MENTORS IN ORTHOPEDICS

SIMULTANEOUS PERIACETABULAR OSTEOTOMY AND ARTHROSCOPICALLY ASSISTED TREATMENT OF CAM-RELATED PATHOLOGY IN ACETABULAR DYSPLASIA

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SUMMARY

Background: Acetabular dysplasia (AD) and femoroacetabular impingement (FAI) frequently coexist, with cam-type deformities occurring in 10% to 80% of dysplastic hips. While periacetabular osteotomy (PAO) is the established treatment for AD, suboptimal correction of associated cam lesions or intra-articular chondrolabral pathology can negatively impact long-term joint survivorship and accelerate the progression of osteoarthritis.

Objective: This article describes a specialized surgical technique combining PAO with traction-based, arthroscopically assisted intra-articular surgery to simultaneously address acetabular coverage, femoral asphericity, and chondrolabral lesions.

Key Points: Indications for this combined procedure include symptomatic AD (LCE angle <25°) with MRI-confirmed chondrolabral pathology and cam morphology (alpha angle >50°). Using a traction table and a modified anterior approach, a T-shaped capsulotomy allows for direct visualization and arthroscopic access to the central compartment. This enables precise labral refixation with suture anchors, chondral flap stabilization, or microfracture under distraction. Subsequent femoral osteochondroplasty is performed to restore head-neck offset. Following intra-articular repair, the PAO is completed using standard Bernese bone cuts to reorient the acetabular fragment. Mid-term data indicate that patients undergoing this combined approach achieve clinical outcomes comparable to those undergoing isolated PAO, without increased morbidity from the integrated procedure.

Conclusion: Integrating arthroscopically assisted intra-articular surgery with PAO allows for the comprehensive management of complex hip deformities in a single operative setting. This approach effectively addresses both extra-articular instability and intra-articular pathology, potentially optimizing joint mechanics and delaying osteoarthritic degeneration.

KEYWORDS

Acetabulum; Hip Dislocation, Congenital; Osteotomy; Femoracetabular Impingement; Arthroscopy

INTRODUCTION

Acetabular dysplasia (AD) as well as femoroacetabular impingement (FAI) are frequent disorders and play an important role in the development of hip osteoarthritis (OA). The two entities can occur independent from each other, but also in combination (fig. 1).

Fig.1: Anteroposterior pelvic radiograph of a patient with acetabular dysplasia and femoral head asphericity (indicative of cam-FAI) with initial joint space narrowing on both sides

According to selected prevalence studies, the frequency of additional cam deformities in AD is between 10% and 80% (Table 1). Since the natural history of combined AD and FAI may even lead to earlier OA than AD alone (Wyles et al. 2017), it is important to treat both deformities appropriately.

Author (year)	Country	Total number of patients with dysplasia	Percentage of patients with cam-deformity
(Günther et al. 2008)	Germany	105	18 %
(Clohisy et al. 2009)	USA	108	75 %
(Nogier et al. 2010)	France	35	22 %
(Domb et al. 2014)	USA	17	64 %
(Ida et al. 2014)	Japan	100	40 %
(Anderson et al. 2016)	USA	164	10 %
(Kohno et al. 2016)	Japan	68	22-50 %
(Wells et al. 2017)	USA	50	42 %
(Matsuda et al. 2018)	USA	117	80 %
(Mimura et al. 2018)	Japan	128	20 %

Table 1: Frequency of associated cam-deformities in patients with acetabular dysplasia (AD) according to selected publications

Periacetabular osteotomy (PAO) as initially developed by (Ganz et al. 1988) has been shown in several long-term studies to be a successful operation for the treatment of AD, but the outcome depends on adequate correction of associated cam deformities (Albers et al. 2013; Beaule et al. 2015; Ziebarth et al. 2011). Although bump resection and head-neck recontouring can be performed though an arthrotomy either before or after the osteotomy, appropriate treatment of more extended intra-articular pathology (i.e. labral rupture or cartilage lesions), which needs distraction of the joint, is difficult to achieve. Based on our previously reported technique of arthroscopically-assisted anterior decompression for femoroacetabular impingement (Hartmann &Günther 2009) we developed a procedure to combine PAO with intra-articular surgery for labral and/or cartilage lesions. This technique has successfully been used over several years now and shall be described in detail.

