Satellite Article

The equine bicipital apparatus - review of anatomy, function, diagnostic investigative techniques and clinical conditions

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Introduction

This article accompanies the Case Report by Hawe and McDiarmid (p 60). It describes the anatomy and function of the bicipital apparatus, the technique of investigation and various conditions that may be encountered in practice.

Anatomy and function

The equine *biceps brachii* (bicipital apparatus) is a complex structure that has 2 functions: contributing to the forelimb passive stay apparatus and assisting in forelimb protraction (Gyuru and Zajer 1982; Hermanson et al. 1991). The bicipital apparatus spans the scapulohumeral (shoulder) and elbow joints and this permits the extension of the shoulder and flexion of the elbow.

The *biceps brachii* originates from the supraglenoid tubercle of the scapula. In the proximal area it is entirely tendonous and has a bilobed structure with an isthmus connecting the 2 lobes (Sisson 1975; Reef 1998). This bilobed structure conforms to the ‘M’ shape of the cranial humerus (Fig 1). The lateral lobe of the tendon is ‘tear drop’-shaped and the medial lobe has an elongated rectangular shape (Gillis 1996). Interposed between the tendon and the humerus is the intertubercular (bicipital) bursa. Considering the embryonic development and function, the intertubercular bursa resembles a tendon sheath (Dyson 1991). The humeral surface of the bursa is covered with fibrocartilage but its composition does not appear to have been described.

The tendon of the *biceps brachii* muscle is bound down to the proximal humerus by a tendonous band of the *pectoralis ascendens* muscle that extends between the lesser tubercle and the cranial part of the greater tubercle of the humerus (Sisson 1975). The tendon continues through the more distal *biceps brachii* muscle and divides into 2 portions. The short (thicker) tendon inserts onto both the radial tuberosity and the medial collateral ligament of the elbow. The long tendon (*lacertus fibrosus*) blends with the fascia of the forearm and the medial collateral ligament of the elbow. The long tendon (*lacertus fibrosus*) blends with the fascia of the forearm and the tendon of the extensor *carpi radialis* (Sisson 1975). Palmieri et al. (1986) proposed that the *lacertus fibrosus* may co-ordinate the action of both the *biceps brachii* and the extensor *carpi radialis* muscles and, therefore, synchronise shoulder, elbow and carpal joint movements.

![Fig 1: Post mortem demonstration of the intertubercular bursa. Note the bilobed structure of the biceps brachii tendon and the adjacent ‘M’ shape of the cranial humerus. X = intermediate tubercle of the humerus.](image1)

![Fig 2: Site for synoviocentesis of the intertubercular bursa. The needle is inserted at the cranio-lateral edge of the humerus (black) in a medial and proximal direction beneath the biceps brachii tendon (red).](image2)
Fig 3: Mediolateral radiograph of a colt age 20 months that had 2 months previously fractured the supraglenoid tubercle. The fracture is markedly displaced cranially and appears irregular in outline due to concurrent fracture rotation. The fracture also involves a significant portion of the cranial aspect of the glenoid cavity.

The *biceps brachii* muscle has 2 heads; **medial** and **lateral**. The **medial head** contains primarily *type II* myofibrils and the **lateral** mainly the relatively shorter *type I* myofibrils (Hermanson and Hurley 1990). This arrangement suggests that the lateral head of the *biceps brachii* contributes to the postural role of the muscle and the medial head is important during dynamic activity during movement (Hermanson et al. 1991).

**Investigative techniques for bicipital disorders**

**Intra-synovial anaesthesia of the intertubercular bursa**

This is performed approximately 3 cm proximal to the deltoid tuberosity, at the craniolateral edge of the humerus (Adams and Blevins 1989). A 7.6 cm 18-gauge needle is inserted in a medial and proximal direction under the *biceps brachii* tendon (Fig 2). Synovial fluid can usually be retrieved before deposition of 15 ml of local anaesthesia. Communication between the scapulohumeral joint and the intertubercular bursa occurs in some horses (Dyson 1986) and this may result in a false positive result to intrasynovial anaesthesia (Grant et al. 1992).

