ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/228011995

Treatment of upward fixation of the patella in the horse: An update

Article *in* Equine Veterinary Education · January 2010

DOI: 10.1111/j.2042-3292.2003.tb00534.x

CITATIONS
5

READS
5,830

1 author:

Aziz Tnibar

62 PUBLICATIONS **234** CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:

The use of a stent bandage in horses undergoing exploratory celiotomy View project

PAAG / Arthramidvet View project

All content following this page was uploaded by Aziz Tnibar on 20 November 2017.

The user has requested enhancement of the downloaded file.

EQUINE VETERINARY EDUCATION
Equine vet. Educ. (2003) **15** (5) 236-242

Satellite Article

Treatment of upward fixation of the patella in the horse: an update

A. TNIBAR

Clinique Equine, Ecole Nationale Vétérinaire d'Alfort, 7 Avenue du Général de Gaulle, 94704 Maisons-Alfort, France.

Keywords: horse; lameness; stifle; upward fixation of the patella; treatment; surgery

Introduction

Upward fixation of the patella (UFP) in the horse was well known in antiquity (Apsyrtos cited by Leclainche 1955). In the standing position of the equine hindlimb, the patella is located at the top of the femoral trochlea, and the medial patellar ligament, with its parapatellar fibrocartilage, hooks over a notch of the medial ridge of the femoral trochlea. This locking mechanism enables the horse to remain in the standing position with minimal muscular effort (Nickel *et al*. 1986; de Lahunta and Habel 1986). When the stifle is flexed, the *quadriceps femoris* muscle first contracts to lift the patella clear of the notch, then relaxes to allow it to slide down the trochlea (Nickel *et al*. 1986).

Upward fixation of the patella occurs when the medial patellar ligament with its parapatellar fibrocartilage fails to disengage the notch of the medial ridge of the femoral trochlea at the commencement of limb flexion. In that position, the stifle cannot be flexed and, as a result of the reciprocal apparatus, the hindlimb is fixed in extension with the fetlock flexed. Consequently, the horse assumes a posture with the affected limb extended in a caudally abducted position (**Fig 1**). **In this issue** (p 233), an unusual case of permanent UFP in a foal is described (Toniato and Torre 2003).

This article is intended to provide an update on the current knowledge of treatment of UFP in the horse.

Anatomical considerations

Three patellar ligaments (**lateral**, **middle** and **medial**) (Sisson 1975) act as the functional insertions of the *quadriceps femoris* and *biceps femoris* muscles in attaching the patella to the tuberosity of the tibia (**Fig 2**). **The medial patellar ligament is longer and weaker than the others** (Sisson 1975). This ligament runs in an oblique distolateral direction,

Fig 1: Typical posture of upward fixation of the patella in a 4-year-old Anglo-Arabian horse.

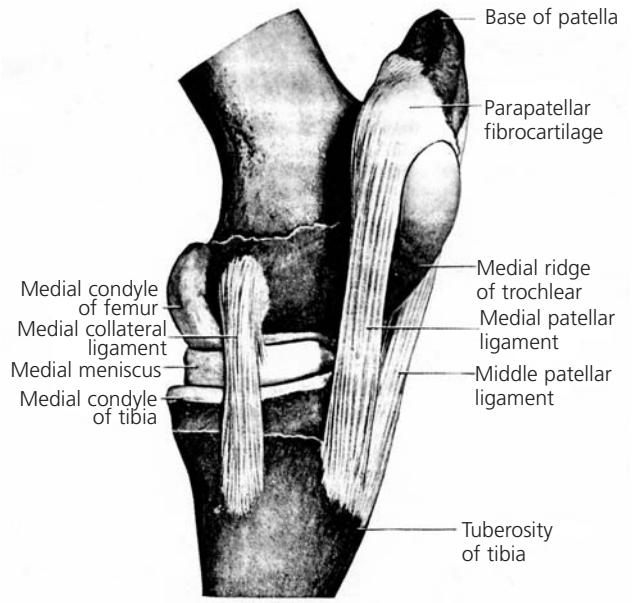

Fig 2: Left stifle joint in the horse; medial view (Sisson 1975).