INDICATION

The indication for POA is radiographically confirmed acetabular dysplasia with a lateral center-edge (LCE) angle of less than 25° and hip pain for at least 6 months, which does not adequately respond to conservative therapy. The decision about additionally necessary intra-articular procedures is based on clinical and imaging findings. In order to search for potential morphologic damages resulting from asphericity of the femoral head, each patient with radiographically confirmed AD undergoes a standardized MRI investigation with radial sequences and measurement of femoral torsion. If patients show less than 10° internal rotation of the hip with or without a positive anterior impingement test, a normal femoral antetorsion and there is evidence of a cam pathology (alpha angle >50°), head-neck recontouring is performed together with the osteotomy. The choice of bump resection through arthrotomy alone or additional arthroscopically-assisted surgery is depending on the diagnosis of chondrolabral pathology on preoperative MRI investigation. If signs of chondrolabral pathology (i.e. labral tears, lesions of the chondrolabral transition zone) are present, arthroscopically assisted exposure and treatment of the lesion on a traction table is performed. In cases with abnormal acetabular version (either retroversion or elevated anteversion as diagnosed on native pelvic radiographs and confirmed by MRI), the orientation of the acetabular fragment is corrected through the osteotomy. In significantly elevated femoral anteversion (>30°) or retroversion, an additional intertrochanteric osteotomy may be considered, which can also be performed on the traction table. Contraindications for simultaneous PAO and cam-treatment are advanced radiographic OA (Kellgren-Lawrence Grade 3 and 4), incongruency of the joint space on pelvic antero-posterior radiographs or abduction view, and a patient age over 50 years.

SURGICAL TECHNIQUE

Patients are positioned on a traction table (fig. 2a and 2b) allowing traction, rotation as well as intermittent disconnection and flexion of the ipsilateral leg to evaluate contact between femoral neck and acetabular rim intraoperatively.

Fig.2: Supine patient position on traction table with arthroscopy and fluoroscopy set up (a) and completed draping (b)

Sterile preparation and draping of the entire hemipelvis up to the inferior ribs and the affected lower limb is carried out in a way which ensures access to the iliac crest and free mobility of the lower limb. With the patient in supine position, the skin incision is performed from the anterior third of the iliac crest (one finger width below the to the anterior superior iliac spine) to the inguinal fold (fig. 3a). The exposure follows the recently described modification of the original Bernese PAO technique (Lerch et al. 2016; Siebenrock et al. 2015), although preparation is initially limited to the distal part of the incision (Hartmann and Gunther 2009) in order to limit exposure time of the proximal soft tissues. A combined skin and subcutaneous soft-tissue flap are mobilized distally, exposing the fascia of the thigh over the tensor fasciae latae and sartorius muscles. The superficial aponeurosis of the tensor fasciae latae is incised and blunt dissection separates the muscle from the medial wall of the fascial sheet, which is left intact to protect the lateral cutaneous femoral nerve. After identification of the rectus femoris origin, the iliacapsularis muscle is sharply dissected and detached from the underlying capsule as well as from the anterior inferior iliac spine from lateral to medial. The rectus femoris muscle is retracted laterally and the iliocapsularis muscle medially until the anteroinferior portion of the capsule is visible. Before the capsulotomy is made, the iliocapsularis muscle is further mobilized medially to allow access to the infra-articular space and palpation of the ischial bone (fig. 3b), as exposure for later osteotomy of the ischium would be impaired after previous capsulotomy. For this purpose the infra-articular space is opened by inserting a rasp or by spreading a pair of curved scissors. Typically, the iliopsoas tendon becomes visible on the medial side. With the help of a rasp the proximal ischium can be palpated. Once the entry point for the ischium osteotomy is clearly defined at the infra-articular space, the rectus tendon is retracted medially and two blunt Hohmann retractors are placed medially and laterally around the femoral neck. A T-shaped capsulotomy is made (fig. 3c), which allows full inspection of the anterior parts of the labrum and the anterior head–neck region.

