Reattachment of osteochondritis dissecans lesions in the lateral femoral trochlear ridge with bioabsorbable screws in yearling standardbreds

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Abstract

This case series aimed to describe an alternative surgical technique to obtain internal fixation and the reattachment of osteochondritis dissecans (OCD) lesions in the lateral trochlear ridge (LTR) of the femur in horses and the clinical and radiological outcome of treated cases. Four yearlings standardbred (from 8 to 10 months) with a large OCD defect in the LTR of the femur underwent surgical fixation of the lesions under arthroscopy guidance. Internal fixation of the OCD flap was obtained with headless 3.0 mm bioabsorbable poly-L-lactic acid (PLLA) screws inserted perpendicularly to the cartilage surface into the lesion through a small arthrotomy. All horses were discharged from the hospital without complications. Clinical and radiological follow-up of the treated lesions at 6 and 12 months were collected and reviewed. Successful fixation of the OCD flap occurred in all treated horses. The horses of this case series had a favorable outcome in term of athletic performances and reduction of femoro-patellar synovitis.

1. Introduction

Osteochondritis dissecans (OCD) localized to the lateral trochlear ridge (LTR) of the femur is a common lesion among skeletally immature racehorses [1]. Therefore, a radiographic screening of the stifle is routinely performed in immature racehorses at the weanlings age raised for sales and racing. Based on radiographic appearance, the OCD lesions in the LTR are classified considering the length of the defect, according to the grading score proposed by Foland et al., in 1992 [2]. The OCD lesions at this site ranged in severity from a simple trochlear ridge flattening to the presence of large OCD fragments. Grade I lesions are <2cm long, grade II lesions are 2-4 cm long, whereas grade III lesions are longer than 4 cm, when measured on the lateromedial x-ray view of the stifle. Grade I and II lesions are usually asymptomatic in young horses, while horses with grade III OCD lesions are commonly presented with notable femoro-patellar joint effusion and hindlimbs' stiffness [2]. Lesions more than a half the length of the LTR warrant invariably a poor prognosis concerning the athletic career [3].

A percentage of 6.2% of French Standardbred trotters has been reported to be affected by OCD localized to the LTR of the femur in a study including 161 foals at the age of 6 months [4]. Abnormal radiological findings in the LTR of the femur identified at the age of 6 months had disappeared at the age of 18 months in 46.6% of cases, emphasizing the spontaneous healing capacity of LTR at the early age [4]. Large OCD lesions in the femoral LTR are frequently combined with irregularly deepen defects in the underlying bone >5 mm in depth. Those OCD lesions, apparently stable at the early age, may become unstable OCD flaps and trigger a chronic inflammatory synovitis without a satisfactory healing. Unstable LTR lesions in the adult life can detach and move freely into the joint compartment causing continuous synovial inflammation and even lameness. This is the main reason because surgical treatment in the affected horses is currently indicated at around 18 months for any femoral OCD lesions that contains osseous densities in presence of synovial effusion [5,6]. A common point of debate for the asymptomatic and radiographically evident OCD lesions in the LTR is the real need to perform surgery and the effectiveness of surgical interventions in term of future athletic soundness. It has been demonstrated that even grades I and II OCD lesions in the LTR of the femur have the potential to impact future athletic performances, lowering the percentage of horses qualified to race from 55% to 25% in Standardbred trotter if OCD lesions are left untreated [7].

The current surgical intervention proposed for OCD of the LTR is the arthroscopic removal of loose osteochondral fragments and the surgical curettage to the underlying bone until the bleeding was reached [1,8]. A micro-picking technique is encouraged after OCD debridement to stimulate subchondral bone healing [9]. In term of athletic performance, the arthroscopic debridement of the OCD localized to the LTR of the femur and longer than 4 cm was reported to have a favorable success rate in 54% of the affected horses only, in comparison to the 78% of horses with lesions less than 2 cm long [2]. Therefore, grade III OCD lesions of the LTR pose a particular challenge. Conservative management of such grade III OCD lesions commonly failed to be successful, due to the chronic synovitis and the early development of degenerative joint disease in the affected joints, independently from the athletic activity the horse is destinated. Extensive arthroscopic debridement of large OCD flaps in the LTR of the femur could compromise the femoro-patellar joint, leading to patellar instability and early osteoarthritis [3,4]. For these reasons, major concern exists when a full debridement of large OCD flaps of the LTR is going to be planned.