has its origin on the parapatellar fibrocartilage and inserts on the craniomedial aspect of the tibial tuberosity. Caudally, the medial patellar ligament lies in close proximity to the synovial membrane of the femoropatellar joint. Cranially, the femoral fascia lies between the ligament and the skin. In its distal half, the medial patellar ligament lies over the infrapatellar fat pad. The caudal margin of this ligament is confluent with the common aponeurosis of the *sartorius* and *gracilis* muscles, whereas its proximal part furnishes insertion to portions of the *vastus medialis* muscle (Sisson 1975). **On ultrasonography**, the medial patellar ligament has a craniocaudal thickness of 6–10 mm in mature horses (Denoix *et al*. 1996) and approximately 4 mm in Shetland ponies (M.A. Tnibar, unpublished data).

Aetiology and pathogenesis

The aetiology and pathogenesis of UFP are not well understood, although some **predisposing factors** are recognised. These include **poor muscular conditioning**, **conformation of the hindlimb** (excessively straight hindlimb), **trauma** to the stifle and **hereditary factors** (Norrie 1982; Wyn-Jones 1988; Stashak 2002). The condition is more common in young horses and ponies, and Shetland ponies are most commonly affected (Walmsley 1994). UFP can appear in young horses beginning training with poor muscular condition, but debilitation can provide the necessary conditions. This condition is also seen in horses abruptly taken out of training and confined to a stall or hospitalised and loose weight and muscle condition. Another suggested cause of this condition is a **poor coordination** between the flexor and extensor muscles of the stifle (Wyn-Jones 1988). However, the clinician should be aware that UFP can be seen in well-conditioned and even in fat animals.

UFP is thought to occur in horses with a **straight hindlimb conformation** whose stifle angle is nearer 140° than 135° of the normal standing position, so that only a small degree of extension is required for upward fixation to occur (Rooney and Robertson 1996). Although attractive in theory, this cause in not easy to quantify. The author has noticed that some horses and ponies with UFP had 'normal' femorotibial angle based on radiographic examination. Furthermore, hyperextension of the hindlimb, exacerbated by walking a horse downhill, causes the situation to occur more frequently (Stashak 2002). The condition occasionally occurs after a traumatic injury to the stifle and has also been seen following fracture of the ilial shaft of the pelvis (Dugdale 1997). These animals can experience a loss of muscle tone and coordination. Body type is greatly inherited; therefore, the predisposing conformation for UFP is probably hereditary and could be congenital (Stashak 2002), especially in Shetland ponies. UFP occurs in all classes of athletic and other horses and also in mules and donkeys.

Clinical signs

Clinical signs of UFP are variable in both severity and frequency. The **severe form** of UFP occurs when locking of the patella prevents flexion of the stifle and hock but the fetlock is normal, although usually the fetlock is flexed with the toe resting on the ground or dragging as the horse moves forward. With the severe form, the horse assumes a posture with the affected limb extended in a caudally abducted position (**Fig 1**). The duration of UFP can vary from momentary to several minutes or even be permanent. This situation can occur on a daily, weekly or occasional basis. Temperament seems to govern the reaction to locking; most animals accept it stoically, whereas others seem to panic and make strenuous efforts to release the leg (Wyn-Jones 1988). Palpation reveals

Fig 3: Coxofemoral luxation as a complication of upward fixation of the patella in a Selle-Français filly. Note *the stifle-out, toe-out attitude of the limb.*

Fig 4: Medial patellar desmotomy in a 3-year-old Standardbred. The end of the tenotome is palpated caudal to the ligament before the ligament is severed close to its tibial insertion.

quadriceps muscle contraction and tense patellar ligaments. Synovial distension of the stifle joints may be present.

In most instances, there is a partial and intermittent locking of the patella and a palpable and sometimes audible click as the patella is released. This **mild form** of UFP may be shown for only a few strides, the gait then becoming normal. Some horses learn to carry the foot close to the ground and take short strides to avoid catching the patella.

The **mildest form** of UFP is manifested by a subtle delayed release of the patella, which appears to move in a jerky fashion, especially as the horse decelerates, without the limb becoming fixed in extension. Repeated delayed release of the patella can cause stifle soreness and unwillingness to work, although overt lameness is unusual (Dyson 2002). The clinical signs may be accentuated when the horse is worked in deep, holding going, or if it is tired (Dugdale 1997).