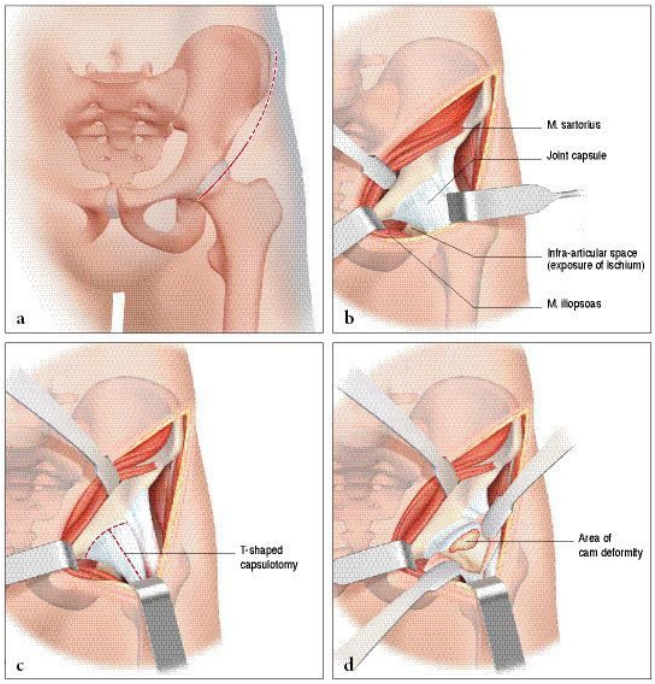

Fig.3: Skin incision -initially limited to distal part (3a), exposure of infra-articular space (3b), capsulotomy (3c) and exposure of cam-area (3d)

Arthroscopically assisted intra-articular surgery

Details of the following steps have been described by (Hartmann and Gunther 2009). By disconnecting the traction device, a dynamic evaluation of hip motion under direct observation of labrum, head and neck is performed and the area of reshaping of the head–neck junction can be clearly defined (fig. 3d).

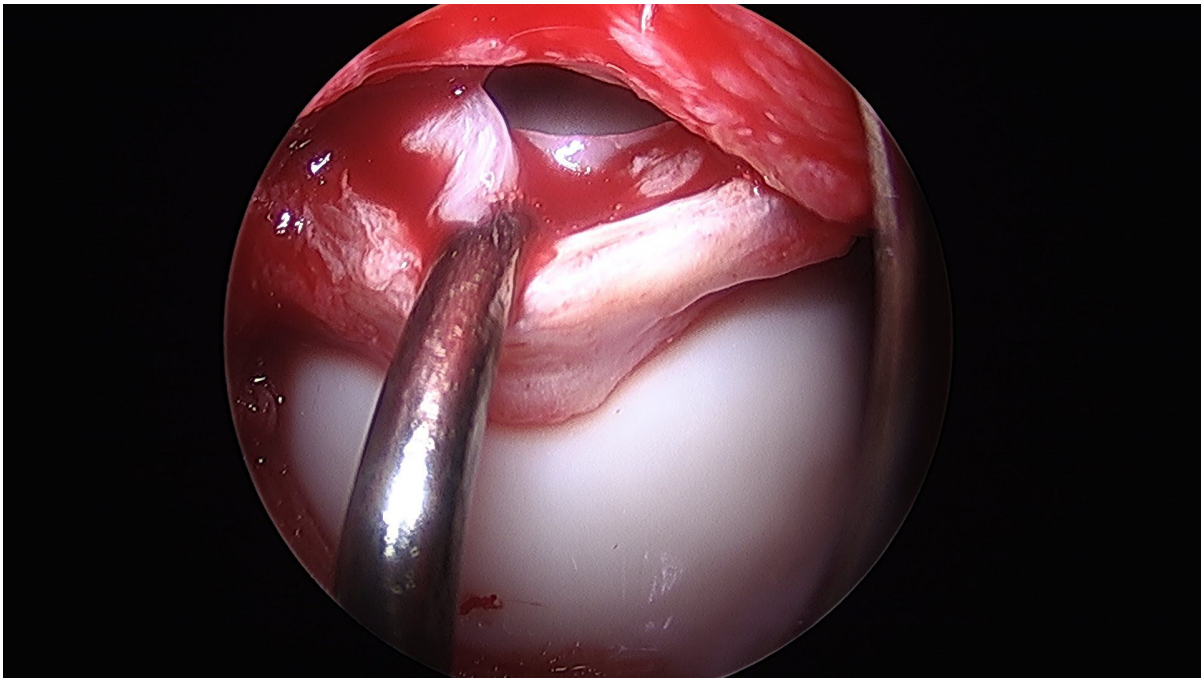

Fig. 4: Ruptured labrum before (4a) and after refixation (4b) with resorbable suture anchors

