Reverse Periacetabular Osteotomy

12

Michael Wettstein

12.1 Introduction

Besides a normal cervicocephalic offset, a correct three-dimensional (3D) orientation of the acetabulum is essential to achieve normal hip joint motion. Among possible deformations, retroversion is a malorientation of the socket leading to more or less posterior instead of anterior opening [1]. This results in an abnormal contact between the femoral neck and the acetabular rim, known as femoroacetabular impingement (FAI), in this case of pincer-type [2]. FAI leads to inguinal pain, decreased motion in flexion and internal rotation, and, finally, osteoarthritis of the hip [2].

The easiest treatment option consists in trimming of the prominent anterior wall [3]. In the setting of true acetabular retroversion, this however decreases the size of the articular surface and results in an iatrogenic dysplasia. Therefore, reorientation by the means of a reverse periacetabular osteotomy (PAO) is the treatment of choice in this situation [4, 5].

M. Wettstein (✉)
Institut de Traumatologie et d'Orthopédie du Léman Suisse, Clinique de Genolier, Genolier, Switzerland

Service d'Orthopédie-Traumatologie, Hôpital Riviera-Chablais Vaud-Valais, Centre Hospitalier de Rennaz, Rennaz, Switzerland
e-mail: m.wettstein@itols.ch

12.2 Definition of Acetabular Retroversion

Among etiologies for pincer impingement, focal acetabular overcoverage, coxa profunda or protrusion, and acetabular retroversion have been described [2]. It is of paramount importance to distinguish between these entities, as the treatment is based on the anatomic shape of the acetabulum.

The diagnosis of acetabular retroversion is based on the correlation between clinical and radiographic findings: Typically, patients will complain about anterior groin pain with a decreased flexion and internal rotation [5]. The anterior impingement test reproduces the patient's inguinal pain [6].

Conventional imaging is based on an anteroposterior (ap) pelvic radiograph, centered on the symphysis pubis and with strict control of inclination and rotation, as these parameters may change the projected orientation of the acetabulum, increasing or decreasing the version, and thus leading to a wrong diagnosis [7]. If in doubt about the correct projection, an analysis with a dedicated program, allowing to reorient the pelvis, might be used [8].

On the correctly centered ap-view, the relative position of the acetabular walls needs to be evaluated. A normal shape is defined as the anterior wall projecting medially of the posterior wall, both meeting at the level of the roof at a sharp angle (Fig. 12.1a). If the anterior crosses the posterior wall (positive cross-over sign), the amount

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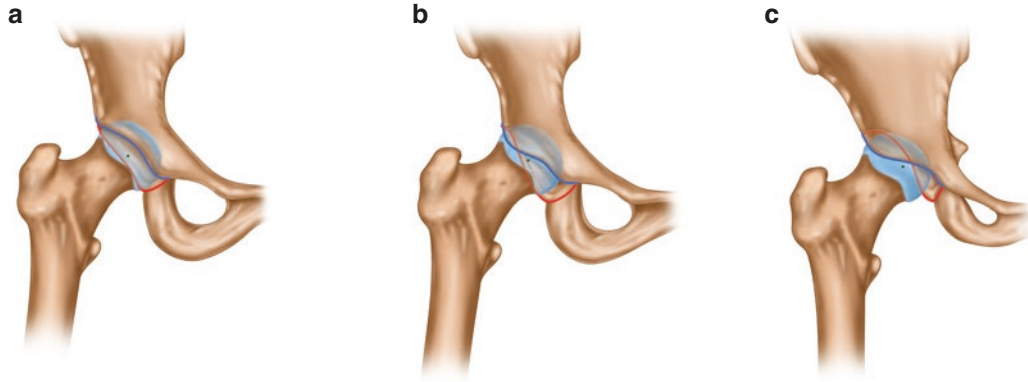

Fig. 12.1 (**a**) Normal acetabulum with anterior and posterior wall meeting at sourcil with a sharp angle. Head center medial projects medially of posterior wall. Ischiatic spine not visible. (**b**) Overcovering with positive cross-over, but head center still projects medially of posterior wall and ischiatic spine is not visible. (**c**) Retroversion. Positive cross-over with head center lateral of posterior wall and ischiatic spine visible. Furthermore, the retroversion index is higher than 30%, the convergence angle of the walls at the sourcil much flatter, and the iliac wing much larger with a laterally prominent anteroinferior iliac spine (AIIS) and a narrow obturator foramen

of crossing must be assessed, using the retroversion index. This index indicates the ratio of posterior wall covered by the anterior wall. If the index is lower than 30%, this represents a focal overcoverage (Fig. 12.1b). If the index is higher than 30%, there is a high risk of real retroversion of the acetabulum. In this case, further signs are found, with a positive posterior wall sign (posterior wall medial to the center of the femoral head) and positive ischiatic spine sign (spine visible medially of the ilio-pubic line), which are typical for acetabular retroversion (Fig. 12.1c) [5, 9–11]. Rarely, extreme cases of complete acetabular retroversion can be found with the anterior wall completely covering the posterior wall. These cases may be misleading, but can be diagnosed by a flatter convergence angle of both walls at the lateral roof.

The prevalence of isolated retroversion was described as 5% [12].

As additional diagnostic criteria, a much larger iliac wing, a very prominent anteroinferior iliac spine (AIIS), and a narrow obturator foramen have been described as consequences of a global external rotation of the hemipelvis [13, 14].

The lateral coverage of the head must always be evaluated, as a significant number (17–37%) of dysplastic hips can also be retroverted [15–17]. Fuji et al. showed that retroversion associated to dysplasia induces earlier appearance of symptoms than in lateral or anterior dysplasia, whatever the degree of dysplasia [18]. This can be explained by the increased degree of posterior wall hypoplasia in these cases.

As a decreased cervicocephalic offset (cam deformity) can be found simultaneously in a significant number of cases, this must also be evaluated on the conventional radiographs [2]. Classically, an axial view of the femur (cross-table, Dunn, Lauenstein, etc.) is made to see the anterior cervicocephalic junction. However, the ap pelvic view shows the lateral offset and, in convergence with the sagging-rope sign described in Legg-Calvé-Perthes disease, also the anterior offset (Fig. 12.2) [19]. Using this sign, I did not do any axial view for years, as I found a good correlation between this sign and the morphology found on radial magnetic resonance arthrography (MRA) sequences [NP].

