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1. Separate Title Page

The Arthroscopic Trochleoplasty

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Abstract

Since a dysplastic trochlea has been identified as the main pathomorphology in recurrent patellofemoral instability, trochleoplasty became a surgical solution in some of these cases. However, in comparison to other surgical procedures, stabilizing the patellofemoral joint, trochleoplasty is a major operation with an arthrotomy, weakening the passive stabilizers (medial or lateral capsular and ligaments) and being related with typical risks of open surgery such as arthrofibrosis. Therefore, we developed a technique to perform an arthroscopic trochleoplasty via suprapatellar portals using shaver burrs. Comparable to the open procedure, a cartilage flake is released and a new bony trochlea is created according to the normal anatomy. Then, the cartilage flake is re-fixated using Vicryl tapes and anchors. This method seems to be an obvious advantage in patellofemoral surgery, since an arthrotomy can be avoided, and postoperative pain as well as soft tissue healing time can be reduced. In respect of postoperative pain, scar tissue and fast rehabilitation, the preliminary results seem encouraging.

Keywords: Patella; Instability; Patella dislocation; Trochleoplasty; Medial Patellofemoral Reconstruction; Knee

Introduction

Chronic patellofemoral instability is a disabling condition and the surgical solution for this condition has improved owing to an increased understanding of the anatomy and pathomorphology of the unstable patellofemoral joint. H. Dejour demonstrated in 1994 that a trochlear dysplasia is present in 85% of the cases with patellofemoral instability (1). In order to restore anatomical abnormalities and to address the instability causing factors rather than performing indirect procedures, deepening trochleoplasty has been found to be a surgical solution to treat recurrent patellofemoral instability in these cases (2-5). However, trochleoplasty is an open procedure and the surgical trauma, the scar and the postoperative pain seems to be more pronounced compared to the other stabilizing methods. Furthermore, an open procedure is related to an increased risk of infection and arthrofibrosis, compared to an arthroscopic procedures (4). We therefore have seen the need for an arthroscopic technique.. In the following, the surgical technique as well as the first results of our patients will be presented.

SURGICAL TECHNIQUE

A tourniquet is mounted to the thigh, in case bleeding occurs and reduces visualization. Initially, an arthroscopy is performed via a standard lateral arthroscopic portal to determine the trochlear shape and to inspect the cartilaginous situation. If the indication for trochleoplasty is verified, the procedure is continued using further arthroscopical portals.

Special arthroscopical portals and preparation of the cartilaginous flake:

To have an optimal view to the bony border of the proximal trochlea, still with the arthroscope in the lateral portal and with the knee extended, one medial and one lateral superior arthroscopic portal is set in the proximal part of the suprapatellar bursa close to the quadriceps tendon, using a needle as a guide. An ExpanularTM canula with an 8.25 mm diameter (Arthrex) is introduced in the superolateral portal. This allows the tensioning of the knee capsule towards proximal, giving more space and a better overview to the joint from this proximal portal. The arthroscope is now switched to the superomedial portal. Then, an additional lateral working portal is placed at the level just proximal to the lateral border of the trochlea and a partially threaded Crystal canula with a diameter of 5.75 mm (Arthrex) is introduced (Figure 1). Through this lateral working portal the synovial tissue in a 10 mm wide zone proximal to the trochlear groove is ablated with a Radiofrequency energy device (RF) until the cortical bone is exposed.

The cartilaginous flake is then released using a 4 mm round burr (bone cutter) shaver. This may seem to be a very difficult step, but surprisingly the shaver blade relatively easy find the cleavage between bone and cartilage without harming the cartilage. Working with the shaver blade from side to side, switching between the two different superolateral portals, it slowly releases the cartilage flake until the curve of the trochlea gets to bend (Figure 2). In order to avoid bone loss from the top of the lateral femoral condyle, the cartilage in this area can be released using an osteotome.

Preparation of the trochlea groove:

Again using the same 4 mm round burr shaver blade, the trochlea groove is modeled giving it a deeper and more lateralized shape via the superolateral portal (Figure 3). If present, a supratrochlear bump or spur is removed in the same way. In order to evaluate the shape and depth of the new-modeled groove, the cartilage flake is regular pressed down into the new groove, using the numb side of the bone cutter. If the new created trochlear groove is not yet deep enough according to a normal anatomy, more bone is removed in the above-described way.