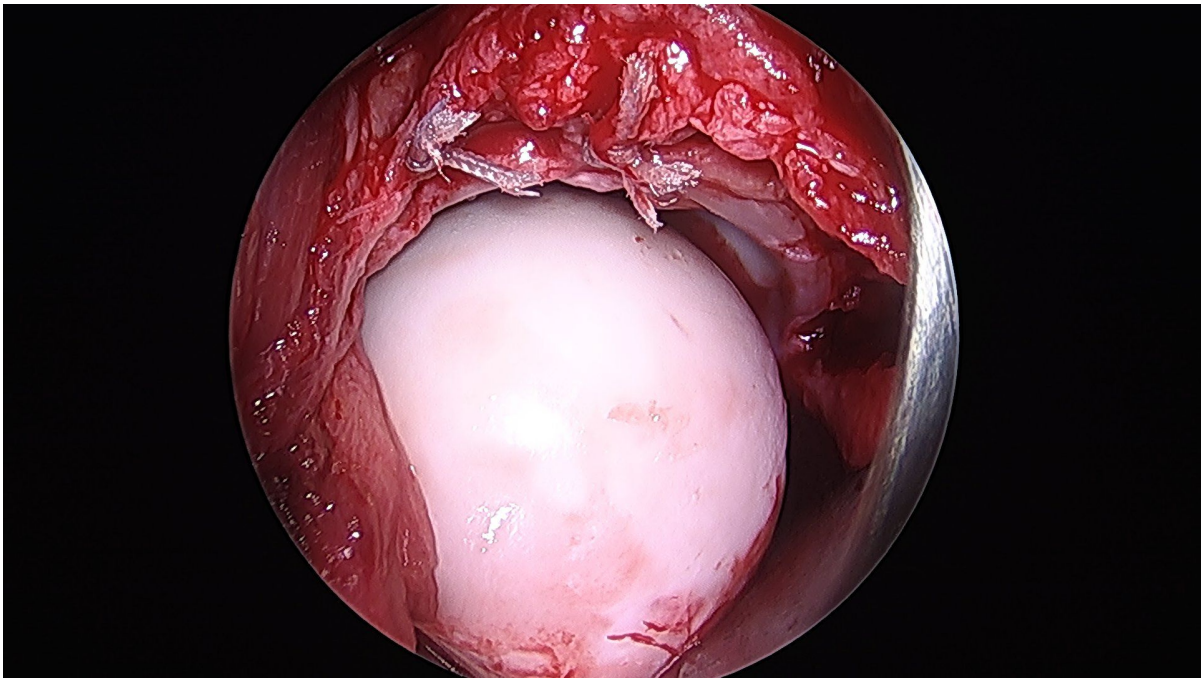

Fig. 4: Ruptured labrum before (4a) and after refixation (4b) with resorbable suture anchors

Visualisation of the central compartment of the joint for chondral and labral lesions is performed arthroscopically. After having applied distraction of the leg a 3.5 mm arthroscope (70° optics) is inserted from the anterior incision. Fluid management as in normal arthroscopy with continuous flow allows proper visualisation. The anterosuperior and lateral parts of the acetabular labrum with the adjacent articular cartilage and the femoral head are inspected. These are the areas where most of the relevant labrum and cartilage lesions are located. Depending on the amount as well as type of damage, reconstructive procedures are performed with and without traction. Ossified or ruptured parts of the labrum are resected or refixation of a partially detached labrum is performed with resorbable suture anchors (fig. 4a and 4b). Refixation of debonded cartilage flaps (fig. 5 a–d) curettage and microfracturing of damaged cartilage fragments and even autologous chondrocyte transplantation is possible (Bretschneider et al. 2020).