UFP is often bilateral and may affect one limb more than the other. Even when apparently unilateral, thorough examination can disclose a predisposition to upward fixation of the contralateral patella. In long-standing cases, this condition can result in gonitis, with palpable swelling of the femoropatellar joint (Stashak 2002). This may complicate the condition, as gonitis may remain even though UFP is correctly treated. Furthermore, persistent UFP predisposes horses to coxofemoral luxation (**Fig 3**); this is more frequently observed in Shetland ponies (Clegg and Butson 1996).

Diagnosis

The history, owner's description and clinical features of UFP are almost pathognomonic if a horse has locked the patella, but the partial locking and subtle delayed release of the patella can be much more difficult to identify, because of their episodic or subtle nature. Care should be taken to diagnose the condition accurately. Locking of the patella can occur at any pace, usually the walk or trot. It is often noticed when the horse moves off from a standstill or turns in the stable (Wyn-Jones 1988). **To provoke locking** of the patella, the horse should be trotted slowly, backed up and turned in very tight circles toward the affected hindlimb, walked with repeated stops and starts or walked down a slope. The toe of the involved limb should be evaluated for excessive wear caused by dragging of the foot.

This condition should also be **checked by forcing the patella upward and outward** with the hand; this will lock the patella over the notch of the medial ridge of the femoral trochlea. If the limb can be manually locked in extension for one or more steps, it is predisposed to UFP (Stashak 2002). A false negative test is more likely in large horses and a false positive test more likely in small horses. However, many horses resent this test.

In cases in which the patella locks only partially, the hindlimb usually jerks up quickly, mimicking stringhalt. Severe cases of UFP must be differentiated from coxofemoral luxation (**Fig 3**), and subtle delayed release of the patella should not be confused with low-grade hindlimb ataxia (Dugdale 1997).

Radiographic and ultrasonographic examination of both femoropatellar and femorotibial joints as part of the diagnostic work-up is advocated, because any concurrent stifle disease (osteochondrosis, osteoarthrosis, ligament or meniscal injury) affects decisions as to treatment and prognosis (Walmsley 1994; Dyson 1998). Although uncommon, hypoplasia of the medial trochlear ridge, as occurs with osteochondrosis, facilitates the displacement (Stashak 2002).

Treatment

If the horse presents with the patella locked, pushing the patella medially and distally and backing the animal are recommended, and pulling the limb forward is often necessary in severe cases (Stashak 2002).

Treatment of UFP should be based primarily on elimination of predisposing factors when these can be identified. A variety of approaches to treatment of UFP exist. In most cases, conservative or medical treatment is indicated initially. Cases unresponsive to such treatment, or those with a more severe form, should undergo surgery.

Conservative and medical treatments

Conditioning programme

With mild forms of UFP which are not causing lameness or gonitis, especially in young horses, strengthening quadriceps muscle tone and improving the horse's fitness is the goal. Treatment consists of trotting exercise on soft ground preferably in straight lines rather than circles or walking and trotting up and down hill. Administration of anthelmintics and an increased plane of nutrition as appropriate for each case are recommended. If necessary, **phenylbutazone** should be administered to relieve pain until the condition has resolved. However, once an affected horse drops a level of fitness, UFP may recur (Stashak 2002). **Complete stable rest is contraindicated.** Even healthy young horses are occasionally affected, and improvement is normally observed as the horse begins training, probably due to improved coordination between the flexor and extensor muscles of the stifle.

Injection of counterirritants

Injection of counterirritants containing iodine into and around the medial and middle patellar ligaments has been recommended in persistent cases to increase fibrosis of the ligaments with subsequent thickening and potential shortening (Norrie 1982; Brown *et al.* 1984; Stashak 2002). This is performed in the standing, sedated horse. Horses so treated should be exercised lightly every day to minimise the loss of muscle tone that results from the injections (Stashak 2002). This treatment has been associated with irregular results. This author has little experience of this treatment. Recently, the effects of injecting 2% iodine in almond oil and ethanolamine oleate were compared experimentally. The use of the former induced a more severe ligament inflammation and fibroplasia than the latter (van Hoogmoed *et al.* 2002). This study reported that maturation of the inflammation and

fibrous response may contribute to resolution or attenuation of the UFP by **subsequent stiffening of the ligaments**. Injection of counterirritants containing iodine into synovial sheaths of the stifle joint is rare, **but has been associated with disastrous sequelae in this joint.**

Other treatments

Steroidal anti-inflammatory drugs

Injection of such drugs into and around the medial and middle patellar ligaments has also been associated with good results in some cases (J.-M. Denoix, personal communication).

