plantar abaxial margin of the SLB was disrupted and the defect contained torn and haemorrhagic ligament which had avulsed from the PSB. There was good agreement between the surgical findings and pre-operative ultrasonographic evaluations. As there appears to be no evidence in the literature of an intrinsic mechanism to remove disrupted collagenous tissue, the authors' hypothesis was that removal of torn/avulsed tissue may limit chronic inflammatory drive and enhance formation of inert scar tissue.

In the current study return to racing was reasonable (66%) and exceeded both anecdotal [5,11] and quantifiable [12] expectations from the literature particularly in the light of periligamentous fibrosis as previously reported in sports horses [8,9]. However, outcome comparison with other treatments is impossible as the current cases are a specific pre-selected group of SLB injuries whereas previous reports have grouped lesions in a non-specific manner. A study of yearling Thoroughbred racehorses reported 66% racing, 27% as two-year-olds and 62% as three-year-olds compared to 89%, 57% and 82% of unaffected cohorts following identification of insertional SLB lesions. However, the degree of initial clinical compromise in this group is unclear [1]. Seventy-two percent (13 of 18) intra-articular SLB tears in mixed use horses (including 6 racing Thoroughbreds) returned to an equal or greater level of performance following arthroscopic removal of torn/avulsed tissue [4]. Forty-four percent (10 of 23) sports horses with primary SLB lesions returned to athletic function for ≥one year after diagnosis. Periligamentous fibrosis adversely influenced outcome [9].

The cases reported here all had defects in the palmar/plantar abaxial margin of the SLB adjacent to the PSB and appeared to be avulsion injuries. The majority of subclinical ultrasonographic abnormalities recognised in Thoroughbred horses in flat race training were also noted to be in this location [2] which may represent a prodromal form of the lesions reported here. Why the injuries occur at this site and why there appears to be a lateral predisposition are not known. Nonetheless, the consistent site and morphology of the lesions reported suggest pathogenetic commonality. The lesions are recognisable ultrasonographically but the radiological evidence of sesamoiditis, based principally on the number and nature of radial lucencies (vascular channels) reported in other SLB injuries in young racing Thoroughbreds [17,18] does not appear with a high level of frequency in this study (6 out of 32 limbs; 19%). In a post mortem study of racing Thoroughbreds, SLB lesions were most common adjacent to the PSB and the authors considered the bone-ligament interface as susceptible to injury [15]; the results of the current study support this premise. By contrast an in vitro study suggested that fatigue of the muscular elements in the body of the suspensory ligament may explain the high incidence of lesions at the insertion and the branches [19]. However, the gross appearance of the lesions in the current study is more akin to the failure of the bone-ligament interface.

The surgical treatment employed is based on basic pathophysiologic principles and is a different approach to the current trend for use of "regenerative" therapies for tendon or ligament injuries in horses. It is considered to be contributory to outcome but in the absence of a comparable population of non-surgically managed horses, cannot confidently be assessed. Identification of further subgroups of lesions may direct more specific management protocols and thus enhance prognosis.

Twelve out of 29 horses had re-examination and ultrasonography at Newmarket Equine Hospital by I.M.W. and G.J.M. following surgery. This was thought insufficient in number to draw conclusions and not included in the results and is a limitation to analysis of follow up expectations. This is likely to remain difficult to generate due to many cases returning to their owners or rehabilitation facilities remote from the hospital when re-evaluation is performed by the referring veterinary surgeon or a different veterinary surgeon producing variability in both assessment and imaging.

Fluoroquinolones have been defined as critically important antimicrobials for human use [20]. A previous study from our hospital documented an association between sodium benzyl penicillin and post-operative colic [21]. This prompted a change in peri-operative prophylactic antimicrobial medication and, after consideration of potential surgery site contaminants, their likely antimicrobial susceptibility profiles, suitable routes of administration and licencing for equine use, enrofloxacin was selected. Initially one (of four) surgeons cases received enrofloxacin. No complications were encountered and a reduction in post-operative colic rate followed. This antimicrobial strategy was then adopted in, appropriate cases, across the hospital's surgical population. The presence of a moist incision and the dead space associated with a post-operative seroma were considered, on clinical grounds, sufficient justification for prolonging antimicrobial administration beyond the peri-operative period

**Authors' declaration of interest**

No competing interests have been declared.

**Ethical animal research**

Research ethics committee oversight not required by this journal: descriptive clinical report. Explicit owner informed consent for inclusion of animals in this study was not stated.

**Authorship**

D. Kadic was responsible for data collection and wrote an initial draft of the paper. G. Minshall and I. Wright proposed the hypothesis, designed the study, diagnosed and operated on the cases and rewrote the paper. All authors approved the final draft.

**Figure legends:**

**Fig 1:** Visible change in limb contour produced by plantar abaxial swelling of and adjacent to the lateral suspensory ligament branch insertion (arrows) in a left hindlimb.