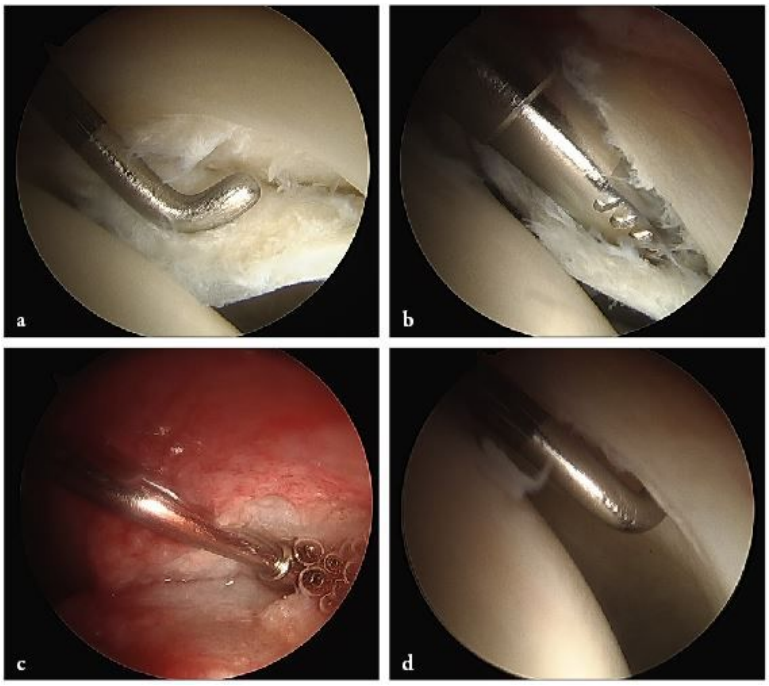

Fig. 5: Refixation of a debonded cartilage flap: Initial exposure of flap (5a), debridement of subchondral bone (5b), injection of fibrin glue (5c) and final result (5d)

Contouring of the femoral head and neck by osteochondroplasty is performed with a partially covered acromionizer (fig. 6a and 6b).

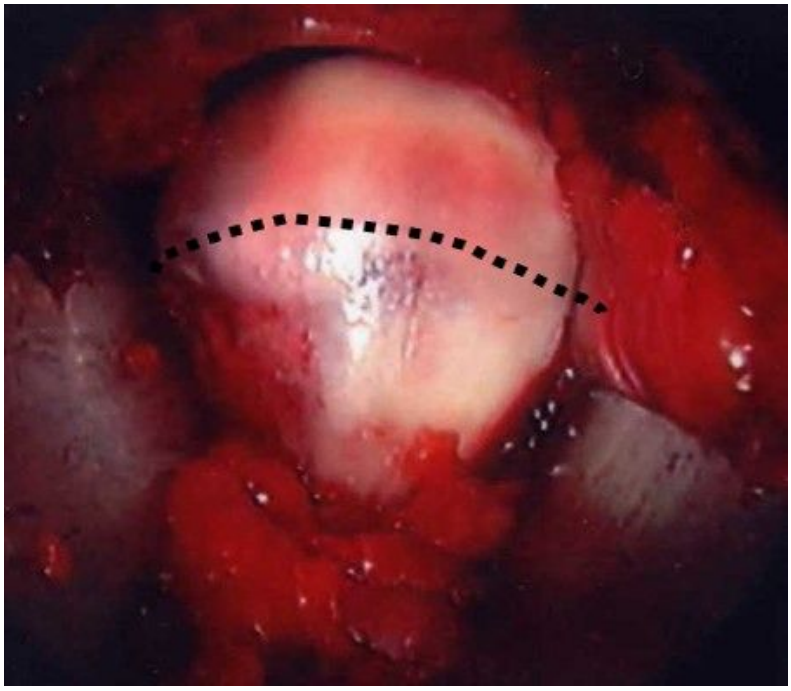

Fig. 6: Exposure of cam-deformity (6a) and contouring of head-neck transition by osteochondroplasty with an acromionizer (6b)

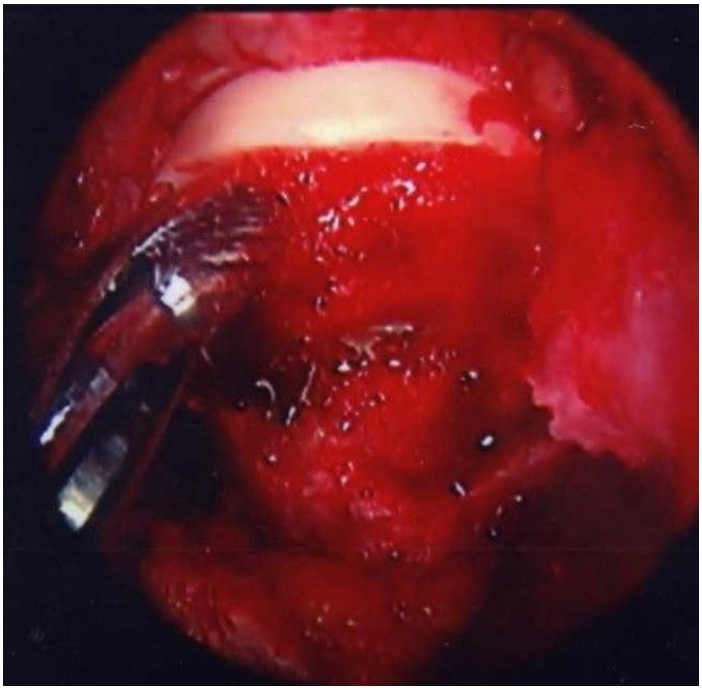

Fig. 6: Exposure of cam-deformity (6a) and contouring of head-neck transition by osteochondroplasty with an acromionizer (6b)