Shoeing

A shoe with a raised heel is used by some practitioners to make locking less likely in horses with mild intermittent UFP. The angle of slope on the summit of the trochlea varies in individual animals and this anatomical feature may account for those cases which improve when extension of the stifle joint is limited by raising the heels of the shoe (Hickman and Walker 1964). However, the effect of shoeing is less likely on the proximal joints of the limb, especially the stifle joints.

Surgical treatments

Surgery is indicated only when there is certainty of diagnosis, in cases unresponsive to conservative management and in severe forms. In young horses, surgical treatment should be delayed to determine whether the horse will grow out of the problem. For many years, the recommended surgical treatment for UFP involved performing medial patellar desmotomy (MPD). Recently, a new surgical technique has been described by the author and consists of splitting the proximal third of the medial patellar ligament (Tnibar 2002).

Medial patellar ligament desmotomy

Medial patellar ligament desmotomy (MPD) is a surgical technique that aims at disrupting the locking mechanism, and is well described in the literature (Turner and McIlwraith 1989; Stashak 2002). This procedure is usually performed under local anaesthetic in the standing horse, so that the medial patellar ligament is clearly defined. The area over the middle and medial patellar ligaments is prepared for surgery. This requires a small skin incision over the distal part of the medial patellar ligament (**Fig 4**). A curved Kelly forceps is advanced caudally under this ligament, developing a path for a blunt-ended bistoury. The end of the bistoury can be palpated caudal to the ligament before this is severed close to its tibial insertion. The skin is closed using one or two sutures. Stringent asepsis should be observed and care taken to avoid excessive tissue damage. Some surgeons perform this surgery in the standing horse by exteriorising and cutting the ligament through an incision. A modification of MPD that involves cutting the aponeurosis of the *sartorius* and *gracilis* muscles has also been described (Wright 1995).

Short-term complications of MPD are swelling, pain and wound dehiscence. Post operative administration of nonsteroidal anti-inflammatory drugs is advisable to control these complications. Although this procedure is a straightforward means of treating UFP, it is **not without adverse effects**. MPD results in an unstable femoropatellar joint, and the instability may lead to fragmentation of the

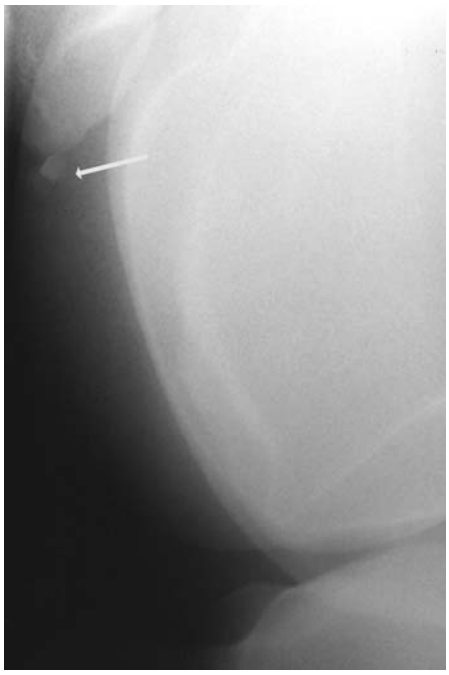

Fig 5: Lateromedial radiographic view of the right patella of a 7-year-old horse showing distal patellar fragmentation (arrow) following medial patellar desmotomy.