The second radiograph is a false-profile view, as described by Lequesne [20]. This allows to analyze the morphology of the anteroinferior iliac spine (AIIS) and the joint space. Specifically, early joint space narrowing would be seen on the false-profile view rather than on the ap-view, either in an anterosuperior location in cam impingement, or posteroinferior in pincer

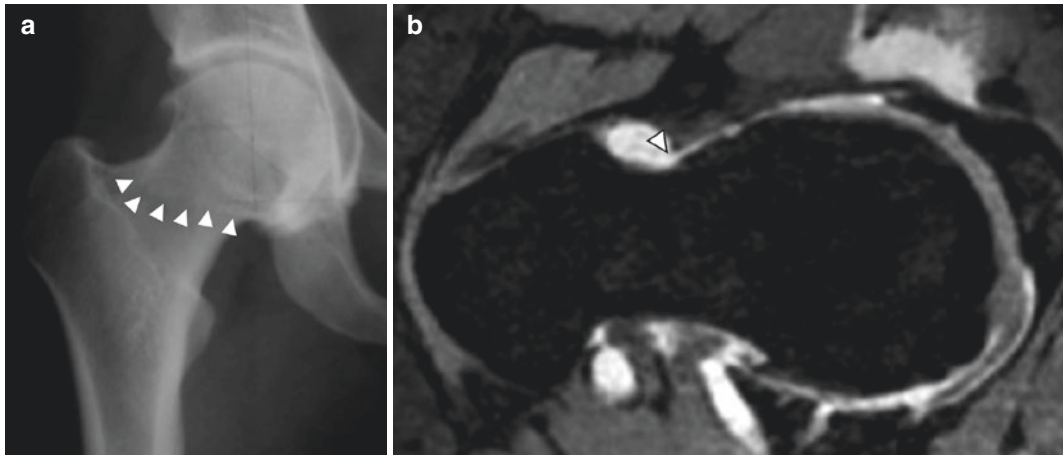

Fig. 12.2 (**a**) Anteroposterior (ap)-view of a right hip showing the sagging-rope sign, marked with arrowheads, which marks the lateral border of the femoral head, showing a decreased anterior offset. (**b**) Radial arthro-MRI sequence of the same patient, confirming the lateral position of the head–neck junction corresponding to the sagging-rope sign

impingement. This allows for a more precise conventional evaluation of the cartilage, any significant narrowing of the joint space or displacement of the head (subluxation with positive crescent sign) being a sign of a significant lesion of the cartilage, which contraindicates conservative surgery [21].

Further evaluation of the labrum and the cartilage needs a magnetic resonance arthrography (MRA). The gold standard is to obtain radial sequences and distraction images to improve the 3D visualization of bone morphology and the discrimination of chondro-labral lesions [22, 23]. Additional images of the distal femur can be obtained to measure femoral antetorsion, which recently gained increasing interest in the setting of FAI [24].

Computerized tomography (CT) imaging may be used to evaluate the 3D morphology of the acetabulum or femoral antetorsion, but is rarely used by the author as the above-mentioned imaging modalities supply all the necessary information. Based on local habits, CT-arthrography may be used instead of magnetic resonance imaging (MRI) to evaluate the chondro-labral complex.

The term "retroversion" is frequently misused in the literature in the context of a positive cross-over sign. To avoid misleading concepts and inadequate treatments, I suggest to adhere to the above-mentioned definition of true retroversion and to use the term retroversion only in this situation. Other situations with a positive cross-over sign correspond to a focal overcoverage.

12.3 Indications and Contraindications

Steppacher et al. showed that the lunate surface in retroverted acetabula is of the same size as a normal acetabulum [4]. This means that the anterior wall is not oversized nor the posterior wall undersized, which could however be the case in dysplasia, but they are malpositioned.

Any trimming of the anterior wall in this situation decreases the size of the joint surface, leading to an iatrogenic dysplasia and possible instability of the joint. This treatment is the first choice in cases with a retroversion index lower than 30% and a negative posterior wall and ischiatic spine sign, corresponding to focal overcoverage. In cases with significant anterior cartilage lesions, where a reverse PAO would turn these lesions into the weight-bearing zone, a partial rim trimming with offset correction could be considered as palliative treatment in young patients. This can be realized either by arthroscopy or by surgical hip dislocation (SHD), depending on the situation.

In true retroversion, the treatment of choice is to correct the orientation of the acetabulum with a reverse PAO. This treatment has been proposed for patients younger than 40 years, but encouraging results were also found in older dysplastic patients [25]. I therefore consider that the health of cartilage is a more significant indicator than chronological age. Of course, the importance of such an operation has to be weighed-out in every single situation compared to patient age, cartilage state, and possible outcome, as well as discussed with the patient.

Osteoarthritis Tönnis grade higher than 1, significant cartilage lesions on arthro-MRI, or subluxation of the head on the false-profile view should be considered as contraindications for conservative surgery.

As a cam deformity is frequently associated, and must be diagnosed based on the preoperative imaging, testing of hip motion in flexion and internal rotation is mandatory after correction of the acetabular orientation [26]. If 30° of internal rotation are not achieved in 90° of flexion, I consider that an arthrotomy must be done for offset correction to avoid any residual impingement. Even if actual results about concomitant treatment of the cam deformity during PAO are controversial, the risk of further cartilage lesions and the necessity of a potential second operation outweigh the additional time necessary for an arthrotomy [27–30].

If a significant torsional problem was diagnosed before (normal femoral torsion is considered between 5° and 25°, ideal at 15–20°), a femoral rotation osteotomy should be performed simultaneously to avoid residual instability or impingement problems [24, 31].

12.4 Patient Positioning and Incision

Basically, the surgical technique regarding approach and osteotomies does not differ from standard PAO [32].

The patient is positioned on a radiolucent table under general anesthesia with full muscle relaxation. Sterile draping of the operated leg is necessary, as it must be freely mobile during the procedure. A cell-saver device as well as tranexamic acid are used as routine because of the potential risk of bleeding and to decrease the transfusion requirements [33, 34].