Fluid is again used during most of the time to ensure cooling of the mechanical instruments and to use the arthroscope for better visualisation in the more lateral parts of the joint. This allows even contouring of the femoral neck in the most lateral and medial parts close to the joint capsule without dislocation. The area where retinacular vessels enter the epiphysis dorsolaterally is avoided. Repeated removal of traction, testing of hip motion and—if necessary—further osteochondroplasty is performed, until impingement-free internal rotation in 90° of hip flexion is reached. After completion of all necessary intra-articular procedures, a preliminary suture

of the capsule is performed, to allow better exposure of the infra-articular space, when the ischium osteotomy is performed at a later stage.

Periacetabular osteotomy

Now the exposure is completed in order to perform the PAO. As the surgical technique has been described extensively already by the Bernese group (Ganz et al. 1988; Lerch et al. 2016; Siebenrock et al. 2015), the principal steps shall be summarized only. The incision is extended proximally and abdominal wall muscles are detached from the anterior iliac crest in order to expose the iliac fossa and the pelvic brim. The origins of the sartorius muscle and the inguinal ligament are sharply detached from the anterior superior iliac spine and retracted medially together with the abdominal wall muscles. Medial retraction of the muscles is facilitated by placing a curved blunt retractor over the pelvic brim. The superior pubic ramus is exposed subperiostally and blunt retractors are placed to ensure a safe pubic bone osteotomy. After completion, the infra-articular space medial to the sutured capsule is exposed in order to introduce a curved chisel and perform the osteotomy of the ischium. Finally the supra-acetabular horizontal osteotomy is performed, which starts at the anterior superior iliac spine and ends 2 cm lateral to the pelvic rim. At this point the osteotomy is angled 100° distally (fig. 7).

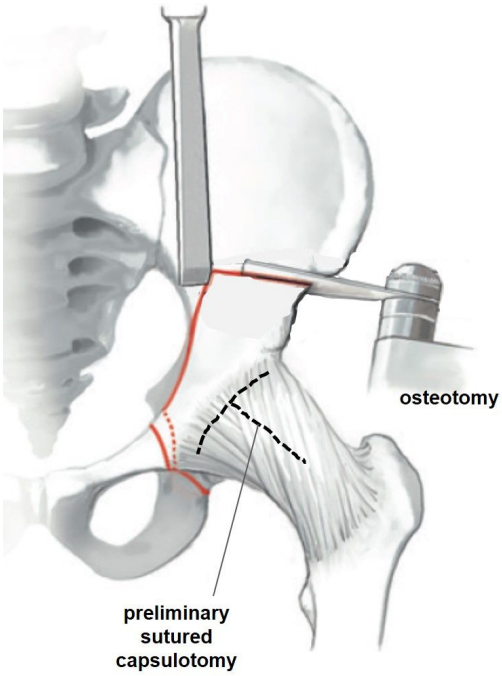

Fig. 7: Bone cuts for periacetabular osteotomy

After completion of the osteotomy, the acetabular fragment is mobilized with the help of a spreader and two 4.5-mm threaded Schanz pins. Due to our experience, the application of two pins facilitates reorientation of the acetabular fragment. After the desired position has been achieved, the fragment is fixed with four 3.0mm K-wires and an intra-operative radiographic or fluoroscopic control is performed. If necessary, the fragment position can be changed in order to ensure adequate coverage. (Millis, Siebenrock, and Session 2012) have described relevant radiographic parameters to achieve best possible spatial acetabular orientation by outlining the contours of the anterior and posterior rim. With the preliminary K-wire fixation in place, internal rotation in 90° of hip flexion is checked again. If the range of motion is worse than after previous osteochondroplasty, the capsule suture can be opened again and – if necessary – the offset still be improved or the anterior coverage of the acetabular fragment reduced. Finally an internal rotation of at least 20° in 90° of hip flexion should be achieved. If the fragment orientation is sufficient, the K-wires are replaced by 3.5-mm cortical screws. After repeated irrigation the wound is closed in layers with absorbable sutures. In addition to sufficient hemostasis we apply local tranexamic acid and

waive wound drainage. Perioperatively 1,5mg cefuroxim are applied, and if the operation time exceeds 90 minutes, the application is repeated.