**Fig 2:** Radiographs of the right metacarpophalangeal joint of the horse illustrated also in Figs 3 and 4.

a) Dorsopalmar projection demonstrating irregularity of the abaxial margin of the lateral proximal sesamoid bone (between arrows).

b) Dorsolateral-palmaromedial oblique projection demonstrating irregularity of the abaxial margin with an ill-defined zone of radiolucency (arrows) in the lateral proximal sesamoid bone. A small amount of entheseous new bone is evident on the distal palmar margin of the bone (circled).

c) Medial 45$^{o}$ proximal-lateral distal oblique projection demonstrating irregular radiolucency (arrows) adjacent to the abaxial margin of the lateral proximal sesamoid bone.

**Fig 3:** Ultrasonographic images of the lateral suspensory ligament branch (SLB) of the horse in

Figs 2 and 4.

a) Transverse image demonstrating irregular disruption of the palmar abaxial margin of the SLB immediately adjacent to the proximal sesamoid bone. Echogenic material, isoechoic to the SLB is seen extending palmar to the SLB and consistent with extruded torn tissue (arrows). Layered echogenic material consistent with periligamentous fibrosis is also evident. D = dorsal, Pa = palmar, SLB = suspensory ligament branch, 2 white lines = superficial skin surface, 4 yellow lines = skin/periligamentous fibrosis interface, 2 yellow lines = abaxial margin of the SLB/periligamentous fibrosis interface.

b) Longitudinal image demonstrating irregularity of the abaxial surface of the proximal sesamoid bone (between round headed arrows). Hyperechoic foci (arrows) are present in the tract of hypoechoic SLB (arrow heads) consistent with bone debris in avulsion tract found at surgery. Pr = proximal, Di = distal.

**Fig 4:** Intraoperative photographs of the horse illustrated in Figs 2 and 3.

a) Initial exposure of the suspensory ligament branch (SLB) by palmar reflection of the lateral neurovascular bundle secured by Gelpi retractors revealing adhesions extending from a palmar abaxial defect in the SLB (between arrows).

b) Removal of adhesions reveals a defect in the palmar abaxial margin of the SLB containing a bundle of avulsed haemorrhagic ligament fibres (between arrows).

c) Appearance following removal of the torn/avulsed tissue and debridement to organised tissue margins.

D = dorsal; Pa = palmar; Pr = proximal; Di = distal.

**Fig 5:** Intraoperative photographs oriented as Fig 4 demonstrating consistent location of the lesion of a right fore lateral suspensory ligament branch

a) Granulation over and adjacent to the avulsed tissue and haemosiderin deposits in the metacarpal fascia.

b) Isolation of extruded avulsed fibres.

c) Appearance following debridement.

**Table 1:** Ultrasonographic findings in 32 limbs with palmar/plantar abaxial defects in suspensory ligament branches.

| **Ultrasonographic findings** | **LF** | | **RF** | | **LH** | | **RH** | | **Total %** |
|---|---|---|---|---|---|---|---|---|---|
| | L | M | L | M | L | M | L | M | |
| Total number of affected SLBs | 12 | 1 | 11 | 1 | 3 | 2 | 0 | 2 | 32 |
| Enlargement of the SLB | 12 | 1 | 11 | 1 | 3 | 2 | 0 | 2 | 32 (100%) |
| Palmar/plantar defect in SLB with extrusion of echogenic material isoechoic to the SLB | 12 | 1 | 11 | 1 | 3 | 2 | 0 | 2 | 32 (100%) |
| Communication between insertional hypoechoic area and palmar/plantar defect in SLB | 12 | 1 | 11 | 1 | 3 | 2 | 0 | 2 | 32 (100%) |
| Layered echogenic periligamentous tissue | 12 | 1 | 11 | 1 | 3 | 2 | 0 | 2 | 32 (100%) |
| Mild (<2.5 mm) | 5 | 1 | 8 | | | | | | 14 (44%) |
| Moderate (2.5 mm-5 mm) | 3 | | 3 | 1 | 2 | 1 | | | 10 (31%) |
| Marked (>5 mm) | 4 | | | | 1 | 1 | | 2 | 8 (25%) |
| Irregular hyperechoic abaxial surface of the PSB at the insertion of the SLB | 10 | 1 | 9 | 1 | 3 | 2 | 0 | 2 | 28 (88%) |
| Hyperechoic foci in hypoechoic zone in SLB proximal to its insertion | 10 | 1 | 8 | 1 | 3 | 2 | 0 | 1 | 26 (81%) |

LF = left fore; RF = right fore; LH = left hind; RH = right hind; L= lateral; M = medial

SLB = suspensory ligament branch; PSB = proximal sesamoid bone.

**Manufacturers' addresses**

[a]GE Healthcare, Amersham, Buckinghamshire, UK.

[b]Dechra Veterinary Products, Skipton, North Yorkshire, UK.

[c]Pitman-Moore Ltd, Crewe, Cheshire, UK.

[d]Franklin Pharmaceuticals Ltd, Trim, Co. Meath, Ireland.

[e]KVP Pharma and Veterinär Produkte GmbH, Kiel, Germany.

[f]Smith & Nephew Endoscopy, Huntingdon, Cambridgeshire, UK.

[g]Johnson & Johnson, Edinburgh, Midlothian, UK.

[h]3M Health Care, St. Paul, USA.