Surgical reattachment of large OCD flaps has been proposed using polydioxanone resorbable pins to avoid extensive debridement of the subchondral bone in the LTR of the femur. The ideal candidate for this procedure is an horse having a smooth cartilage surface at the arthroscopic observation of the OCD and >50% of the flap border still continuous with the surrounding unaffected cartilage. The procedure was described in 12 horses having 9.7 ± 3.3 months [10]. Long-term follow-up of pins' reattachment of dissected articular cartilage flaps showed an improved clinical and radiographic outcome over more traditional debridement [11]. Farther, a tissue engineered scaffold were implanted with success in a 15-months TBR filly with bilateral lesions with large OCD defect of the LTRs [12]. Controversial opinions still exist on the best age to perform surgery due to the report of spontaneous radiographic resolution of OCD lesions in young horses. On the other side it is well reported that OCD lesions over the age of 8 months are substantially stable [4,13]. It must be considered that deterioration of the LTR surface can be rapid in affected animals and the ability to obtain cartilage reattachment and save the subchondral bone decline soon if the surgery is delayed too far [11].

Bioabsorbable poly-L-lactic acid (PLLA) screws are newly developed implants for treatment of osteochondral fragmentations traumatic in origin in the humane knee and thereafter have the potential to perform fixation of unstable OCD under arthroscopic observation [14]. The use of PLLA implant has the advantage of avoiding the need of a second surgery for implant removal [15].

Degradation time of PLLA is undetermined [16–18]. The aim of this study is to report for the first time the use of bioabsorbable screw fixation to stabilize large osteochondral flaps in a small group of yearlings Standardbred trotter having grade III OCD lesions in the LTR of the femur.

2. Case Report

This report documents the surgical treatment of OCD lesion of the LTR of the femur with PLLA screws and the clinical outcome in four Standardbred yearlings referred to the Veterinary Teaching Hospital of Turin.

2.1 Case history

Four young trotters ranging from 10 to 14 months of age were diagnosed with large OCD defects of the LTR of one or both stifles at the pre-sale radiographic screening. An arthroscopic fixation of the OCD flap with bioabsorbable screws was planned early after the initial diagnosis, due to the large osteochondral flaps observed in those animals, using a surgical technique previously prepared on cadavers.

2.2 Clinical findings and diagnosis

All the enrolled horses were screened radiographically for OCD in the fetlock and hocks joints at the age of 10-12 months. Stifle were screened for OCD only when a synovial effusion was identified by direct observation of the femoro-patellar joints from the side of the animals. One horse of this series had a synovial effusion identified by the breeder in the last 3 months when it was examined.

For this purpose, a latero-medial and caudo-cranial x-ray views of the affected stifle were performed. There were four yearlings with an average age of 11.5 months, two males and two females. Data reporting clinical characteristics of the animals treated in the article are summarized in **Table 1.** Two of these horses had a radiographic lesion on the LTR of one stifle only. The other foals had radiographic lesions in the LTRs of both stifles. The size of the lesions was determined and measured in the latero-medial x-ray view of the stifle (**Fig. 1**).

Table 1

Figure 1_Preoperative x-rays

Table 1_Signalment and clinical details of the OCD in the LTR of the femur observed in four operated horses

Case ID	Age (months)	Gender	Degree of synovial effusion	Lesion location	Defect length*	Number of used PLLA screws
1	12	Male	Mild	LTR, left stifle	42 mm	2
2	10	Female	Mild	LTRs, left and right stifle	40 mm (L) 32 mm (R)	2 1
3	12	Female	Severe	LTRs, left and right stifle	36 mm (L) 42 mm (R)	1 2
4	11	Male	Mild	LTR, right stifle	46 mm	3

*Measure obtained on the latero-medial x-ray view of the stifle

2.3 Surgical treatment

The surgery was planned shortly after the radiographic OCD screening was performed. Preoperatively, lesions length, measured on the latero-medial x-ray projection, ranged from 32 to 46 mm, with an average of 38 mm.

Horses were operated in general anesthesia after a premedication with acepromazine, followed by a combination of medetomidine and butorphanol and the induction of general anesthesia with a combination of ketamine and diazepam. Ampicillin (15 mg/kg) and gentamicin sulphate (6.6 mg/kg), both intravenously were administered only one shot perioperative, half an hour before general anesthesia. Phenylbutazone were administered pre-emptive during the surgery day at 4.4 mg/kg intravenously.

During the surgical procedure, the anesthetized animals were positioned in dorsal recumbency with the stifle in full extension and prepared with sterile scrub in one or both joints, accordingly to the surgical planning. A routine cranial arthroscopic approach to the femoro-patellar joint, between the lateral and the middle patellar ligaments, was made. An oblique x-ray views were taken intraoperatively to confirm the position of the osteochondral flap in comparison to the intended position of the arthroscope and a skin staple was positioned at the level of the lesion. The angle of the stifle extension was further adjusted intra-operatively to allow the best surgical access to the lesion. The articular surface of the OCD lesions during arthroscopy examination of the joint

appears grossly smooth, without any irregular surface or articular cartilage softening. A clear demarcation line in the hyaline cartilage was observed intraoperatively only in 3 examined stifles. In the others, a superficial demarcation line between the normal cartilage and the OCD flap surface was visible. All the OCDs appeared stable at palpation with the arthroscopy probe.