12.5 Surgical Approach

Initially, the modified Smith-Peterson approach was used, then modified to a more minimal invasive approach with a short vertical incision, as proposed by Lara et al. [35]. Actually, a low ilioinguinal-type or bikini incision is favored, because of its better cosmetic results and easier exposure of the pubic ramus. The incision is parallel to and approximately 2 cm below the iliac crest, the medial part being oriented more downwards to facilitate later access to the joint (Fig. 12.3). Medially of the tensor fasciae latae, care must be taken to avoid the lateral femoral cutaneous nerve (LFCN), by not dissecting the subcutaneous fat over the sartorius.

The fascia of the tensor is incised longitudinally, approximately 2 cm from of the medial border, and the muscle belly retracted laterally inside the fascial sheath, which further protects the LFCN (Fig. 12.4). After 30° of flexion of the hip, using a leg holder that will be kept in place during the whole surgery to decrease muscle tension, the deep innominate fascia is incised longitudinally to

Fig. 12.3 Modified inguinal or bikini incision, parallel to the iliac crest. Pincette points to the anterosuperior iliac spine (ASIS). To decrease skin tension, the superficial incision goes 2–3 cm more medial than the medial border of the tensor fasciae latae

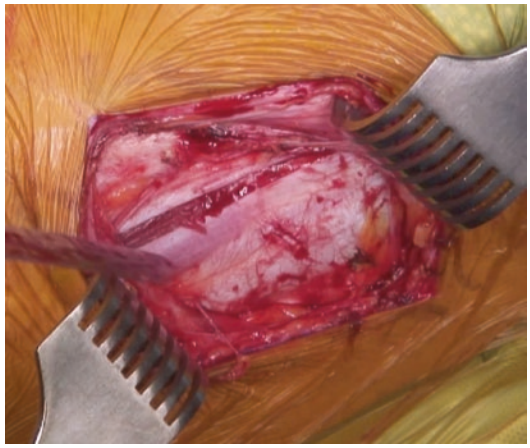

Fig. 12.4 Incision of fascia tensor fasciae latae over the muscle to keep a safe distance with the lateral femorocutaneous nerve

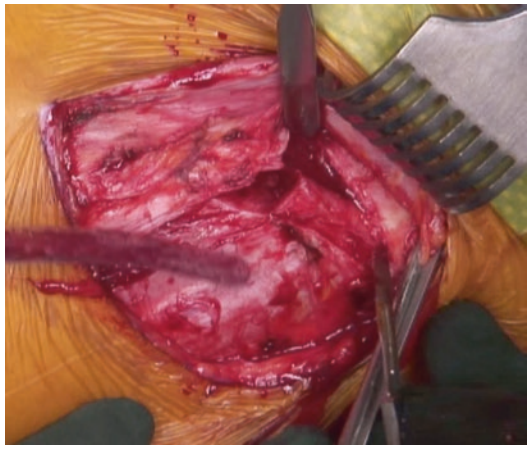

Fig. 12.5 After osteotomy of the anterosuperior iliac spine (ASIS), the abdominal muscles are sharply detached from the iliac crest, the iliopsoas is subperiosteally detached from the medial iliac wing using a sponge and retracted medially. The sartorius origin and inguinal ligament remain attached to the ASIS

gain access to the rectus femoris. The distal dissection should not go further down than the ascending branch of the lateral femoral circumflex artery, which crosses the interval between tensor and rectus, and needs to be preserved.

The abdominal muscles are detached from the anterior third of the iliac crest and the anterosuperior iliac spine (ASIS) is osteotomized and retracted medially with the sartorius insertion (Fig. 12.5). I prefer to realize an osteotomy, as I feel that the LFCN is better protected than by detaching the inguinal ligament subperiosteally [36]. The iliacus muscle is then subperiosteally detached from the iliac fossa with a sponge.

Further dissection is done by retracting the rectus origin laterally and detaching the iliocapsularis muscle origin from the AIIS and the anterior capsule. The psoas tendon and iliopectineal bursa are also lifted from the capsule, allowing a complete anteromedial exposure to the level of the calcar femoris, which can be palpated through the capsule. Adapted hip flexion and adduction may help during this dissection.

The fascia separating the posterior muscle compartment of the thigh is opened with the tip of long scissors, between the capsule and the psoas tendon, before palpating the ischiatic bone. The tip of the scissors may be moved medially and laterally to get a feeling of the width of the ischiatic bone.

12.6 Partial Ischial Osteotomy

A special osteotome with 30° angulation and a 15 mm blade (Ganz or periacetabular osteotome) is inserted into the space between the capsule and the psoas tendon. A similar but curved osteotome has been developed, which makes the ischiatic osteotomy easier in the author's hands.

The hip is abducted to lateralize and protect the sciatic nerve. The infracotyloid groove (notch between the posteroinferior acetabular wall and the ischium) is palpated and the chisel seated in the correct position, which can be verified using fluoroscopy (Fig. 12.6a). This control is helpful, all the more during early experience, but not mandatory in experienced hands. Care should however be taken in retroverted hips as the posterior horn of the acetabulum is less prominent than in dysplasia, which makes palpation more difficult and increases the risk for an intra-articular osteotomy. The osteotome should always aim toward the opposite shoulder to avoid a lateral orientation of the cut, which could injure the sciatic nerve [36]. It is then hammered into the bone to a depth of 3–4 cm, but not deeper as this osteotomy is incomplete to preserve the integrity of the posterior column. The curvature of the osteotome helps