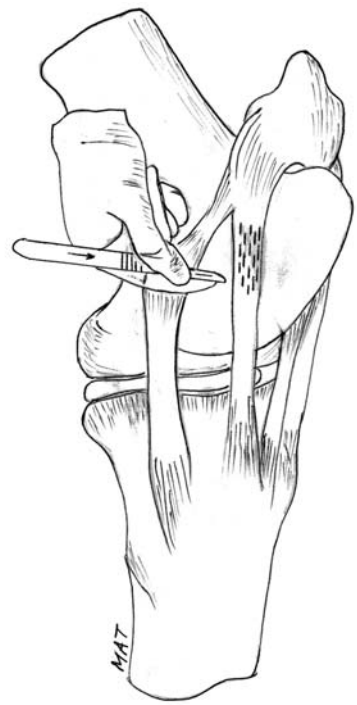

Fig 6: Splitting of the proximal third of the medial patellar ligament. The parapatellar fibrocartilage should not be split.

articular cartilage and subchondral bone at the apex of the patella, in the region of attachment of the middle patellar ligament (**Fig 5**). In this author's experience, some horses experience **persistent low-grade post operative lameness** and, frequently, femoropatellar synovial effusion. Radiographic control after MPD showed that the patellar base was displaced cranially from the femur and remained in this abnormal position until 8 months after surgery (Riley and Yovich 1991). **Entheseous new bone** at the insertion of the middle patellar ligament is another complication of this surgery. Arthroscopic treatment of osteochondral fragmentation of the patellar apex is advisable and may allow return to full athletic function (McIlwraith 1990). MPD was found to have detrimental effects on the femoropatellar joint of normal horses (Gibson *et al.* 1989).

If a horse undergoes MPD, it should be rested for 3–5 months before training resumes. Three months seems to be the minimal period necessary for ligament healing and stabilisation of the femoropatellar joint. However, no data have been published indicating that a long convalescence period decreases the likelihood of post operative complications.

Failure of MPD to correct UFP has been reported (Hickman and Walker 1964; Dyson 1998). **MPD should be approached with caution if UFP is not confirmed, or the possibility of additional femoropatellar or femorotibial damage exists.**

Medial patellar ligament splitting

For the surgical procedure of medial patellar ligament splitting (MPLS) (Tnibar 2002), horses are placed under general anaesthesia in dorsal recumbency. Both hindlimbs are suspended under complete extension to hook and subsequently tense the medial patellar ligament over the medial ridge of the femoral trochlea. The medial patellar ligaments are not as easily palpated in this position as in the standing horse. The surgery site is shaved and surgical skin preparation performed. Horses undergo ultrasound-guided percutaneous splitting of the proximal third of the medial patellar ligament using a surgical knife with a No. 15 blade (**Fig 6**).

Fig 7: Ultrasound-guided percutaneous splitting of the proximal third of the medial patellar ligament. *The limb is suspended under complete extension and a surgical knife with a No. 15 blade was used.*

The **ultrasonographic transducer** is placed transversally over the proximal part of the medial patellar ligament and the blade is introduced longitudinally into the ligament in a craniocaudal direction (**Fig 7**). It is fully visualised as it enters and progresses into the ligament, and throughout the splitting procedure (**Fig 8**). The blade enters the medial patellar ligament, but **should not proceed through the femoropatellar synovial pouch**, which lies immediately under the ligament, **nor through the articular cartilage** of the medial ridge of the femoral trochlea. The blade is then fanned 45° proximally, then distally, laterally and medially. The procedure is repeated at approximately 5 mm increments until the entire length of the proximal third of the medial patellar ligament, as determined by intraoperative ultrasonography, has been split. **Splitting is not performed on the parapatellar fibrocartilage.**

The largest skin incisions are sutured and a sterile bandage is applied over the surgery site. Perioperative antibiotics are used for 5 days, but **no anti-inflammatory drug is administered**. Some horses were more painful than others, and received one single dose of nonsteroidal anti-inflammatory drug. **Horses begin exercise the day following surgery.** Walking in-hand for 15 mins, 3 times a day, is continued for 2 weeks after surgery. Thereafter, horses are allowed progressively to resume their normal activity. Clinical signs of localised desmitis of the proximal third of the MPL develop immediately after ligament splitting. Moderate local swelling and heat with variable pain on palpation are most evident over the splitting site. Some horses show complete resolution of UFP within 24 h of surgery, while others show progressive improvement until resolution in 2 to 15 days after surgery.