A 3-mm diameter bioabsorbable screws equipment (Bio-Compression screws; Arthrex, Inc., Naples, FL, USA) was employed. At the beginning, a 1.3 mm K-wire was placed in the middle of the OCD flap under arthroscopic guidance and confirmed by an x-ray view. The K-wire was placed as much perpendicular to the cartilage surface as possible, to maximize the axial compression of the screw over the osteochondral flap against the healthy subchondral bone. All the instruments used to drill and thread the subchondral bone are cannulated and could be inserted through the pre-positioned K-wire. The PLLA screws only are not cannulated, and they were inserted under arthroscopy guidance without the help of any guide. Screws were seated about 1 mm under the cartilage surface of the joint (**Fig. 2**) to avoid any interference [19]. At least two bioabsorbable screws were employed for each OCD flap, using 3.0 mm of diameter screws, and ranging from 22 mm to 26 mm of length, depending on the depth of the lesion, to provide a satisfactory anchorage of the OCD to the healthy underlying subchondral bone. This is required for an optimal stabilization of the OCD flap. The joint was flexed and extended at the end of the procedure by the surgeons to check the preservation of the full range of motion, after screws implantation. The closure of the arthroscopy portals was performed in one layer and 10 mg of morphine were injected intraarticularly at the end of the procedure. A sterile self-adhesive plastic anti-microbial dressing were placed on the dorsal aspect of the stifle prior to recovery from general anesthesia.

2.4 Post-operative management

Six femoro-patellar joints were operated in four animals. Post-operatively all the operated animals received a course of non-steroid anti-inflammatory drugs for two days (phenylbutazone 2.2 mg/kg intravenously). All the horses were discharged from the hospital within 5 days after surgery. A moderate effusion of the femoropatellar joints was still observed at discharge from the hospital in two horses (cases 1 and 3). The surgical incisions were intact at that time. No fever, no discharge from the arthroscopic portals, or signs of lameness developed during the hospitalization period. The owners were instructed for restricting the exercise to box rest for 12 weeks, then a daily walking program in hand was introduced, by increasing 5 minutes per week. Free exercise in

the paddock was not allowed for 12-16 weeks after the procedure. The synovial effusion resolves completely in all the operated stifles at 12 weeks post-operatively.

2.5 Long-term follow-up

The x-ray view was performed at 6 and 12 months after surgery. The radiographic outcome was defined satisfactory for subchondral contour and subchondral filling in two out of four operated animals at 6 months and in all the operated animals at 12 months as summarized in Table 2. This indicated a complete integration of the OCD flap with the subchondral bone of the LTR of the femur in the operated stifle (**Fig. 3**). In one case, although healing was considered satisfactory, only a small fragment was still evident at the site of the previous lesion. All the operated animals enter a regular training program in a period from 12 to 36 moths. Two animals were sold in an international sale after the x-ray views have been re-evaluated by a veterinary commission.

Table 2

Table 2_Clinical outcomes in the operated horses

	Lameness		Synovitis		Radiographic healing	
Case ID	**Preop**	**Postop**	**Preop**	**Postop**	**Subchondral contour**	**Subchondral filling**
1	0/5	0/5	+	-	Normal	+/++
2	0/5	0/5	+	-	Flat	++/++
3	1/5	0/5	+	-	Normal	+/++
4	1/5	0/5	+	-	Normal	++/++

3 Discussion

This small case series describes an alternative technique for the fixation of large OCD flaps localized to the LTR of the femur, proposing an alternative approach to the classical debridement, fragment removal and bone curettage. We employed bioabsorbable screws to fix large OCD flaps to the subchondral bone using an arthroscopic approach.

This surgical technique has been applied to grade III lesions, those with the worst prognosis reported in the literature, because the main part of the horses diagnosed with this severe grade of OCD develop degenerative osteoarthritis [2].

Articular osteochondrosis is a well-known manifestation of the interruption of the blood supply to the epiphyseal bone at the level of the ossification front in growing animals. The articular cartilage overlying the bone with an interrupted blood supply will rupture creating an OCD flap [20]. The OCD of the LTR of the femur is an invalidating condition in yearling racehorses, where a strong relationship exists between the extension of articular cartilage lesion and the risk of early osteoarthritis. Contrary to the findings of a large retrospective study in racehorses, length of the lesion did not have a significant effect on the long-term outcome in a cohort of sport-horses. This is probably the consequence of a different training strategy between racehorses and sport-horses[3].