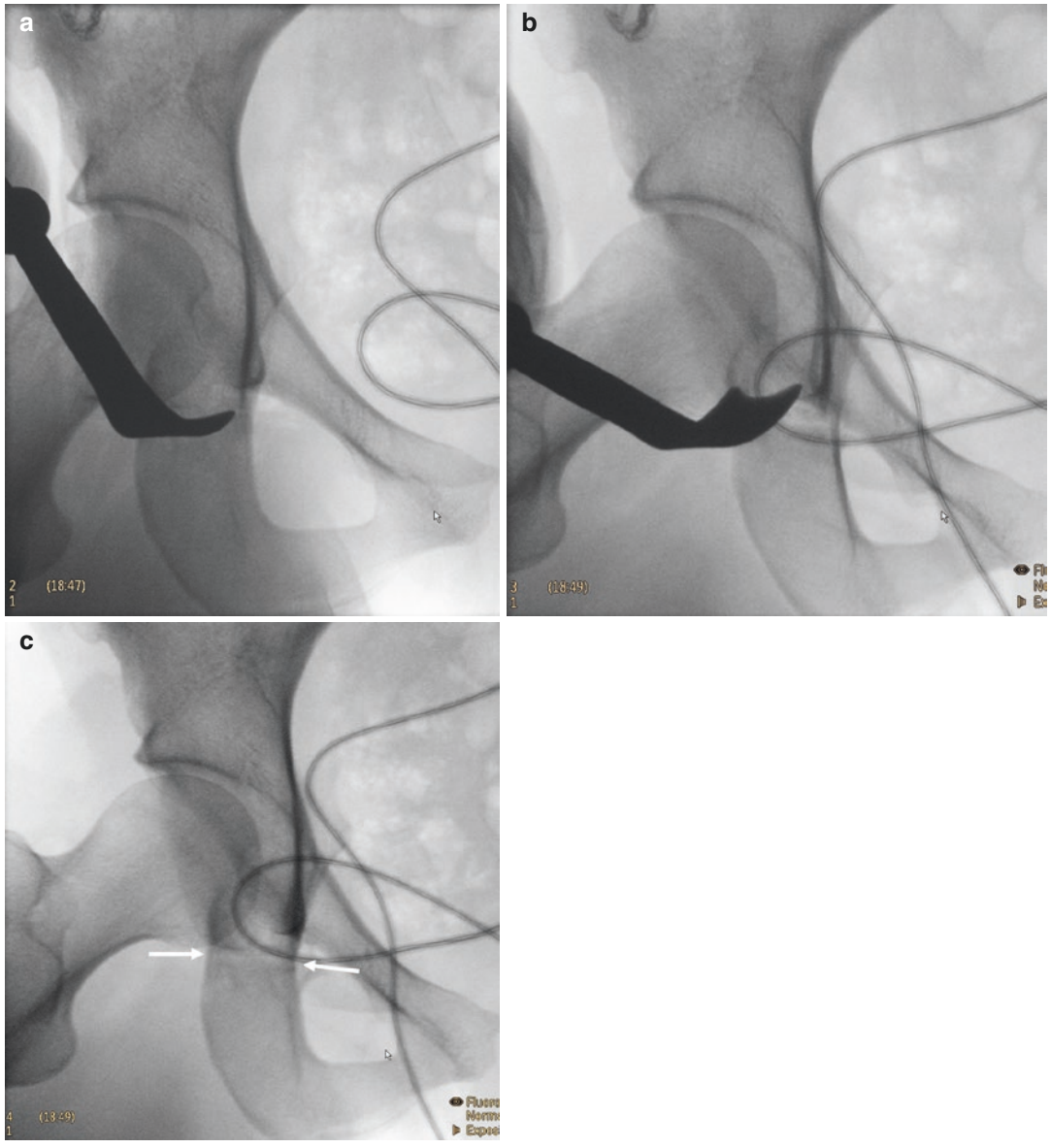

Fig. 12.6 (**a**) Fluoroscopic control of positioning of the curved Ganz osteotome in the infracotyloid groove. (**b**) Fluoroscopic control of positioning for cutting the lateral cortex. The chisel is oriented toward the opposite shoulder to avoid the closely located sciatic nerve. The hip is abducted and externally rotated to further protect the nerve. (**c**) Fluoroscopic control showing the osteotomy of the full width of the ischium (between arrows)

to curve the osteotomy upwards, parallel to the posterior wall and aiming at the ischiatic spine. After palpation and displacement of the osteotome medially in the first cut, a second more medial osteotomy is performed, allowing to cut the medial cortex. A lateral displacement from the first osteotomy allows to cut the lateral cortex, which should only be scored (Fig. 12.6b). In no case should the osteotome be advanced further than 10 mm at this level as the sciatic nerve is close [37]. Finally, after removal of the osteotome, a radioscopic control may be obtained to make sure that the whole width of the ischium has been osteotomized (Fig. 12.6c).

12.7 Pubic Osteotomy

The pubic ramus is exposed by hammering a pointed Hohmann retractor into the bone 2 cm medially of the ilio-pectineal eminence. This protects the psoas and overlying neurovascular structures. The thick periosteum is then incised longitudinally over the bone and two blunt retractors are placed subperiosteally proximal and distal of the ramus. A complete transverse, medially oblique (45°) osteotomy of the pubis is performed medially of the ilio-pectineal eminence with a chisel. The oblique orientation avoids articular penetration of the osteotome and also decreases the risk of lesion of the underlying obturator neurovascular bundle. The medial pubic ramus should move as the osteotome is moved to be sure that the osteotomy is complete.

In cases of retroversion, it is useful to resect a small piece (2–3 mm) of proximal cortex at the level of the osteotomy to decrease the risk of cortical blocking during repositioning of the fragment.

12.8 Supra- and Retroacetabular Osteotomies

After lifting the iliacus muscle from the inner iliac wing, a nutrient artery to the iliac bone of the ilio-lumbar artery may bleed above the pelvic brim [38]. As the artery retracts into the bone, it needs to be stilled by drilling a hole to increase the size of the nutrient foramen, which is then filled with bone wax.

Further endopelvic exposure is achieved by blunt dissection over the quadrilateral surface from the ischiatic notch to the obturator foramen. A reverse Eva retractor or pelvic retractor is then positioned at the level of the ischiatic spine.

On the outer aspect of the pelvis, the gluteus minimus and medius are tunnelized between the ASIS and AIIS toward the sciatic notch to place a blunt retractor, which protects the muscles and the sciatic nerve. This limited dissection protects the insertions of the tensor fasciae latae and gluteus minimus, as well as the inferior branch of the superior gluteal artery, which is important for the vascularization of the fragment [38].

The iliac (supraacetabular) osteotomy, which is realized with an oscillating saw, is a horizontal osteotomy above the acetabulum, starting immediately under the ASIS and going toward the pelvic brim. As the patient is lying supine, the orientation of the saw blade is strictly vertical. Depending on the pelvic shape, the osteotomy stops 1–2 cm above the pelvic brim.

The retroacetabular osteotomy, using a chisel, starts from the most posterior part of the iliac cut and is oriented distally by 100–120°, aiming at the tip of the retractor placed on the ischiatic spine (Fig. 12.7). Furthermore, the ischiatic notch can be palpated to be sure not to enter it, as this would interrupt the posterior column. A bone bridge of at least 1–2 cm should be preserved. The depth of this osteotomy is approximately 4 cm.