Refixation of the cartilage flake:

The cartilage flake is re-fixated using four suture anchors (Bio-PushLock®, 3.5 x 14 mm, Arthrex). The first central anchor is loaded with one 3 mm vicryl tape (Ethicon) and one 1-0 vicryl suture (Ethicon). By working through a standard medial portal, the hole is predrilled just distal to the hinge of the cartilage flake, and the preloaded anchor is then introduced into the hole, so the tape and suture are kept fixated (Figure 4a).

A new stab incision is needed so the additional anchors can be placed perpendicular to the bone, in the area proximal to the cartilage flake. This stab incision is made just medial to the proximal edge of the patella, and beforehand correct placement is tested with a needle.

One by one the tapes are retrieved through this stab incision and the anchors are placed at the proximal boarder of the cartilage flake, holding down the flake in a spider like configuration. Athird Push Lock is loaded with the two sutures together and inserted using the above mentioned techniques at the most adequate spot (Figure 4b).

Reinsertion or reconstruction of the medial patellofemoral ligament (MPFL)

To achieve stability close to extension, each of the procedures was combined with either reinsertion (6) or reconstruction (7) of the MPFL. No additional intervention such as a lateral release or transfer of the tibia tuberosity, has been performed.

Cadavers

The technique was developed in cadaver labs and arthrotomies were done after the above technique has been applied. The shape and quality of the trochleoplasty were evaluated and we concluded, that the results were comparable with the standard open procedure.

Patients

Indications for trochleoplasty were 2 or more patellar dislocations with a persistent Fairbank's apprehension sign from 0 - 30° of flexion and trochlear dysplasia grade B or more as defined by Dejour et al and regraded by Tecklenburg et al (8;9). Exclusion criteria was a cartilage defect in the trochlea ICRS grade 3 or 4 with a diameter of 5 mm or more. Three of our patients previously have had an imbrication of the medial soft tissue structures and a lateral release, and one patient was operated twice with an Elmslie-Trillat procedure first, followed by an MPFL reconstruction due to instability, but still suffering from ongoing subluxations and pain in early knee flexion.

Preoperatively, all patients have undergone patellar-stabilizing training for a minimum of 3 month under survey of a physiotherapist.
Since March 2008 the above-described procedure has been performed in eight knees in seven consecutive patients.
In one case a tourniquet had to be applied due to reduced visualization caused by bleeding.
All patient were operated using spinal anesthesia and 20 ml of 0.25% Bupivacaine and epinephrine was distributed in the incisions and intraarticular at two time points before the incision and after wound closure Postoperative full weight bearing was allowed immediately after surgery, while a knee immobilizer with limited extension of 30° and free flexion was prescripted for 2 weeks. Postoperatively all patients had physiotherapist guided knee stabilizing training for a period of 12 weeks. Clinically, the 100 mmVAS pain score, Tegner, Kujala and KOOS scores have been recorded preoperatively as well as during the postoperative clinical controls, while the type of trochlear dysplasia as well as the tibial tuberosity to trochlear groove distances (TTTG) were evaluated preoperatively in the MRI scans.

Results

All patient left the hospital the morning after surgery and besides normal analgesics (i.e.paracetamol), additional one or two doses of morphine (p.o.) have been requested in all cases at the day of surgery. Stitches were removed 14 days after surgery without any problem in wound healing, except for one case that had per oral antibiotic prescribed from her general practitioner because of a suspected infection from the superolateral portal.
All patients have achieved full weight bearing from the first postoperative day and reached the preoperative range of motion when the knee immobilizer has been removed. Three months postoperatively, the apprehension sign was negative in all patients seen until now (7 out of 8)

Discussion

Since it is known that patellofemoral instability is the result of a combination of different pathomorphologies and that a dysplastic trochlea is found in 85% of the patients with a recurrent instability, trochleoplasty became an accepted procedure to treat recurrent instability. However, this procedure was always combined with an arthrotomy and a soft tissue defect.
Even though the above-described technique is a technical demanding procedure, the arthroscopical performed trochleoplasty shows several advantages in comparison to the open procedure. These advantages seem to be a reduced pain, a faster mobilization, less risk for development of

arthrofibrosis and reduced scar formation. Especially the removal of the trochlear spur seems to be an easy and helpful procedure.