Currently, methods for the preservation of articular cartilage had been developed [11]. An innovative surgical technique using absorbable polydioxanone pins for flap fixation was firstly described by the group of Nixon [10]. Reattachment of osteochondral flap in a joint affected by large OCD is a suitable technique when mineralized and smooth to mildly irregular flaps have still continuous borders with the surrounding unaffected cartilage [10,11]. This flap condition is often observed in young horses at the beginning of the disease. Most OCD flaps in the LTR in older animals are irregular, clefted or ulcerated, and appear inadequate for any reattachment technique. Nixon reported 17 horses with an age <18 months treated with OCD flap reattachment using polydioxanone pins [10]. To obtain a correct fixation of osteochondral flaps, the reattachment technique required two to ten polydioxanone pins [10]. In our case series, one or two bioabsorbable screws has been employed to fix a single osteochondral flap. This is probably related to the elevate compression force, exerted by the PLLA screws penetrating the subchondral bone. Comparing with arthroscopic debridement alone, where grade II and III lesions have been respectively reported a 63% and 54% success rates [2], the reattachment technique increases the success rate of treatment of these lesions until 95% [11]. In children and adolescent knees, Din et al. reported the use of a 3.9 adsorbable pins (average) per patient, to perform internal fixation of unstable OCD [21]. PLLA screws can be easily applied without arthrotomy and do not need to be removed, in contrast to other metal implants. This technique is recently proposed in humane to treat knee OCD [22,23] and for fixation of scarf osteotomy in case of hallux valgus [24]. The authors described a recovery time of 8 weeks before the involved knee can progressively tolerate

an increase of the weight bearing, and the complete healing can occur after one year [23]. Reported complications of this procedure in humane are fragment non-union, osteolysis, synovitis, and breakage of the screws [23]. Different clinical reports described an unknown reabsorption time for the PLLA screws. Three years after surgery screws were still visible in a single case of hallux valgus causing a negative skin reaction, due to a small protrusion of one screw [23].
Even if a small number of cases had been treated with this technique, an optimal bone contouring and filling of the OCD defect was observed. This is a promising result that support the attempt to recur at an active fixation of the lesion rather than conservative treatment. Multiple study reported good results after performing OCD debridement and multiple drilling. However, the advantage of avoiding articular cartilage removal and provide a solid fixation of the flap is undoubted, due to the ability to preserve an optimal cartilage surface. A second look arthroscopy should be optimal to assess the articular cartilage at long term after flap reattachment, but it was never possible in racehorses that are normally sold for training purpose. In the study by Chun et al. in 2016 the effectiveness of the technique applied to the knees had been demonstrated in 11 humane patients through MRI and second-look arthroscopy [14].

4 Conclusion

In treating juvenile OCD lesions in the LTR of the equine femur, arthroscopic implantation of bioabsorbable screw fixation seems to be an effective treatment method for large flap reattachment and show satisfactory preliminary results in a limited number of cases.

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Tables (submitted in the text)

Supplementary material

None

Author contributions

AB and MP participated in the conceptualization; MP,GP and DV participated in data curation; AB, MP, and EP participated in the investigation; AB was the supervision; GP, DV, and MP wrote the original draft; AB, EP and BR performed a critical review & editing

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Fig. 1. (A) The arthroscopic image from case n.2 shows a stable OCD lesion of the lateral trochlear ridge of the femur. (B, C) The drill and the thread bits were inserted in perpendicularly to the cartilage surface into the lesion. (D) The arthroscopic image shows a bioabsorbable screw positioned in the middle of the OCD flap. The head of the screw is positioned 1-2 mm below the cartilage surface.

Fig. 2. (A) Radiographic images from a 10-months-old standardbred with chronic, extensive OCD of the right LTR of the stifle. The image is more caudolateral to craniomedial oblique than a lateromedial view to better delineate the LTR lucency with mineralization within the flap. (B) Follow-up radiograph of the stifle 6 months after surgical reattachment with PLLA screws showing restoration of the LTR contour, with only a residual subchondral bone lysis. Satisfactory radiographic healing will require other 3 months.

Fig. 3. (A) Radiographic image from a 11-months-old standardbred with extensive, mineralized OCD flap of the right LTR of the stifle localized in the distal third of the ridge. (B) The proximocranial-distocranial flexed view of the same stifle shows the extension of the lesion depth into the subchondral bone. (C) Follow-up radiograph of the stifle 12 months after surgical reattachment with PLLA screws showed satisfactory healing of the LTR

Fig. 4. (A) Radiographic images from a 12-months-old standardbred with extensive OCD of the left LTR of the stifle. (B) Follow-up radiograph of the stifle 36 months after surgical fixation with PLLA screws showed satisfactory bone filling of the LTR defect suggesting optimal cartilage flap

reattachment. A small radiolucency in the LTR is still visible at the deep margin of the repaired LTR flap.