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Surgical Hip Dislocation Approach for Hip Preservation Surgery: Technical Note

Kalça Koruyucu Cerrahide Cerrahi Kalça Dislokasyonu: Teknik Not

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ABSTRACT

Surgical dislocation of the hip (SHD) as described by Ganz has been shown to be to be a safe and reliable technique to treat pre-arthritic hip disorders, providing unrestricted access to both the acetabulum and proximal femur and permitting complex corrections such as femoral head reductions and relative neck lengthening while preserving femoral head vascularity. SHD has been effective for wide range of pathologies and surgical procedures spanning femoro-acetabular impingement (FAI), synovial chondromatosis, and hip resurfacing. At the core of SHD is precise knowledge of the extracapsular anatomy of the medial femoral circumflex arteries (MFCA) and its surrounding structures ensuring to avoid iatrogenic avascular necrosis of the femoral head. Despite having precise knowledge about hip anatomy and surgical technique, surgical dislocation has inherent risks and various complications.

Keywords: *Hip Preservation, Surgical Dislocation, Femoroacetabular impingement, complex deformities.*

ÖZET

Ganz tarafından tanımlanan cerrahi kalça çıkığı (SHD), femur başı vaskülaritesini koruyarak hem asetabulum hem de proksimal femura sınırsız erişim sağlaması ve femur başı redüksiyonu ile relatif boyun uzatma gibi karmaşık düzeltmelere olanak tanıması sayesinde, artrit öncesi kalça ağrısının tedavisinde güvenli ve güvenilir bir teknik olduğunu kanıtlamıştır. SHD; femoroasetabular sıkışma (FAI), sinovyal kondromatozis ve kalça yüzey yenilemesi gibi geniş bir patoloji ve cerrahi prosedür spektrumunda etkili bir yöntemdir. SHD'nin temelini, medial femoral sirkumfleks arterlerin (MFCA) ekstrakapsüler anatomisi ve çevresindeki yapıların ayrıntılı olarak bilinmesi ve böylece femur başında iyatrojenik avasküler nekroz gelişiminin önlenmesi oluşturur. Kalça anatomisi ve cerrahi teknik hakkında kapsamlı bilgiye rağmen, cerrahi kalça çıkığının doğası gereği bazı riskleri mevcuttur. Komplikasyonlar majör, orta ve minör olarak sınıflandırılmıştır

Anahtar Kelimeler: *Kalça Koruma, Cerrahi Dislokasyon, Femoro-Asetabular sıkışma, Kompleks deformiteler.*

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INTRODUCTION

The goal of surgical hip dislocation (SHD) as described by Ganz is the safe and reproducible access to the hip joint and subsequent post-operative functional recovery [1]. This approach, which preserves femoral head vascularity while allowing comprehensive exposure of both the acetabulum and the proximal femur, facilitates hip-preserving surgical treatment aimed at preventing the progression of osteoarthritis. [2]. Within the field of joint preserving surgery of the hip, surgical dislocation of the hip is a versatile approach allowing a comprehensive and circumferential access to the hip joint in the treatment of patients with pre-arthritic disease [2], oncological conditions [3,4], complex deformities associated with residual Perthes, slipped capital femoral epiphysis (SCFE) [5] and post-traumatic disorders [1]. Inspection of the entire hip joint allows accurate fragment reduction under direct visual control for certain acetabular [6] and femoral head fractures[7] as well as other hip reconstruction procedures such as hip resurfacing [8].

Advantages:

Hip arthroscopy (HA) and SHD can be used to address femoral and acetabular bony abnormalities as well as intra-articular cartilage lesions [9,10]. With the increased dissemination of HA and improved instrumentation, a shift away from SHD is becoming a noticeable reality [11]. While HA has now become the most frequently used technique to treat chondrolabral pathology as well as mild to moderate proximal femoral deformities, it has limitations in dealing with extra-articular deformities as well as circumferential abnormalities of both the acetabulum and proximal femur.SHD provides unrestricted access to both the acetabulum and the proximal femur and permits complex corrective procedures—such as femoral head reduction and relative femoral neck lengthening—while preserving femoral head vascularity (Table 1).