The disadvantage of the arthroscopic trochleoplasty is the difficulties by the technique and especially how to estimate the correct shaping of the new trochlea.

Regarding the lost of apprehension it is difficult to estimate, if that occurred due to the trochleoplasty or the additional treatment of the MPFL. However, since it has been proven biomechanically that the patellofemoral stability in flexion of more then 30° is mainly given by the presence of a trochlear grove, while the MPFL is the passive structure to stabilize the joint in extension, the disappearance of the apprehension in all flexion degrees indicate the trochleoplasty to provide stability in early flexion degrees. And since it is estimated that the MPFL is insufficient, absent or chronically torn in cases of trochlear dysplasia, we advise to reconstruct the MPFL instead of reinserting it in all cases, where a trochleoplasty is performed.

Although the isolated MPFL reconstruction can provide good results in cases with a low grade trochlear dysplasia, the combination of both interventions is demanding in cases with a higher grade deformity, since the decrease of the tilt and shift, achieved by the MPFL reconstruction leads to an increase of the patellofemoral pressure and eventually leading to arthrosis. As it has been shown that the cartilage viability is given after open trochleoplasty, no reason has been detected so far that cartilage degeneration should occur using the arthroscopic technique (10). A further advantage of the arthroscopic treatment is the integrity of the lateral patellofemoral soft tissue complex, since all recent biomechanical studies have shown that a weakening of the lateral structures leads to an increase of the patellofemoral instability (11). Especially, since the arthroscopic technique shows promising results without arthrofibrosis and a fast wound healing as well as minimal pain, we are encouraged to proceed with this combination procedure in terms of above explained indications. A 2 years follow-up, with the objective and subjective scores from these relative seldom procedures will be presented in the future.

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Legends

Table 1. Demographic data, Visual analog scale 100mm (VAS) pain score and operating time.

Pt no.	Gender	Height (cm)	Weight (Kg)	Age	TTTG (mm)	Dejour	Years since dislocation	Number of dislocations	VAS score 24 hours	VAS Score 14 days weight bearing	VAS score 8 weeks weight bearing	Operation time (minutes)
1	M	175	72	28	19	C	21	>50	29	2	11	150
2	F	168	52	21	28	D	2	>50	11	1	4	105
3	M	184	76	17	24	C	6	12	44	2	3	150

4	F	168	80	34	40	D	22	>100	23	4	2	120
5	M	175	72	28	18	C	13	>50	24	21	0	140
6	F	173	63	17	17	B	11	8	46	4	0	110
7	F	170	60	13	23	D	2	3	4	1	0	150
8	F	168	60	16	13	B	2	13	69	7		170

Figure 1. This demonstrates a right knee with two canulas and with an arthroscope inserted via a superomedial portal.

Figure 2. Beginning of release in cartilaginous trochlea in a left knee from the lateral side (a) and finalizing the detachment of the cartilage flake in a right knee (b).

Figure 3. Creating the new bony trochlea using a burr at the beginning (a) and after final remodeling (b).

Figure 4. This demonstrates how an anchor, loaded with tapes and sutures, is placed in the center of the trochlear groove (a) and then fixated (b).

Figure 5. Examples of refixation of the cartilage flake, before the release of the flake (a) and after the flake is pressed down into the new-formed trochlea by the tapes and sutures.

Figure 6. Arthroscopic view of two different knees, 6 months postoperatively, looking from proximal (a) and from distal (b). The new-formed trochlea is visible, the reattached cartilage is healed and the sutures are absorbed in both examples.