Postoperative rehabilitation

In order to avoid heterotopic ossification, we established routine administration of Ibuprofene 3x800mg for 2 weeks postoperatively. The standard rehabilitation programme includes mobilisation of the hip without limitation from the first postoperative day (if labral re-attachment was performed, we limit hip flexion to 70° over 4 weeks). Patients are allowed to ambulate with partial weightbearing for 6 weeks and then continue with full weight bearing.

Crutches are recommended for about 8-10 weeks. Routine thromboprophylaxis is administered for the first 6 weeks. Fig. 8 shows the treatment result of a 22 year old male with a combination of AD and cam-FAI, where head-neck osteochondroplasty and microfracturing of acetabular cartilage defects have been performed.

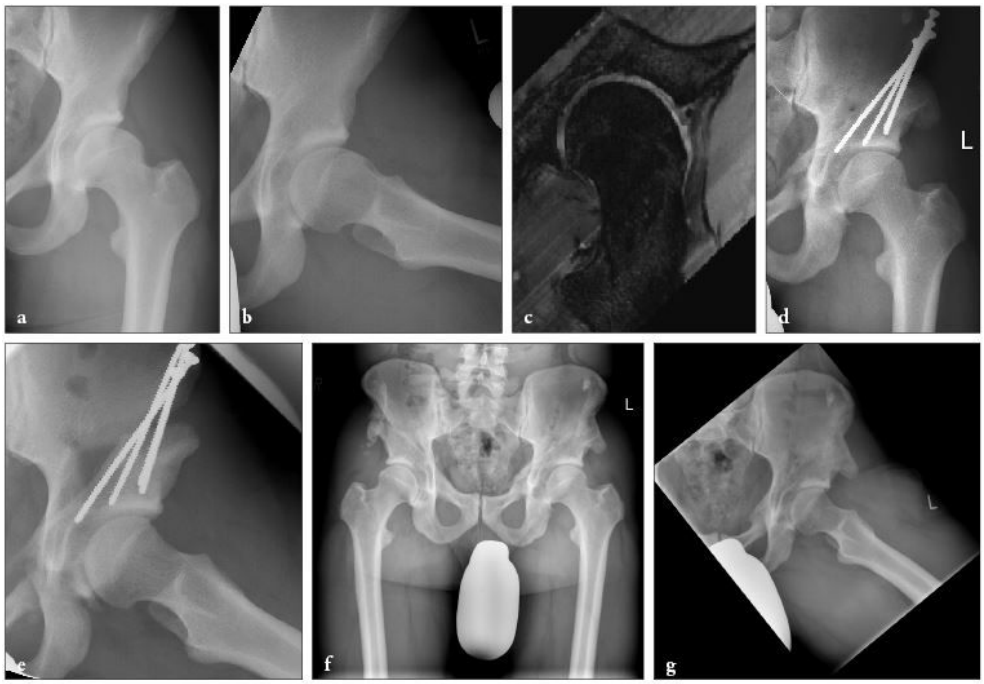

Fig. 8: Combined AD and cam-FAI with pre-op radiographs (8a, b), pre-op radial MRI (8c), postoperative radiographs after PAO with cam resection and microfracturing (8d, e) and final result after 12 years (8f, g)

Fig. 8: Combined AD and cam-FAI with pre-op radiographs (8a, b), pre-op radial MRI (8c),

postoperative radiographs after PAO with cam resection and microfracturing (8d, e) and final result after 12 years (8f, g)

DISCUSSION

It is well known that the lack of appropriate cam treatment in osteotomies for AD as well as inappropriate consideration of acetabular undercoverage in labral surgery can adversely affect the outcome (Albers et al. 2013; Beaule et al. 2015; Haefeli et al. 2017; Vahedi et al. 2019; Ziebarth et al. 2011). Considering the relatively high co-incidence of dysplasia and cam-deformities, which was reported in recent studies (Matsuda et al. 2018; Mimura et al. 2018; Wells et al. 2017), it is necessary to develop surgical techniques, which enable us to adress both

pathologies appropriately. Sankar et al. (Sankar et al. 2015) summarized available approaches in a multicenter-cohort of 972 osteotomies. Together with PAO, anterior arthrotomy was performed in about half of the cases (52.6%) and 19.8% of patients underwent additional hip arthroscopy during the same procedure. Although they state, that asphericity of the femoral head-neck junction and labral pathologic changes have been addressed in these patients together with the osteotomy, they do not provide any details about particular technical details nor reconstructive measures.