Fluoroscopic control of this osteotomy can be used, but I feel that a digital palpation of the sciatic notch is secure enough to orient the osteotomy correctly without fluoroscopy.

The outer cortex of the iliac bone is cut with a curved Simal osteotome, which is placed in the superior part of the retroacetabular osteotomy and aims laterally.

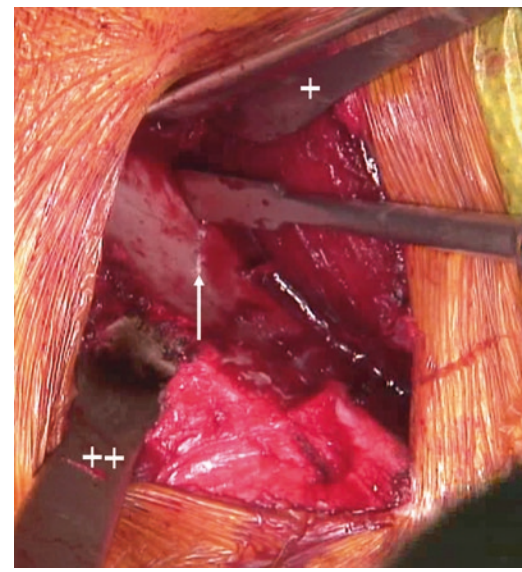

Fig. 12.7 After the horizontal supraacetabular osteotomy (arrow), the retroacetabular osteotomy starts from the most posterior part of the previous cut and is oriented distally by 100–120°, aiming the osteotome at the tip of the retractor (+) placed on the ischiatic spine. The lateral retractor (++) is placed in the sciatic notch to protect the sciatic nerve during these osteotomies

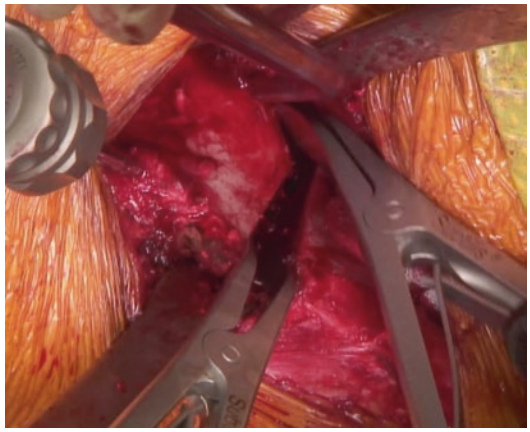

Fig. 12.8 Insertion of a Schanz screw into the anteroinferior iliac spine (AIIS) and distraction of the supra- and retroacetabular osteotomies, using laminar spreaders, to put them under tension

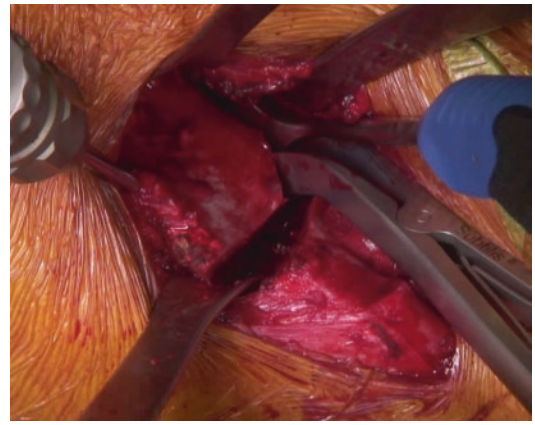

Fig. 12.9 The angled Ganz osteotome is placed into the retroacetabular osteotomy, 4 cm under the brim and aiming toward the first ischiatic osteotomy

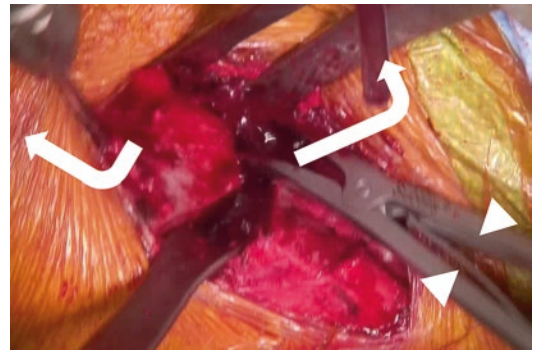

Fig. 12.10 Compression of the laminar spreader (arrowheads) and counter rotation (arrows) of the Schanz screw, and the spreader complete the osteotomies (directed fractures) to completely free the fragment

At this point, a 5 mm Schanz screw is placed into the AIIS, aiming posteriorly in the supraacetabular bone. First the supraacetabular and second the retroacetabular osteotomies are distracted using a laminar spreader to put the osteotomies under tension (Fig. 12.8).

A special osteotome with 30° angulation and a 20 mm blade (Ganz or periacetabular osteotome) is then used to complete the osteotomy of the quadrilateral surface toward the first ischiatic cut (Fig. 12.9). This osteotomy starts 4 cm below the pelvic brim, with the handle of the osteotome pointing vertically. This angulates the osteotomy 50° compared to the quadrilateral surface. The angulation of this osteotome is placed at 4 cm from the tip, which helps positioning. The osteotome is sequentially displaced towards the obturator foramen to join the ischiatic osteotomy. Care should be taken to abduct the leg and avoid a complete penetration of the osteotome, as the sciatic nerve is lying just lateral to the ischium at this level [36].

As an alternative, the Ganz osteotome can be placed in the retroacetabular osteotomy, at 4 cm depth from the brim, and turned distally toward the ischiatic osteotomy, which allows to cut the inner cortex of the quadrilateral surface only, thus decreasing the risk of lesion to the sciatic nerve.

Loosening of tension in the laminar spreader indicates breaking of the bone. A counter-directed movement of the Schanz screw with internal rotation and the laminar spreader with external rotation allows to completely free the fragment from the stable pelvic bone (Fig. 12.10). If the fragment is not fully mobile, the osteotomies should be rechecked to be sure they are complete. Most frequently, the ischiatic osteotomy is insufficient and needs to be completed, either by restarting as described above for the ischiatic osteotomy or from the quadrilateral plate.