Table 1. Advantages and disadvantages of the commonly used approaches to FAI

Approach	Advantages	Disadvantages
Surgical dislocation	Best visualization head/neck junction, acetabular rim. Excellent intraoperative estimation of correction (Figures 7a, 7b) May allow for conversion to hip resurfacing in selected cases. (4)	Morbidity from trochanteric osteotomy: painful trochanteric fixation. 1% of nonunion Large dissection Ligamentum teres disruption
Combined arthroscopic/ Hueter	No dislocation (preserves ligamentum teres) Good, direct visualization of deformity Intraoperative correction can be judged directly Minimally invasive (rapid recovery)	Not suitable for all deformities e.g. coxa profunda, high riding greater trochanter Lateral cutaneous femoral nerve injury
Purely arthroscopic	Minimally invasive (rapid recovery)	Difficult to fully visualize the deformity. Traction related complications

Indications

Surgical hip dislocation (SHD) is indicated for the treatment of a wide spectrum of hip pathologies by providing comprehensive exposure of both the acetabulum and the proximal femur. [1,12-21]. The SHD approach is mainly reserved for young, active patients with relatively severe deformities that are less suitable for arthroscopic treatment. The technique of surgical dislocation of the hip, in combination with a retinacular flap, can be used for complex deformities associated with residual intra-articular and extra-articular Perthes and Perthes-like deformities allowing the relative lengthening of the femoral neck and even femoral head reduction osteotomy[22-28], slipped capital femoral epiphysis (SCFE) allowing anatomical restoration of proximal femur by modified Dunn osteotomy and direct inspection of the articular surface while preserving physeal blood supply[29-34], fractures involving the femur and acetabulum, post-traumatic malunion, and intra-articular loose bodies are also common indications for surgical dislocation[35-37]. Hips with femoral deformities extending posterior to the perforating vessels are also candidates for SHD as this technique is associated with improved deformity correction[38]. In complex deformities with associated acetabular dysplasia or proximal femoral malrotation, the dislocation can be combined with acetabular reorientation or proximal femoral osteotomy[39]. In cases of cam-type femoroacetabular impingement (FAI) with advanced joint space narrowing, surgical hip dislocation (SHD) is generally not recommended, as these patients are more likely to require conversion to arthroplasty.[13]. Other indications for SHD are for the management of certain acetabular fracture as well as femoral head fractures [6,7,35-37] (Figures 1, 2, 3). Thus, inspection of the entire hip joint and accurate fragment reduction under direct visual control are possible. Patients older than 45 years with insidious onset of pain are noted to be at higher risk for moderate to severe chondromalacia and considered a relative contraindication for joint preservation surgery[40]. However, age alone should not be considered a contraindication for surgical hip dislocation and should instead be interpreted in conjunction with joint space width, Tönnis grade, cartilage status, activity level, and duration of symptoms.