**Ultrascanography**

A 7.5 MHz transducer is usually sufficient to examine the *biceps brachii* tendon, the intertubercular bursa and the underlying surface of the humerus; however, in larger horses, a 5 MHz transducer may be required (Reef 1998). In the proximal area, each lobe of the *biceps brachii* tendon should be independently assessed and it is useful to compare any suspicious findings with the contralateral limb (Gillis and Vatistas 1997). The tendon has a relatively uniform homogenous echogenicity with a parallel fibre pattern (Crabill et al. 1995; Reef 1998). Care must be taken not to mistake artefactual areas of reduced echogenicity as intratendonous lesions (Fornage 1987). Deep to the tendon, the combined intertubercular bursa space and humeral cartilage is represented by a narrow (<3 mm wide) hypoechoic space (Crabill et al. 1995). Fluid distension of the bursa is indicated by an outpouching of the lateral and medial recesses of the bursa either side of the tendon. In young horses, the intermediate tubercle is variably ossified and this can result in scattered hyperechoic foci, representing early mineralisation within the hypoechoic cartilage of the tubercle (Pugh et al. 1994).

**Radiography**

The two standard radiographic projections, mediolateral and cranio-medial-caudolateral oblique are taken with the limb protracted (Adam and Blevins 1989). In large horses, general anaesthesia may be required to obtain good radiographs of the distal scapula. A cranioproximal-craniodistal oblique (skyline) projection of the proximal aspect of the humerus is useful to outline the tubercles and intertubercular grooves (Adam and Blevins 1989). This projection was originally described with the horse under general anaesthesia; however, the author has obtained good results in standing horses.

**Endoscopy**

Endoscopy of the intertubercular bursa has recently been described (Adams and Turner 1999). The arthroscope is placed in a similar position to that described for synoviocentesis. The tight interdigitation of the tendon over the tubercles prevents the passage of the arthroscope over the intermediate tubercle to allow examination of the entire medial intertubercular groove.

**Nuclear scintigraphy**

Nuclear scintigraphy can occasionally be of use, as in the case described by Hawe and McDiarmid (1999), but the overlying thorax and lungs can cause artefacts.

**Clinical conditions affecting the equine bicipital apparatus**

**Fractures of the supraglenoid tubercle**

Supraglenoid tubercle fractures represent approximately 1% of all equine fractures (Adams 1996). They occur in horses of all ages, but most commonly affect animals under 2 years of age (Leitch 1977; Dyson 1985; Panowski
et al. 1986; Adams 1996). In foals, the fracture usually occurs through the physis and is therefore classified as a Salter Harris (SH) fracture (Leitch 1977). The supraglenoid tubercle and the cranial part of the glenoid cavity develop as 2 separate centres of ossification (Sisson 1975) and fuse with the parent bone by 9–12 months of age (Pankowski et al. 1993). In foals, most supraglenoid fractures involve both physii and are, therefore, intra-articular (Dyson 1985; Adams 1996). In one survey, supraglenoid tubercle fractures were the fifth most common SH fracture and the third most common forelimb SH fracture (Embertson et al. 1986). In older horses, supraglenoid tubercle fractures usually follow the line of the closed physis and are usually intra-articular (Leitch 1977; Dyson 1985; Adams 1996).

Typical signs associated with fractures of the supraglenoid tubercle are diffuse swelling in the cranial shoulder area, resenment of shoulder manipulation and an absence of tautness in the biceps brachii tendon (Adams 1996). Horses may bear weight on the limb, but there is usually difficulty in protracting the lower limb and a shortened cranial phase of the stride is present (Wagner et al. 1985). Severe lameness and swelling often resolve within 48–72 h (Adams 1996). Long-standing fractures may present with severe shoulder muscle atrophy and may resemble suprascapular nerve damage (Dyson 1985).

Radiography usually reveals the fracture to be markedly displaced in a cranial direction (Fig 3). The fragment often appears irregular in outline, as it tends to rotate (Leitch 1977). Care should be taken not to pull the limb too far forward when obtaining a mediolateral projection as this may reduce biceps brachii tension on the fragment resulting in an underestimate of the degree of distraction (A. McDiarmid, unpublished data). In chronic cases, there may be evidence of osteoarthritis of the scapulohumeral joint (Dyson 1985; Adams 1996).

Earlier attempts to stabilise the supraglenoid tubercle fractures with internal fixation failed due to the strong distractive forces of the bicipital apparatus (Leitch 1977) and internal fixation is now longer recommend for large horses (Adams 1996). Recently, internal fixation combined with partial tenotomy of the biceps brachii tendon has been successful in 2 small (<380 kg) horses (Adams 1987). Two long, 6.5 mm diameter cancellous bone screws or three 5.5 mm cortical screws (both >80 mm) placed in lag screw fashion were used (Adams 1987).