12.9 Mobilization and Reorientation of the Acetabular Fragment

Correction of the retroverted acetabulum is achieved by internal rotation of the fragment around the longitudinal axis (Fig. 12.11). The amount of correction varies with the importance

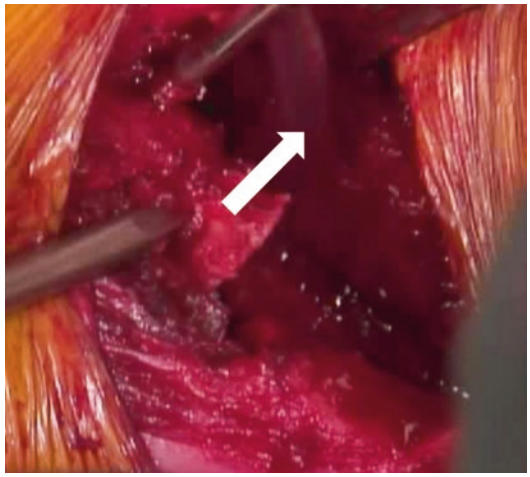

Fig. 12.11 Repositioning of the fragment with internal rotation (arrow)

of retroversion. Additional medialization or lateralization of the fragment must be adjusted individually in each patient, to optimize the balance between anterior and posterior wall. The fragment is then temporarily fixed by two threaded 2.5 mm Kirschner (K) wires.

In cases with an inverted acetabular roof, additional extension of the fragment along the transversal axis is necessary to obtain a horizontal sourcil and avoid increasing lateral coverage of the femoral head. As extension is often limited, a lateral-based bone wedge should be resected from the cranial acetabular fragment, the angulation of which corresponds to the needed correction. The supraacetabular osteotomy should then be closed to achieve the extension. This is frequently the most difficult correction as bone spikes at the level of the ischiatic osteotomy may hook the fragment. This one can be lifted, if necessary, by placing the Ganz osteotome into the ischiatic osteotomy, but taking care not to push the blade of the osteotome laterally to avoid the sciatic nerve.

12.10 Intraoperative Controls: X-Rays and Joint Mobility, Definitive Fixation

A radiological control of the accuracy of reorientation is mandatory. This may be achieved with an ap pelvic radiograph or by using fluoroscopy [32, 39]. Fluoroscopic imaging is my preferred way of doing because of its easy handling, but extreme care should be taken in positioning the device to achieve a reproducible and correct image of the 3D orientation of the acetabulum [39].

Analysis of the orientation should show no more cross-over sign and a positive posterior wall sign. The lateral coverage should not be excessive (lateral center-edge [LCE] angle no more than 33°) and the sourcil must be horizontal [40]. The joint space should also be congruent. The only sign that will not be changed is the ischiatic spine sign, as the posterior column is not reoriented with this type of osteotomy (Fig. 12.12).

As retroversion is more difficult to correct than dysplasia, several attempts to find the correct position may be necessary. In complex acetabular deformities, it may be necessary to accept a compromise in positioning, but accurate joint mobility will indicate whether this compromise is acceptable or not.

Once a satisfactory correction has been obtained, definitive fixation is achieved with two 3.5 mm screws from the iliac crest, replacing the K-wires, and one to two horizontal screws from

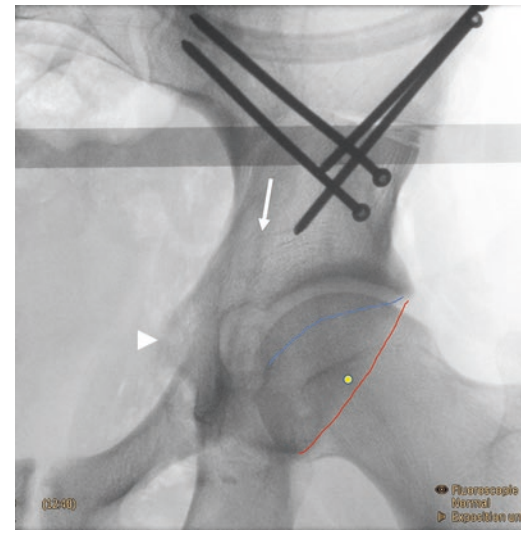

Fig. 12.12 Final fluoroscopic control before recontouring of the femoral head. Correct orientation of the acetabular walls (anterior blue, posterior red), meeting at the lateral sourcil and without cross-over. The head center (yellow dot) is medial of the posterior wall. Good joint congruency. The ilio-ischiatic line (arrow) is complete, confirming the absence of osteotomy of the posterior column. The ischiatic spine (arrow head) is still prominent as it was not included in the reorientation

the AIIS. Additional fixation is rarely needed, only in cases with major corrections.

Frequently, a bone spike from the interspinous crest is found above the AIIS. This is osteotomized and inserted into the supraacetabular osteotomy gap to promote consolidation.

The second mandatory control is joint mobility to exclude residual impingement. In 90° of flexion, an internal rotation of 30° should be achieved. If this is not the case, either should the acetabular fragment be repositioned, or the femoral head–neck offset corrected. This can also be predicted from the preoperative X-ray analysis showing a decreased offset. In their study, Siebenrock et al. found up to 92% of cases needing an osteochondroplasty after acetabular reorientation [41].

12.11 Hip Joint Arthrotomy

If 30° of internal rotation in 90° flexion is not achieved, an anterior arthrotomy must be performed. The capsule is opened with a T-shaped incision and retracted, taking care not to cut the labrum (Fig. 12.13). The use of a blunt retractor inside the capsule helps the exposition, as well as an alternate medial or lateral retraction of the rectus femoris tendon, which does not need to be detached in this way.