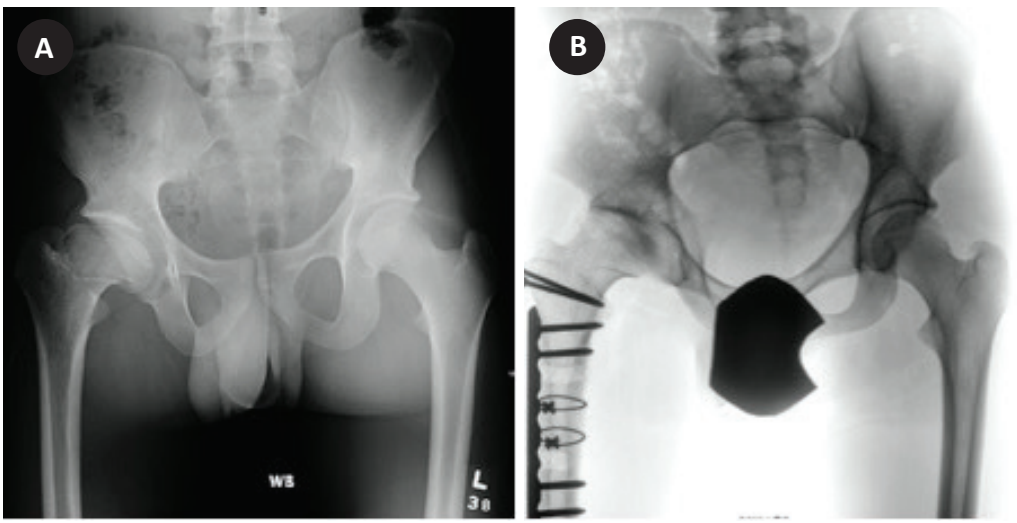

Figure 1. 23 years old male with right hip pain secondary to Legg-Calvé-Perthes: (a) AP pelvis shows right femoral head asphericity, high riding greater trochanter and a 2 cm leg length discrepancy. (b) Surgical dislocation with relative neck lengthening and femoral head-neck recontouring combined with a step-cut lengthening of the femur.

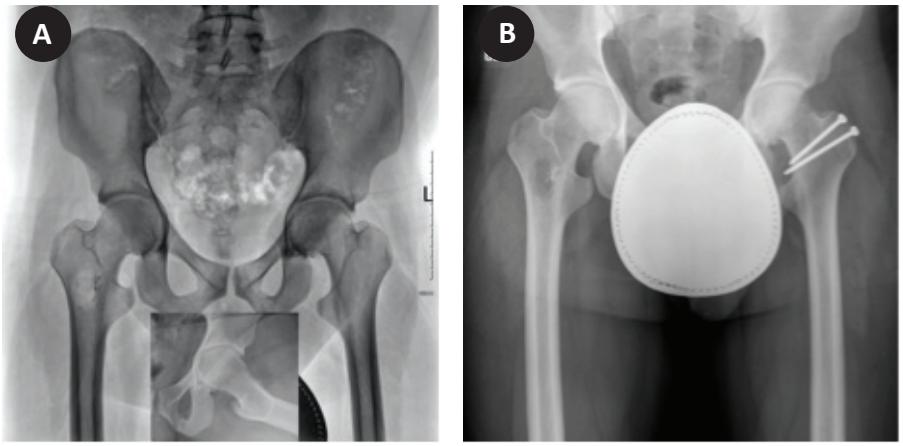

Figure 2. 29 years old male with bilateral hip pain with left being worse than the right: (a) anteroposterior X-ray shows left hip over-coverage with cam deformity extending postero-laterally. Inset is Dunn view for left hip (b) Patient underwent left hip surgical dislocation with acetabular rim trimming and labral refixation using four anchors and chondro-osteoplasty.

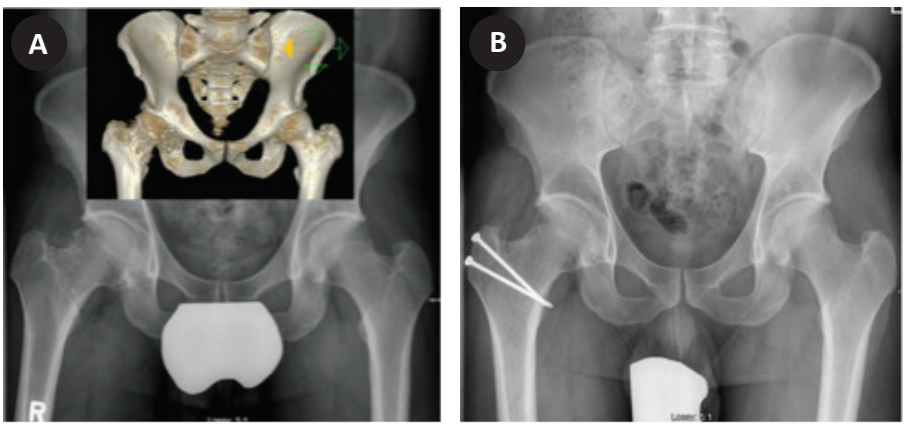

Figure 3. 33 years old male with persistent right hip pain and catching one year post hip arthroscopy secondary to synovial chondromatosis. (a) AP pelvis X-ray and inset 3-D CT scan shows right hip loose bodies. (b) One-year post-surgical right hip dislocation with the patient being pain free.