An important prerequisite for efficient labral and/or cartilage repair techniques is traction during hip arthroscopy in order to separate the femoral head from the acetabulum and provide space for the introduction of the arthroscope and necessary instruments. This is probably the main reason, why most surgeons, who have to address combined hip pathology, prefer to divide initial arthroscopy and later osteotomy into two independent surgical procedures. This staged approach, however, necessitates two surgeries with associated hospitalization and morbidity.

Considering the good results of our previously introduced arthroscopically-assisted anterior decompression for femoroacetabular impingement (Hartmann and Gunther 2009), we developed a procedure to combine PAO with traction-based intra-articular surgery for labral and/or cartilage lesions. After introduction of this protocol, we have analyzed our treatment results in 86 patients (106 hips), who underwent PAO for hip dysplasia between July 2005 and December 2010 (Goronzy et al. 2017). Surgical and outcome data were prospectively collected and retrospectively reviewed in a comparative observational study. In comparison with isolated PAO in patients without symptomatic asphericity as well as PAO with subsequent osteochondroplasty through arthrotomy for patients with symptomatic cam deformity and no labrochondral pathology, the patient group with arthroscopically assisted osteochondroplasty and additional labrochondral repair with subsequent PAO had no different outcomes (i.e EQ-5D, WOMAC, alpha angle, CE-angle) during mid-term follow-up of nearly 6 years.

It may be difficult, to determine which type of femoral head deformity needs to be addressed during PAO and if arthroscopic–assisted surgery is be necessary or if arthrotomy alone might be sufficient. As a rationale for this decision, some authors propose intraoperative dynamic assessment of hip motion through arthrotomy (Myers, Eijer, and Ganz 1999; Siebenrock, Leunig, and Ganz 2001). Other investigators agree that an alpha angle greater than 50-55° reflects a characteristic of cam FAI which should be addressed (Audenaert et al. 2012; Clohisy et al. 2009; Ida et al. 2014; Notzli et al. 2002). There is also evidence that reduced internal rotation of the hip during preoperative clinical examination and a positive impingement test are indicative of the presence of reduced femoral offset. We use a combination of all of these to determine, if patients need additional cam correction together with PAO. If patients show less than 10° of internal rotation, have a positive anterior impingement test and an alpha angle >50°, we schedule concomitant osteochondroplasty during PAO. The decision, if additional labral and/or cartilage surgery with positioning the patient on a traction table is necessary, is based on pre-operative MRI assessment. In case of significant labral damage or tears, ganglion cysts and suspicion of impingement-associated cartilage lesions we start surgery with the described arthroscopically assisted approach. In about 10-20% of our surgeries this approach is currently used.

The main advantage of arthroscopically assisted surgery is the possibility to perform each type of labral and/or cartilage repair, for which traction might be necessary, in direct combination with an osteotomy. Thereby a sequential procedure with additional morbidity can be avoided. Disadvantage might be positioning of patients on a traction table, which can impair the possibility of intra-operative radiographic examination. Domb et al. (Domb et al. 2015), who also propose concomitant arthroscopy during osteotomies, transfer the patient after the endoscopic procedure from the traction table to another radiolucent table. We think, that fluoroscopic control of osteotomies and fragment position is possible on the traction table as well, but a full antero-posterior pelvic radiograph may be difficult to obtain. Being used to fluoroscopy as a routine control in our patients with

conventional PAO as well, we did not observe any relevant limitation in osteotomies on the traction table, although correct adjustment of images is somewhat more demanding.

CONCLUSION

Due to our good experience with concomitant arthroscopically-assisted surgery during PAO, we recommend the application in patients, who need intra-articular treatment for cam-associated labral and cartilage damage in acetabular dysplasia. The advantage of reducing two consecutive surgeries to one single procedure with less morbidity outweighs the potential drawbacks of performing an osteotomy on a traction table.

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