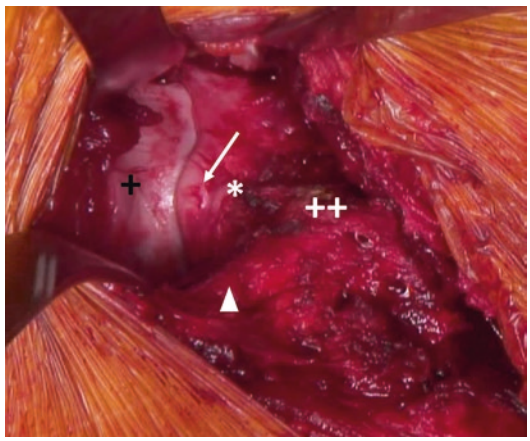

Fig. 12.13 After arthrotomy, visualization of the femoral head (+), the anteroinferior iliac spine (AIIS: ++), and the rectus femoris tendon (arrow head), which is retracted laterally. The AIIS is quite prominent, going straight down to the acetabular rim (asterisk). The arrow points to a deformation of the labrum due to a base ossification, which can be resected before refixation of the labrum

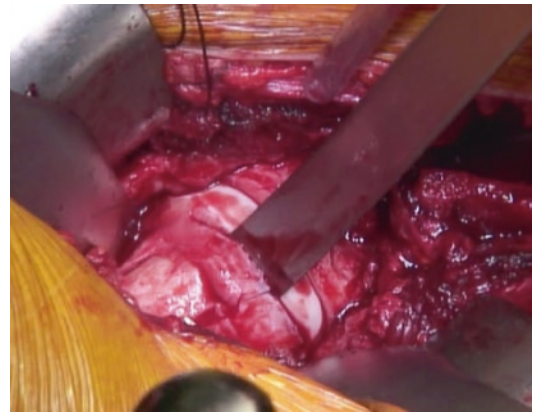

Fig. 12.14 Recontouring of the femoral head, here with a curved osteotome

At this point, the morphology of the AIIS is analyzed, as it is frequently too prominent and induces a so-called subspine impingement [42]. As with arthroscopic techniques, the base of the AIIS is recontoured as deep as necessary to avoid an abnormal contact with the femoral neck, but without harming the overlying rectus femoris tendon.

Based on the preoperative imaging and the intraoperative testing, an osteochondroplasty of the femoral head–neck junction is done, either using osteotomes or a high-speed burr (Fig. 12.14). The head–neck offset should be reshaped to normal, which is controlled by achieving 30° of internal rotation.

12.12 Closure

After lavage of the joint to remove any bone debris, the capsule is closed without tension. The ASIS is repositioned and fixed with a 3.5 or 2.7 mm screw. Refixation of the abdominal muscles and closure of the fascia of the tensor fasciae latae are done. Routinely, no drainage is used.

12.13 Postoperative Reeducation

The leg is positioned in slight abduction in a soft splint. Partial weight-bearing of the operated leg

with 10–15 kg is started from day 1 for 8 weeks. Passive motion using a continuous passive motion (CPM)-machine is also started from day 1. In my experience, this helps in recovering a better joint motion and patients feel decreased pain after exercising. Isometric strengthening and stretching exercises are also started from day 1.

After 8 weeks, radiographs show callus formation and the supra- and retroacetabular osteotomies become less visible as signs of consolidation (Fig. 12.15a–c). Progressive weight-bearing as tolerated is then allowed and formal physiotherapy started.

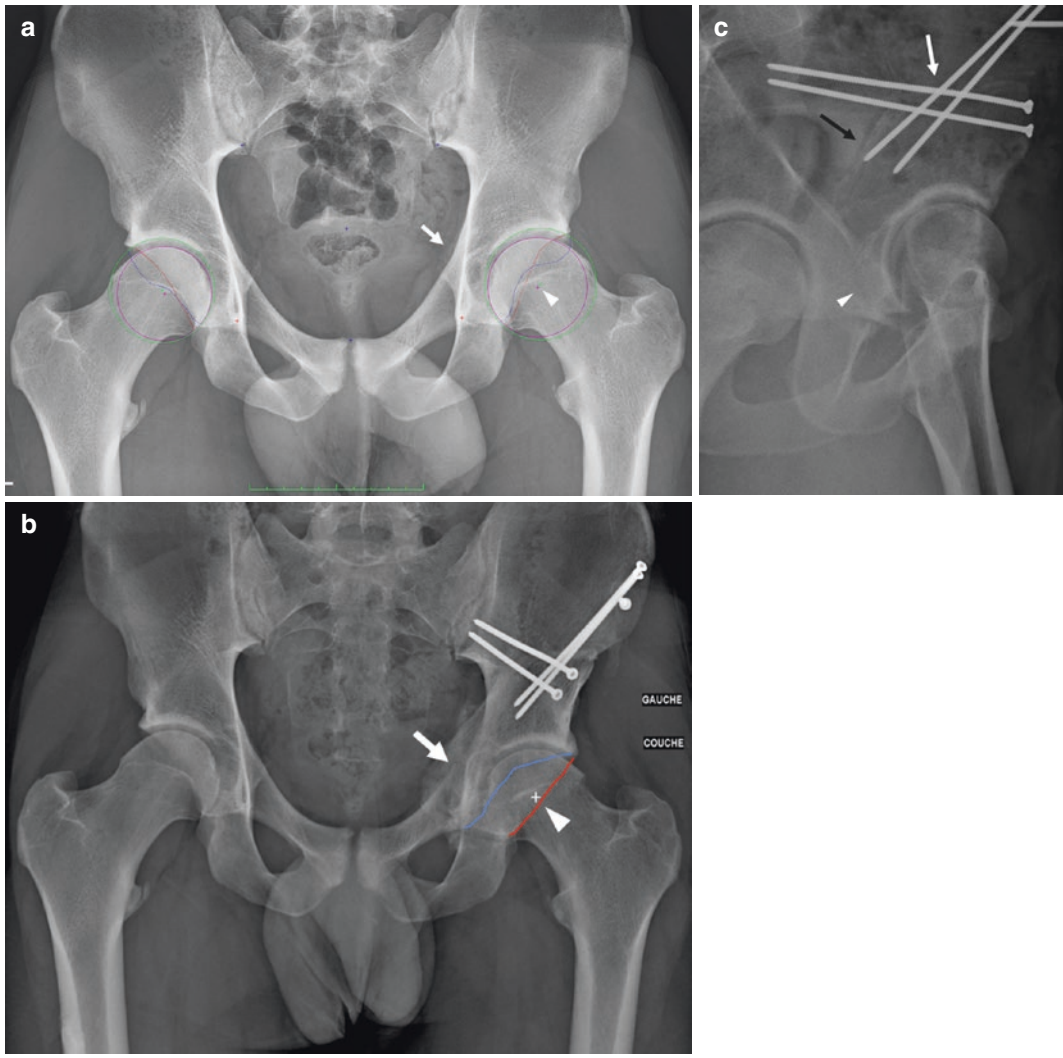

Fig. 12.15 (**a**) A 20-year-old male patient with painful impingement of the left hip. The correctly centered anteroposterior (ap)-pelvis X-ray shows a low cross-over between the anterior (blue) and posterior (red) acetabular walls. The femoral head center is lateral of the posterior wall (positive posterior wall sign) and the ischiatic spine is visible (positive ischiatic spine sign). (**b**) Ap-pelvis 2 months after a reverse periacetabular osteotomy (PAO) and offset correction. The anterior (blue) and posterior (red) walls do not cross anymore; the femoral head center is medial of the posterior wall (arrow head). In this case, the ischiatic spine (arrow), which would remain visible as the posterior column is preserved, is hidden by the prominent pubic ramus and callus. (**c**) On the false-profile view, the supraacetabular (white arrow), retroacetabular (black arrow), and ischiatic (arrowhead) osteotomies show good signs of consolidation. The absence of lesion of the posterior column is nicely visible behind the retroacetabular osteotomy