Resection of the fractured supraglenoid tubercle has been successful in returning horses to soundness (Wagner et al. 1985; Pankowski et al. 1986). Following resection, the tendon reattaches to the scapula by fibrosis (Leitch 1977). Resection is probably the most successful treatment in horses with severely comminuted fractures, chronic fractures difficult to reduce due to local fibrosis and in heavy horses (Adams 1996). It should be undertaken before degenerative changes develop in the scapulohumeral joint (Leitch 1977). Three of 5 cases treated with resection of the tubercle returned to soundness, whilst the other 2 were destroyed due to osteomyelitis and septic arthritis of the scapulohumeral joint (Leitch 1977; Pankowski et al. 1986).

Most horses regain pasture soundness following conservative management (Leitch 1977) but there is only one report of a horse successfully returning to athletic work (Pankowski et al. 1986). The fractures may heal by bony union (Dyson 1985) but scapulohumeral joint osteoarthritis often develops with intra-articular fractures (Adams 1996).

Tension band application using Kirchner wires and cerclage wire was successful in a 3-week-old foal (Leitch 1977). This procedure could only be used for very young animals.

In summary, the prognosis for athletic soundness following internal fixation is fair, but too few cases have been reported to critically compare the various techniques (Panowski et al. 1986; Adams 1996). If the fracture involves the cranial glenoid cavity, the prognosis is poorer than those just involving the tubercle alone (Pankowski et al. 1986).

**Septic bursitis**

This usually arises following a wound to the cranial aspect of the shoulder (Grant et al. 1992; Vatistas et al. 1996) (Fig 4) with signs often occurring several weeks after the original penetration (Riggs et al. 1985). The disorder has also been associated with Brucella abortus infection (Cosgrove 1961) or following fragmentation of the tubercles of the humerus (Pugh et al. 1994).

Lameness is usually severe and associated with a marked head elevation as the affected limb is advanced. There is usually a difficulty in limb protraction and a reduced cranial phase of the stride (Dyson 1986). Pain and bursal distension may be evident on palpation of the cranial edge of the proximal humerus (Dyson and Dik 1995). Ultrasonography can help assess the nature of the synovial fluid (Fig 5), locate the best site for synoviocentesis and in long-standing cases, identify defects in the fibrocartilage and underlying humerus (Pugh et al. 1994; Vatistas et al. 1996). Septic bursitis is confirmed by synovial fluid analysis.

The prognosis following septic bursitis has been quoted as poor; however, Riggs et al. (1995) and Vatistas et al. (1996) found that this is not always true. Surgical treatment is preferred over medical therapy (Grant et al. 1992; Riggs et al. 1995). Although through and through lavage has been successful in the treatment of septic intertubercular bursitis, open drainage of the bursa has proved to give better results (Vatistas et al. 1996). Endoscopy has recently been used in the treatment of septic intertubercular bursitis (Tudor et al. 1998) and is preferred to bursotomy. Partial synovectomy may improve the prognosis with either method of surgical treatment (Vatistas et al. 1996).

**Tendonitis of the biceps brachii tendon**

The accompanying report describes a case of biceps brachii tendonitis (Hawe and McDiarmid 1999). This condition affects all types of athletic horses including racehorses (Thoroughbred, Standardbred and Quarter Horses), show jumpers and Western competition horses (Gillis 1996). Lameness is often severe and is characterised by a
shortened cranial phase of the stride and reduced arc of foot flight (Gillis and Vatistas 1997). The lameness may temporarily respond to a short period of box rest, but often reappears following resumption of exercise. Horses initially show heat, pain and swelling in the region of the biceps brachii tendon (Reef 1998) and the lameness usually responds to intrasynovial anaesthesia of the intertubercular bursa (Dyson and Dik 1995).

Ultrasoundographic changes observed within the biceps brachii tendon include enlargement of one or both heads of the tendon in comparison to the contralateral limb, focal or generalised areas of reduced echogenicity and poor quality fibril pattern in a longitudinal plane (Adams et al. 1989; Gillis and Vatistas 1997; Reef 1998). An associated intertubercular bursal effusion is often present (Gillis 1996; Reef 1998). In chronic cases, areas of dystrophic calcification may develop within the tendon (Gillis and Vatistas 1997). Primary ossification within the biceps brachii tendon has also been recorded (Meagher et al. 1979). It is unclear from this report whether the calcification was dystrophic calcification secondary to chronic biceps brachii tendonitis, or noninflammatory ossification.

Initial treatment consists of nonsteroidal anti-inflammatory agents and cold therapy to the affected area. Intrathecal hyaluronan may reduce inflammation and adhesion formation whilst polysulphated glycosaminoglycans and therapeutic ultrasound may also be of benefit. A controlled exercise programme is an essential part of the treatment. The total period of rest advised for horses with biceps brachii tendonitis is 6–9 months (Gillis and Vatistas 1997).