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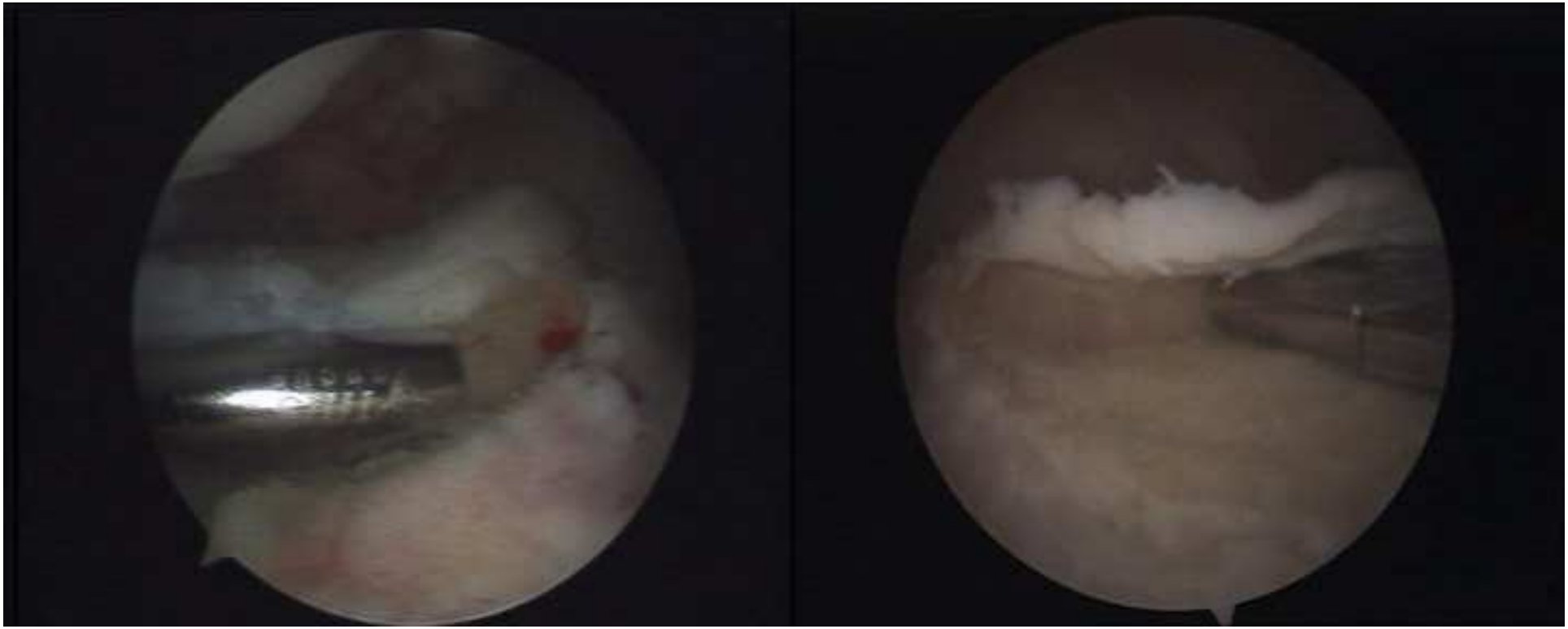