12.14 Results

Hartigan et al. reviewed their results of arthroscopic treatment for acetabular retroversion [43]. At 2-year follow-up, they found 99% survival, one patient needing a total hip replacement (THR) after 6 months, and no progression of osteoarthritis. The Non-Arthritic Hip Score (NAHS) progressed from 65 to 86 points. Such results seem interesting, but based on the basic biomechanic problem of retroversion and the knowledge of the anatomic shape of the acetabular walls, caution must be used when proposing such a treatment. Furthermore, we only have short-term results after such treatments, which does not allow to state about their final adequacy.

Flores et al. show good clinical results after arthroscopic rim decompression in retroversion, which are even increased in cases with simultaneous subspine decompression. They however only have a follow-up of 1 year, which is not sufficient to state about the adequacy of such a treatment regarding evolution to osteoarthritis [44].

Parry et al. analyzed mid-term results after reverse PAO with or without dysplasia [45]. After 5 years, no patient showed progression to osteoarthritis and the mean modified Harris Hip Score (HHS) progressed to 93, respectively 92, points.

In a systematic literature review, Litrenta et al. found significant clinical improvements, low progression of arthritis with a follow-up up to 5.5 years, low revision rates, and complications with arthroscopic and open techniques [46]. However, even if arthroscopy has a proven role, they suggest that hips with greater retroversion or dysplasia may benefit from a reorientation procedure rather than arthroscopy.

Peters et al. describe their algorithmic approach, analyzing the acetabular morphology in terms of dysplasia and wall orientation [47]. The amount of posterior and lateral acetabular coverage is of paramount importance. Normal coverage with surgical hip dislocation (SHD) will give good results, whereas deficient coverage will indicate a reorientation procedure. They state that decision-making regarding the best treatment is difficult and needs thorough consideration of the 3D morphology of the hip.

The Bernese group reviewed their results when treating true retroversion, comparing SHD with reverse PAO [48]. At 5 years, the survival is identical, but SHD shows a steep decrease thereafter. At 10 years, they only found 23% survival with SHD, whereas PAO still showed a survival of 79%, decreasing to 73% at 15 years.

They state that the decrease in surface of the anterior acetabular wall produces an iatrogenic dysplasia, which accelerates joint deterioration. Therefore, resection of the anterior wall is critical and should only be done, using SHD or arthroscopy, in cases with acetabular overcoverage and not true retroversion.

12.15 Conclusion

In a setting with true acetabular retroversion, acetabular rim trimming is contraindicated, except in rare situations where reorientation of the acetabulum would move cartilage defects into the weight-bearing zone. A precise morphologic diagnosis is mandatory to avoid under- or overtreating these cases.

Periacetabular osteotomy is tricky surgery, which however can be learnt. Knowing the difficulties, the technical tricks as well as perseverance until an optimal correction in terms of socket orientation has been obtained allow to achieve reproducible good results with this technique.

Technical Pearls

A precise radiological diagnosis of the acetabular deformation is mandatory.

A correctly centered ap pelvic view is the road map to evaluating the deformation and the appropriate correction in three dimensions.

No major acetabular cartilage damage should be found anterior and lateral on arthro-MRI or arthro-CT if a reorientation is planned.

In true retroversion, a reorientation periacetabular osteotomy is superior to rim trimming.

Because of a better cosmetic result, a bikini-type incision is preferred.

The approach is a modified Smith-Peterson approach.

An osteotomy of the anterosuperior iliac spine is preferable to subperiosteal detachment of the inguinal ligament, because it better protects the lateral femoral cutaneous nerve.

The ischial osteotomy should be realized under fluoroscopic control, at least during initial experience, to secure the positioning and orientation of the osteotomy. Correct placement of the osteotome is more difficult in retroversion, as the posterior horn of the acetabulum is turned backwards and thus less prominent. An osteotomy depth of 3 cm should be obtained to later achieve an easy mobilization of the fragment.

The pubic osteotomy must be oriented medially and transverse to the longitudinal axis of the pubis to allow better rotation of the fragment.

The supraacetabular osteotomy is realized in a strictly vertical direction, starting from the anterior end of the anterosuperior iliac spine and ending 1–2 cm above the pelvic brim.

The retroacetabular osteotomy aims at the tip of a blunt retractor placed on the medial part of the ischiatic spine. Palpation of the ischiatic notch helps to ascertain a correct orientation of this cut, avoiding to interrupt the posterior acetabular column.

A distractor in the retroacetabular osteotomy allows to put the fragment under tension and to realize the osteotomy of the quadrilateral surface, aiming at the first ischiatic osteotomy.

Free mobilization of the fragment confirms complete osteotomies and is necessary to achieve a correct reorientation. Should this not be the case, the osteotomies should be sequentially recontrolled, starting with the ischiatic osteotomy as this is the most difficult one.

In cases with an inverted roof, a resection of a triangle at the level of the supraacetabular osteotomy may be helpful to correct the orientation of the roof by closing the supraacetabular osteotomy gap.

In pure retroversion, the basic correction of the fragment is in internal rotation, additional corrections depending on each individual morphology. Provisional fixation is achieved with Kirschner wires.

Radiological or fluoroscopic control of the correction is mandatory. If unsatisfactory, a new trial is necessary until a perfect correction is achieved! Definitive fixation is done with three to four 3.5 mm screws.

If hip flexion of 110° and internal rotation of 25° are not achieved with a correct reorientation, a recontouring of the anteroinferior iliac spine and femoral head–neck junction must be done, otherwise leaving the patient with an ongoing femoroacetabular impingement.

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