Preoperative Preparation

Patient selection is of prime importance in obtaining successful clinical results. Proper history taking is critical, i.e. patients who experience predominantly groin pain that is exacerbated by hip flexion activities including sitting are likely to benefit from joint preservation surgery[52]. Patients with a history of childhood disorders, such as Perthes[22-28] or SCFE [29-34], are known to have residual FAI that becomes symptomatic in adulthood and are thus indications for SHD. On examination, a positive anterior impingement test (flexion, adduction, and internal rotation) and restricted internal rotation at 90° of flexion (IRF) are all very sensitive tests for intra-articular disease[41]. A positive Patrick (FABER) test (flexion, abduction, and external rotation) is suggestive of intra-articular pathology but is not diagnostic. Finally a radiographic confirmation of cam- and/or pincer-type lesions is critical for establishment of FAI. A comprehensive

hip series is obtained including a supine or standing anteroposterior (AP) pelvis, false profile, frog lateral, cross table lateral, and Dunn view of the hip [42]. Hip MRI is recommended in all cases to determine the extent of intraarticular damage[43], and low-dose three-dimensional computed tomography (3D CT) is useful for the evaluation of complex deformities, SCFE/Perthes sequelae, posterior cam extension, and version analysis.[44-46]

Operative Technique

At the core of SHD is precise knowledge of the extracapsular anatomy of the medial femoral circumflex artery (MFCA) and its surrounding structures ensuring to avoid iatrogenic avascular necrosis of the femoral head.[38,47-53]

SHD can be performed under regional or general anesthesia[1] with the patient in a lateral decubitus position using a method of trunk stabilization described by others[54], a Kocher-Langenbeck incision [55] is made and the fascia lata split accordingly. A similar exposure is possible with the Gibson approach [56] with posterior retraction of gluteus maximus. With the Kocher-Langenbeck incision patient might have a 'saddleback deformity' of the subcutaneous fat due to insufficiency of the subcutaneous sutures at the posterior aspect of the incision. Ganz et al [1] reported five female patents requested plastic surgery to improve the cosmetic appearance. Therefore, the straighter Gibson approach[56] is recommended in this group at risk, namely female patients with thin or lax subcutaneous tissue. The interval between the gluteus maximus and tensor fascia lata is improved. The gluteus maximus muscle was retracted posteriorly and the bursal tissue over the greater trochanter is incised longitudinally to expose the structures attached to the posterior aspect of the greater trochanter. The posterior origin of the vastus lateralis fascia, including connections to the tendon of the gluteus maximus and line aspera, are released and the muscle lifted from the bone epi-periosteally, leaving the tendinous origin from the tubercle intact. The posterior border of gluteus medius is identified by internally rotating the leg. The interval between the piriformis tendon and posterior border of the minimus is dissected, mobilizing the minimus from the retro-acetabular surface.

In planning for the osteotomy, the posterosuperior edge of the greater trochanter proximally while distally the posterior border of the ridge of vastus lateralis is marked with cautery (Figure 4a). A trochanteric osteotomy with a maximal thickness of about 1.5 cm is made along this line with an oscillating saw (Figure 4b). It is recommended to pre-drill the greater trochanter before performing the osteotomy which is helpful in obtaining anatomical repair (Figure 4c). At its proximal limit, the osteotomy should exit just anterior to the most posterior insertion of gluteus medius. This preserves and protects the profundus branch of the MFCA, which becomes intracapsular at the level of the superior gemellus muscle[53]. A Z-shaped stepped trochanteric osteotomy has been described by Bastian et al[57] to minimize risk of mal-union and non-union.