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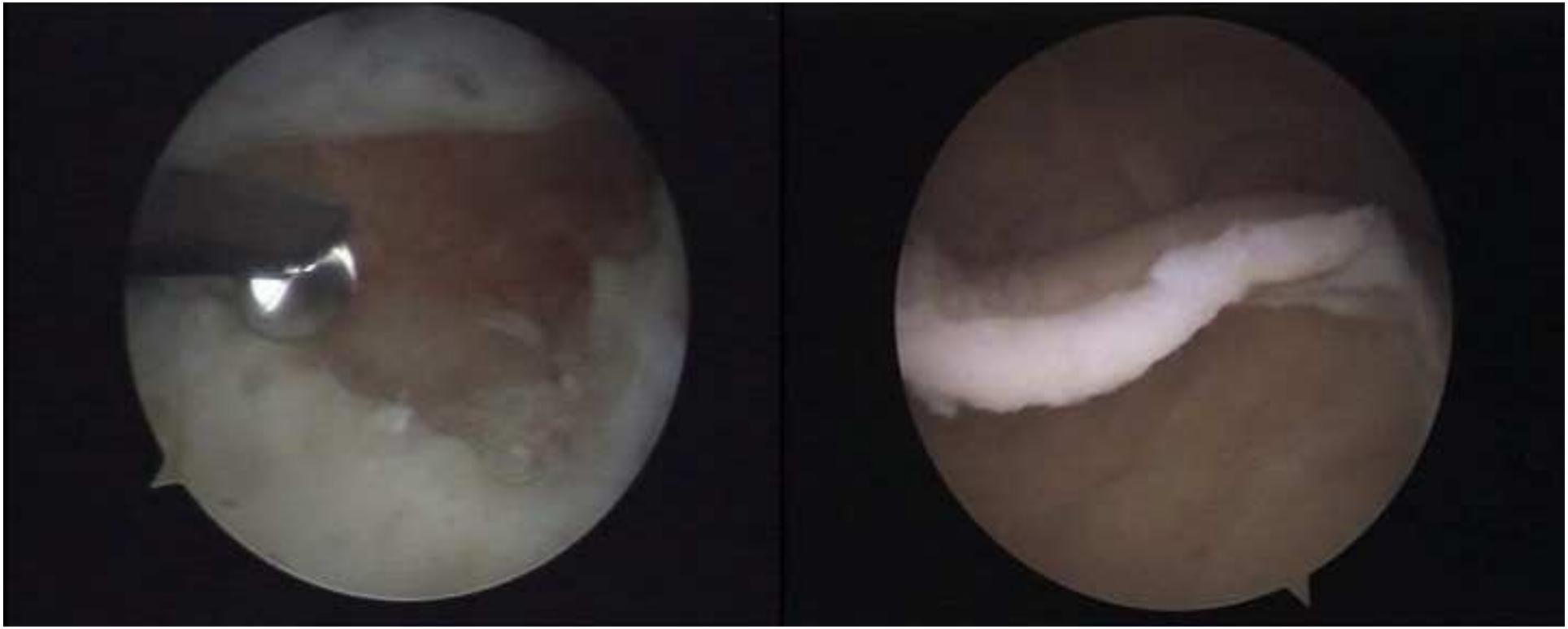

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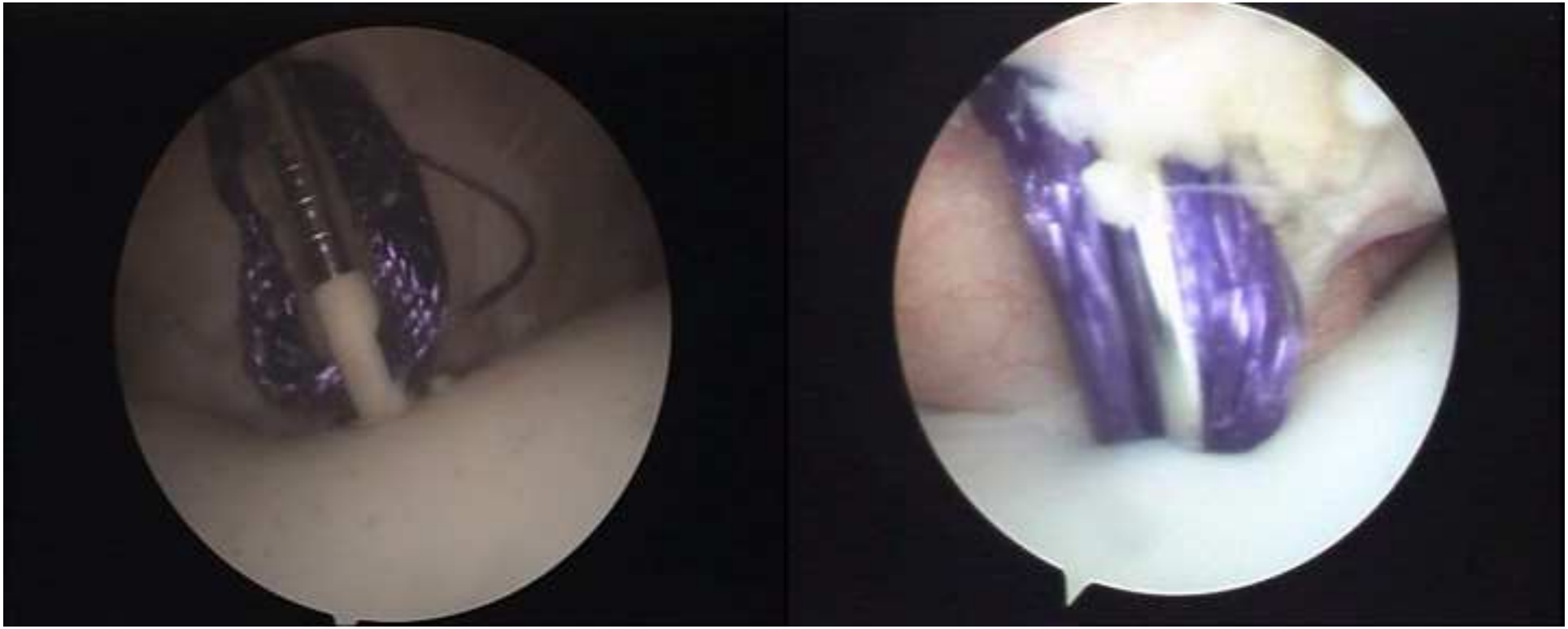