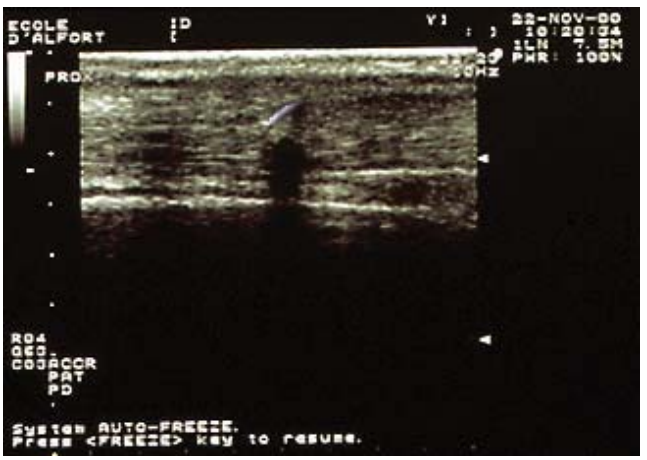

Fig 8: Sagittal ultrasonographic image of the medial patellar ligament with the surgical blade visualised into the ligament during ligament splitting.

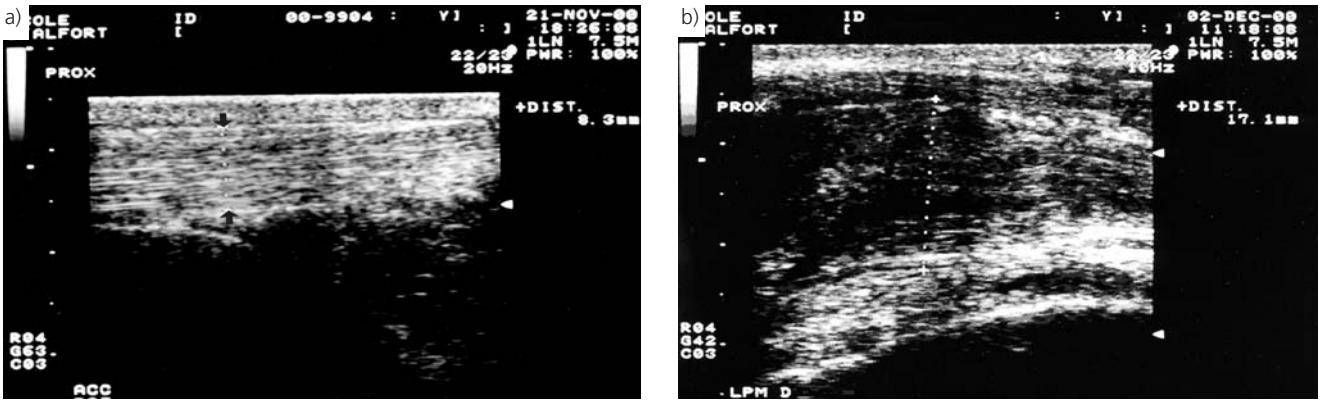

Fig 9: a) Sagittal ultrasonographic image of the medial patellar ligament in a horse before surgery. The ligament has a parallel linear echoic appearance and runs over the medial ridge of the femoral trochlea. b) Sagittal ultrasonographic image of the medial patellar ligament in the same horse 10 days after surgery. Hypoechoic and anechoic areas (desmitis) are visualised within the ligament, which is significantly thickened.

A symmetrical and moderate hindlimb discomfort can be noticed at the walk following the onset of desmitis, but resolves within a few days. Periligamentous oedema persists for a few days and results in moderate cutaneous fibrous reaction in some cases. All surgical sites healed without complication. Ultrasonographic evaluation revealed a significant and progressive increase in the ligament size during the first 4 weeks post operatively, with stabilisation thereafter. Desmitis, accompanied by both anechoic and hypoechoic lesions, was induced in all split ligaments (**Figs 9a,b**). Ultrasonographic evaluation revealed that thickening of the medial patellar ligament is 2 or 3 times the initial diameter.

Long-term follow-up showed that this surgical procedure is successful in the treatment of UFP and, in the author's hands, no short- or long-term complications were observed (Tnibar 2002).

Discussion

UFP is one of the most common causes of gait abnormality referable to the stifle in horses and ponies (Stashak 2002). Care should be taken to diagnose the condition accurately. Radiographic and ultrasonographic examination of both femoropatellar and femorotibial joints as part of the diagnostic work-up is strongly recommended, because any concurrent stifle disease affects decisions as to treatment and prognosis. Surgical measures become necessary only when there is certainty of diagnosis and in cases unresponsive to conservative management.