[i]http://racingpost.co.uk

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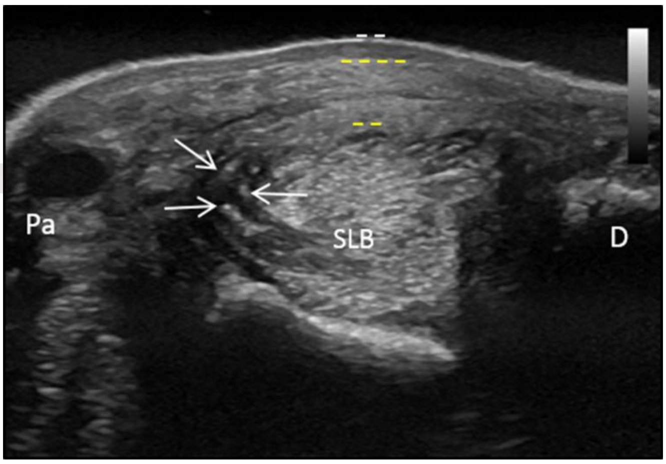
Pa
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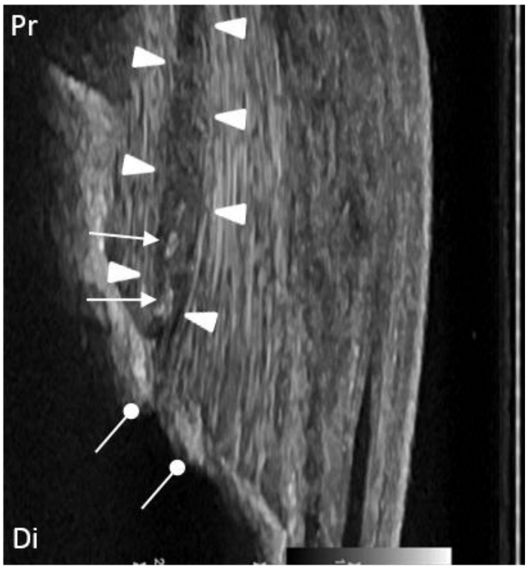

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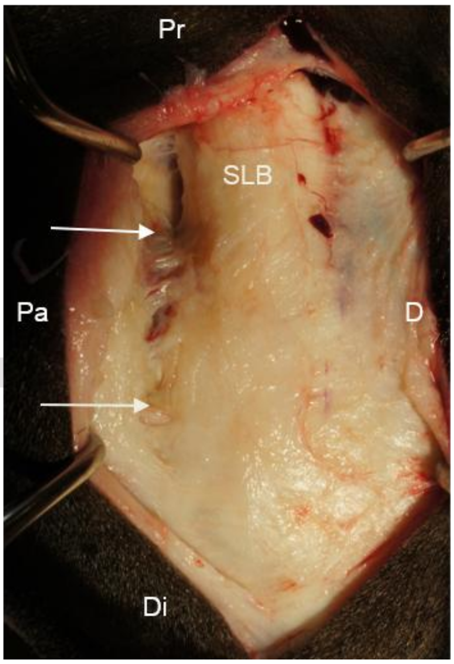

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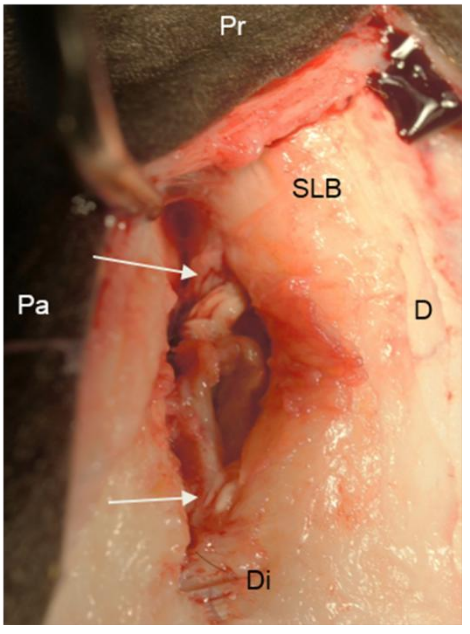
Pr
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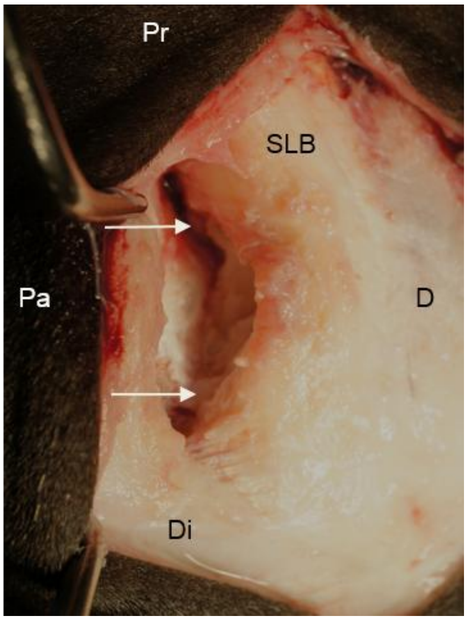
Pr
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