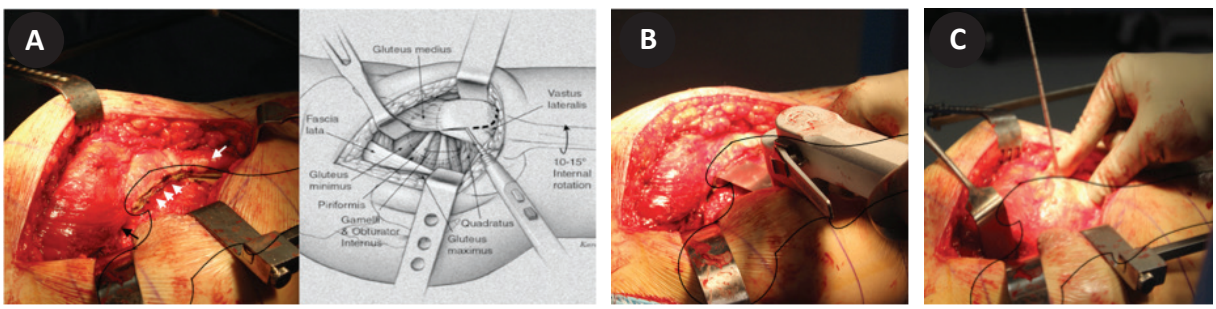

Figure 4. Intraoperative photo for a right hip surgical dislocation (a) marking of the greater trochanteric osteotomy is made from the posterosuperior edge of the greater trochanter (arrow heads), posterior border of the gluteus medius (black arrow) extending distally to the posterior border of the ridge of vastus lateralis (white arrow). (b) A trochanteric osteotomy with a maximal thickness of about 1.5 cm is made along this line with an oscillating saw. (c) It is recommended to pre-drill the greater trochanter before doing the osteotomy which might be helpful in obtaining anatomical repair.

The greater trochanteric fragment is mobilized anteriorly with its attached vastus lateralis after releasing it along its posterior border to about the middle of the tendon of gluteus maximus. The most posterior fibers of gluteus medius are also released from the remaining trochanteric base. The osteotomy is correct when only part of the fibers of the tendon of piriformis must be released from the trochanteric fragment for its further mobilization. With the leg flexed and slightly rotated externally vastus lateralis and intermedius are elevated from the lateral and anterior aspects of the proximal femur. The tendon of piriformis becomes visible by careful anterosuperior retraction of the posterior border of gluteus medius. The inferior border of gluteus minimus is further mobilized from the underlying capsule. The constant anastomosis between the inferior gluteal artery and MFCA, which runs along the distal border of the piriformis muscle and tendon, is preserved[53]. Care must be taken to avoid injury to the sciatic nerve, which passes inferior to the piriformis muscle into the pelvis. When the nerve is double branched it should be released to avoid stretching the branches of the nerve during dislocation. The entire flap, including gluteus minimus, is retracted anteriorly and superiorly to expose the superior capsule. This is facilitated by further flexion and external rotation of the hip. The anterior, superior and posterosuperior capsule can now be visualized. A Z-shaped capsulotomy (Figure 5) is performed with the capsule being first incised anterolaterally along the long axis of the femoral neck since incision in this area avoids injury to the deep branch of the MFCA. An anteroinferior capsular incision is made. The capsulotomy must remain anterior to the lesser trochanter to avoid damage to the main branch of the MFCA, which lies just superior and posterior to the lesser trochanter. The first capsular incision is then extended towards the acetabular rim where it is sharply turned posteriorly parallel to the labrum reaching the retracted tendon of piriformis. This is usually done with a 15-mm blade. Care must be taken not to damage the labrum.