MPD has been advocated as the treatment of choice for surgical correction of UFP. This surgical technique is considered to be somewhat benign and without serious complications; however, recent studies, both retrospective (McIlwraith 1990) and experimental (Gibson *et al.* 1989), along with clinical case studies (Wright and Rose 1989; McIlwraith 1990; Squire *et al*. 1990; Riley and Yovich 1991; Grosenbaugh and Honnas 1995) suggest that MPD predisposes the patella to fragmentation. Furthermore, this procedure has the disadvantage of interrupting the horse's training programme and a small proportion of cases do not respond to this procedure (Hickman and Walker 1964; Dyson 1998). Unfortunately, MPD has gained widespread use in the diagnosis and treatment of vague hindlimb lameness or stiffness, even when UFP has not been demonstrated (McIlwraith 1990). Performing MPD in such cases is inappropriate and **this surgical procedure should be performed only in genuine cases of UFP** which have proved unresponsive to conservative treatments or when severe clinical signs are present. If MPD is performed, the owner should be informed that the resultant patellar instability may lead to pathological changes at the distal aspect of the patella, and that these lesions may induce stifle lameness. Some veterinarians claim that this procedure is innocuous, others acknowledge that some horses show post operative lameness following this procedure. **This author believes that careful follow-up of clinical cases may reveal more problems than previously reported.**

The rationale for MPLS is to induce a localised desmitis without transecting the ligament, which subsequently leads to a localised thickening of this ligament (Tnibar 2002). This prevents the proximal part of this ligament from hooking easily over the notch of the medial ridge of the femoral trochlea, preventing UFP. This surgical procedure abolished UFP even in cases with conformation abnormalities (straight hindlimb). The clinical effects of this surgical technique were attributed to the increase in size of the proximal third of the medial patellar ligament, resulting from the surgically induced desmitis. **It is therefore strongly recommended that splitting of the medial patellar ligament be achieved accurately** to induce a strong localised desmitis. This surgery was performed with horses under general anaesthesia. This has the **disadvantage** of the risks related to anaesthesia, but the **advantage** of allowing a good asepsis and precise and accurate ultrasound-guided percutaneous splitting of the ligament. Blind percutaneous splitting of the proximal third of the medial patellar ligament is possible in a standing horse, but **care should be taken not to traumatise the underlying structures**. This surgical technique was successful; in each case, all evidence of UFP disappeared and the horse regained its normal activity. MPLS is indicated in horses and ponies with UFP unresponsive to conservative treatments, including cases with

severe or mild forms of the condition, as well as those with subtle delayed release of the patella.

Detrimental effects of MPD were acceptable risks when this procedure was the only surgical technique available. MPLS is an alternative surgical technique for treatment of UFP and has demonstrated numerous advantages compared to MPD, not least being an innocuous procedure and allowing a rapid return to normal activity.

References

Brown, M.P., Moon, P.D. and Buergelt, C.D. (1984) The effects of injection of an iodine counterirritant into the patellar ligaments of ponies: application to stifle lameness. *J. equine vet. Sci.* **4**, 82-87.

Clegg, P.D. and Butson R.J. (1996) Treatment of coxofemoral luxation secondary to upward fixation of the patella in a Shetland pony. *Vet. Rec.* **138**, 134-137.

de Lahunta, A. and Habel, R.E. (Eds) (1986) Stifle and leg, horse and cow. In: *Applied Veterinary Anatomy*, W.B. Saunders Co., Philadelphia. pp 152-159.

Denoix, J.M., Perrot, P., Vaslin, C. and Bousseau, B. (1996) L'examen échographique de l'articulation fémoro-patellaire chez le cheval. *Prat. vet. Equine* **28**, 105-115.

Dugdale, D. (1997) Intermittent upward fixation of the patella and disorders of the patellar ligaments. In: *Current Therapy in Equine Medicine*, Ed: N.E. Robinson, W.B. Saunders Co., Philadelphia. pp 82-84.