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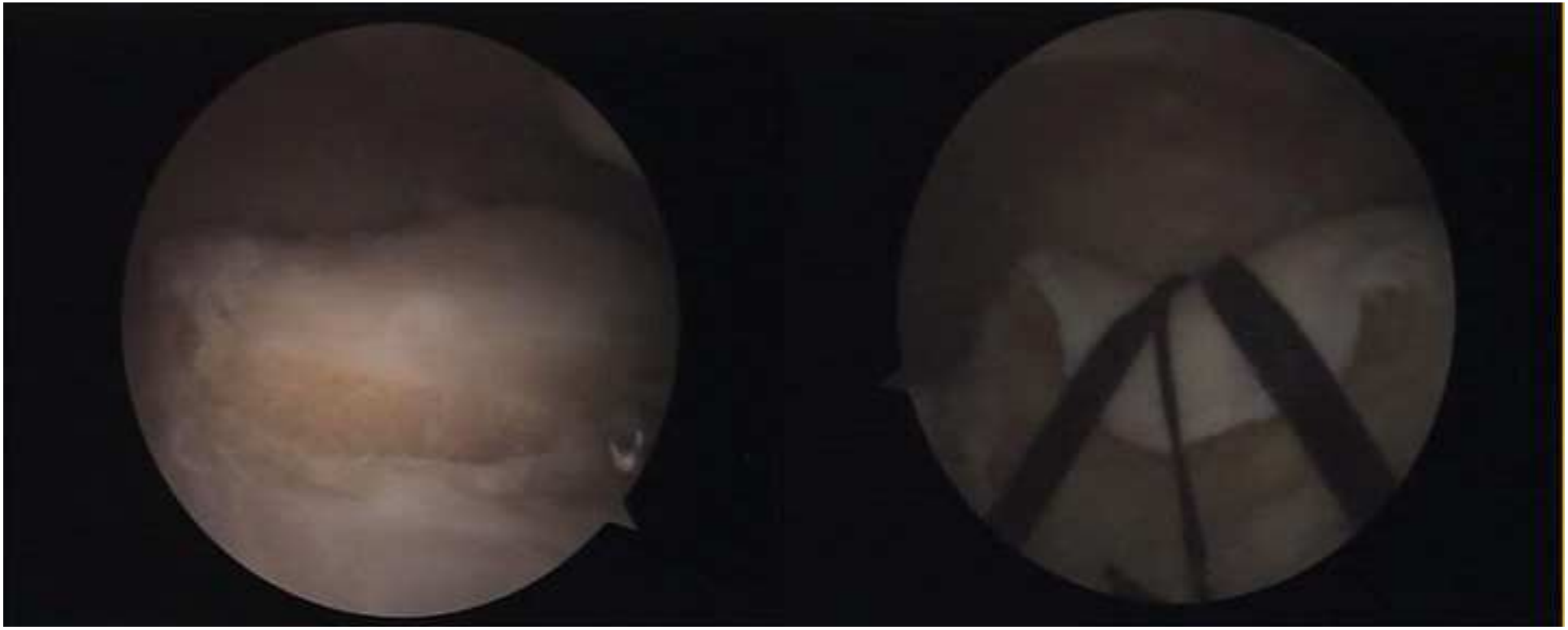

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