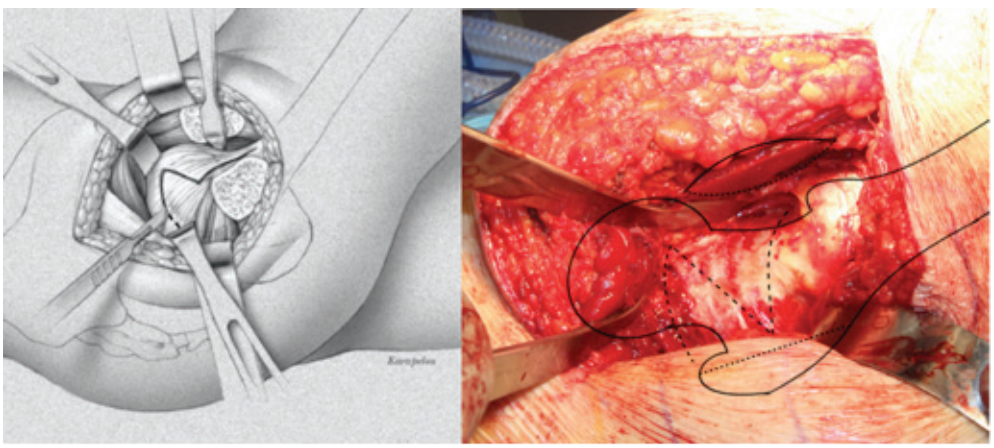

Figure 5. Intraoperative photo for a right hip surgical dislocation after completing the trochanteric osteotomy and anterior hip capsule exposure before capsulotomy (aided by hip flexion and external rotation) Z-shaped capsulotomy (dashed line). Trochanteric flip (dotted line).

The hip can now be dislocated by releasing the ligamentum teres with scissors while bringing the leg in flexion and external rotation over the side of the table in a sterile bag. The remaining portion of the ligamentum teres may be utilized for labral reconstruction in selected cases, when indicated. Elevation of the anteroinferior flap allows visualization of the labrum (Figure 6). Care should be taken to avoid excessive adduction of the leg as it hangs over by placing a bump underneath the knee not to tension the sciatic nerve. By manipulating the leg, the surgeon now has 360° access to the acetabulum and of nearly 360° to the femoral head. In hips with scarring from previous surgery or from trauma, it is advisable to inspect the sciatic nerve and free it from adhesions before completing the dislocation. For a complete inspection of the acetabulum three retractors are used. The knee is elevated with an assistant applying axial pressure to bring the femoral head posterior to the acetabulum.

No retractors are needed for visualization of the femoral head; the knee being merely lowered to allow the head to rise out of the surgical wound. For its most posterior aspect a blunt Hohmann retractor around the neck may be useful. The retinaculum protecting the terminal branches of the MFCA to the femoral head is clearly visible on the posterosuperior aspect of the neck as a mobile layer of connective tissue. Osteochondroplasty to create an optimized waist at the femoral head-neck junction was performed over the entire length of the femoral neck to the intertrochanteric line or even further when indicated to remove additional bone underneath the capsular insertion (Figure 7). Special attention is given to the contour of the anterior distal region to ensure sufficient impingement-free flexion and to reduce the risk of extra-articular subspinous impingement [58]. Following reduction of the femoral head, repeated intraoperative impingement testing is performed to confirm the achievement of commonly targeted parameters, including 30° of internal rotation without impingement and 110° of hip flexion.