Dyson, S. (1998) Patellar injuries. In: *Current Techniques in Equine Surgery and Lameness,* Eds: N.A. White and J.N. Moore, W.B. Saunders Co., Philadelphia. pp 440-447.

Dyson, S. (2002) Lameness associated with the stifle and pelvic regions. *Proc. Am. Ass. equine Practnrs.* **48**, 387-411.

Gibson, K.T., McIlwraith, C.W., Park, R.D. and Nordin, R.W. (1989) Production of patellar lesions by medial patellar desmotomy in normal horses. *Vet. Surg.* **18**, 466-471.

Grosenbaugh, D.A. and Honnas, C.M. (1995) Arthroscopic treatment of patellar lesions resulting from medial patellar desmotomy in a horse. *Equine Pract.* **17**, 23-25.

Hickman, J. and Walker, R.G. (1964) Upward retention of the patella in the horse. *Vet. Rec.* **76**, 1198-1200.

Leclainche, E. (Ed) (1955) La médecine vétérinaire dans l'antiquité. In: *Histoire Illustrée de la Médecine Vétérinaire,* Vol. 1, Editions Albin Michel, Paris. pp 116-128.

McIlwraith, C.W. (1990) Osteochondral fragmentation of the distal aspect of the patella in horses. *Equine vet. J.* **22**, 157-163.

Nickel, R., Schummer, A. and Seiferle, E. (Eds) (1986) Intrinsic musculature of the pelvic limb of the horse. In: *The Anatomy of Domestic Animals*, Verlag Paul Parey, Berlin. pp 432-444.

Norrie, R.D. (1982) Diseases of the rear legs. In: *Equine Medicine and Surgery*, Eds: R.A. Mansmann and E.S. Mc Allister, American Veterinary Publications, Santa Barbara. pp 1137-1138.

Riley, C.B. and Yovich, J.V. (1991) Fracture of the patella after medial patellar desmotomy in a horse. *Aust. vet. J.* **68**, 37-39.

Rooney, J.R. and Robertson, J.L. (Eds) (1996) Upward fixation of patella. In: *Equine Pathology*, Iowa State University Press, Ames. p 203.

Sisson, S. (1975) Equine syndesmology. In: *The Anatomy of the Domestic Animals*, Ed: R. Getty, W.B. Saunders Co., Philadelphia. pp 349-375.

Squire, K.R., Blevins, W.E., Frederick, M. and Fessler, J.F. (1990) Radiographic changes in an equine patella following medial patellar desmotomy. *Vet. Radiol.* **31**, 208-209.

Stashak, T.S. (Ed) (2002) Upward patellar fixation. In: *Adam's Lameness in Horses,* 5th edn., Lippincott, Williams and Wilkins, Philadelphia. pp 737-741.

Tnibar, M.A. (2002) Medial patellar ligament splitting for the treatment of upward fixation of the patella in 7 equids. *Vet. Surg.* **31**, 462-467.

Toniato, M. and Torre, F. (2003) Persistent acquired upward fixation of the patella in a Standardbred foal. *Equine vet. Educ.* **15**, 233-235.

Turner, A.S. and McIlwraith, C.W. (Eds) (1989) Medial patellar desmotomy. In: *Techniques in Large Animal Surgery*, 2nd edn., Lea and Febiger, Philadelphia. pp 133-135.

van Hoogmoed, L.M., Agnew, D.W., Whitcomb, M., Hyde, D.W., MacDonald, M.H. and Snyder, J.R. (2002) Ultrasonographic and histologic evaluation of medial and middle patellar ligaments in exercised horses following injection with ethanolamine oleate and 2% iodine in almond oil. *Am. J. vet. Res.* **63**, 738-743.

Walmsley, J.P. (1994) Medial patellar desmotomy for upward fixation of the patella. *Equine vet. Educ.* **6**, 148-150.

Wright, I.M. (1995) Ligaments associated with joints. *Vet. Clin. N. Am.: Equine Pract.* **11**, 249-291.

Wright, J.D. and Rose, R.J. (1989) Fracture of the patella as possible complication of medial patellar desmotomy. *Aust. vet. J.* **66**, 189-190.

Wyn-Jones, G. (Ed) (1988) Upwards fixation of the patella. In: E*quine Lameness*, Blackwell Scientific Publications, Oxford. pp 170-174.