The prognosis is better for early-recognised cases than chronic tendonitis (Reef 1998). In a series of 48 cases of biceps brachii tendonitis at the University of California, 58% of acute/subacute tendonitis returned to full work, while only 28% of chronic cases did so (Gillis 1996). Horses with chronic biceps brachii tendonitis may have a poorer prognosis due to permanent enlargement of the tendon within the confined space between the tendonous band of the pectoralis ascendens and humerus (Gillis and Vatistas 1997; Reef 1998). It may be possible to reduce the constriction by transendoscopically transecting the tendonous band of the pectoralis ascendens (Adams and Turner 1999), using a technique similar to that described for fetlock annular ligament desmotomy (Nixon et al. 1993).

Aseptic intertubercular bursitis

The clinical signs associated with this are similar to those of biceps brachii tendonitis (Reef 1998). Ultrasonography reveals increased fluid, fibrin and loculations within the intertubercular bursa (Gillis and Vatistas 1997; Reef 1998). Synoviocentesis should be undertaken to rule out septic bursitis. In chronic cases, thickening of the synovial membrane is often present and adhesions may develop between the tendon and the bursal lining (Reef 1998). Treatment is as described for tendonitis of the biceps brachii but intrathecal medication with corticosteroids has also been used (Gillis and Vatistas 1997). In nonresponsive cases, endoscopic lavage of the bursa may be undertaken. It is important to differentiate aseptic intertubercular bursitis from tendonitis of the biceps brachii due to the different treatment requirements and better prognosis for aseptic bursitis. Ultrasonographic re-examination at 45 days has been recommended to assess resolution of the bursitis (Gillis 1996). If the bursal effusion has resolved and the synovial fluid is anechoic, then training can be reintroduced. It should be noted that increased effusion within the intertubercular bursa may develop following scapulohumeral joint problems, fractures and can be associated with tendonitis of the biceps brachii tendon.
Fig 6: Mediolateral radiograph of the proximal humerus demonstrating the presence of an osseous cyst-like lesion in the proximal humerus (open arrows).

Medial displacement of the bicipital apparatus

McDiarmid (1997) described a case of medial displacement of the bicipital apparatus in a Shire cross yearling diagnosed by ultrasonography and confirmed at post mortem. This horse had clinical features to a similar condition in humans and dogs. The entire biceps brachii tendon was medially displaced, resulting in the isthmus resting over the lesser tubercle of the humerus rather than the intermediate tubercle. It was unclear whether this case was congenital or acquired. In humans and dogs medial displacement of the biceps brachii tendon is usually an acquired condition.

Enthesiopathy at the insertion of the biceps brachii

Oikawa and Narama (1998) described 2 horses with enthesiophyte formation at the insertion of the short biceps brachii tendon on the radial tuberosity. Both horses had a history of nondiagnosed forelimb lameness and were destroyed for unrelated problems. Histology revealed changes that were consistent with enthesiophyte formation. Nuclear scintigraphy and ultrasonography would be required to confirm the clinical significance of these features.

Fractures

Fractures and osteitis of the humeral tubercles usually occur following trauma such as a kick or fall (Grant 1992; Pugh et al. 1994). When associated with an open wound there may be concurrent septic intertubercular bursitis and tenosynovitis (Bohn et al. 1992; Pugh et al. 1994). Ultrasonography is useful in the diagnosis and management of these cases (Bohn et al. 1992). Treatment involves removal of the fragment and management of the septic bursitis as previously described (Grant et al. 1992).

Osseous cyst-like lesion of the proximal humerus

The author has observed this condition in a show jumper with history of chronic intermittent forelimb lameness associated with a marked reduction in the cranial phase of the stride, that was more apparent at the walk than the trot or canter. At times, the cranial phase of the stride was only 30–40 cm.

Lameness was isolated to the proximal humeral area by nuclear scintigraphy and intertubercular bursal pain was confirmed by intrasynovial anaesthesia of the intertubercular bursa. Radiography of the proximal humerus revealed a discrete radiolucent area with a sclerotic rim in the lateral intertubercular groove (Fig 6). The lesion could have been classified, radiographically, as an osseous cyst-like lesion.

Miscellaneous conditions

Dyson and Dik (1995) described a horse with a haematoma within the intertubercular bursa. The author has treated a horse following a wound to the cranial aspect of the shoulder that developed adhesions between the brachiocephalicus muscle and the cranial aspect of the biceps brachii tendon (Fig 7). Stanek and Edinger (1992) described a horse with a metastatic tumour in the proximal humerus affecting the bicipital apparatus.
Conclusion
The equine bicipital apparatus can be affected by a number of disorders and a detailed examination should be undertaken before the commencement of any treatment.

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References