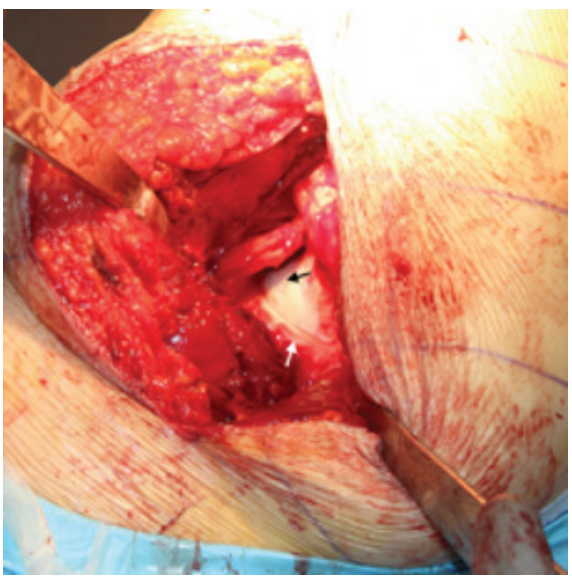

Figure 6. Intraoperative photo for a right hip surgical dislocation after capsulotomy and elevation of the anteroinferior flap allows visualization of the labrum (white arrow). Hip flexion to inspect the mechanism of impingement (black arrow).

The labrum is inspected and probed, and the articular surfaces of the femoral head and acetabulum examined. Acetabular and labral lesions are then addressed. In cases with acetabular over-coverage, partial labral ossification, or labral lesions, the labrum is detached from the acetabular rim, the rim trimmed, and the labrum re-fixed using 2 to 5 bone anchors (Figure 8). Frayed or degenerative labral fibers are sparsely debrided longitudinally, and complete resection is avoided whenever possible. In areas with delaminated chondral lesions unstable chondral flap lesions are resected (chondroplasty), and if necessary, micro-fracturing is performed. The hip may be relocated and put through a full range of movement in order to visualize areas of possible residual impingement. During the exposure the articular cartilage is constantly irrigated with normal saline solution to prevent drying and alteration in its morphology[59]. Reduction of the hip may easily be accompanied by manual traction on the flexed knee and internal rotation. The capsule of the hip can be repaired but not tightened since this may create tension on the retinacular vessels leading to a drop in the perfusion of the femoral head[60]. Avoiding overly tight capsular repair is an important technical point and should be retained, ideally linked to MFCA perfusion. The greater trochanter is re-fixed using two or three 3.5 mm cortical screws. When an intertrochanteric osteotomy is undertaken the trochanteric fragment is transfixed by the blade plate.

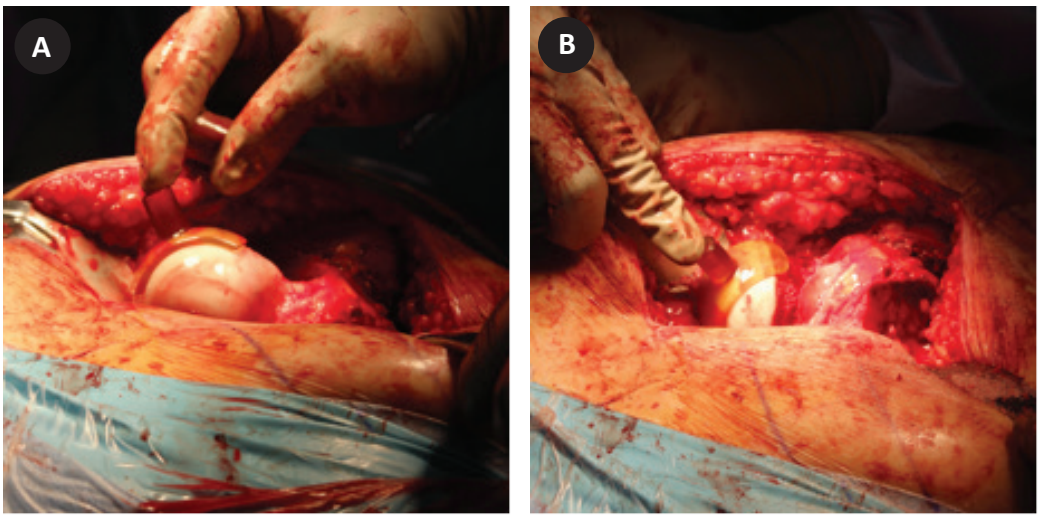

Figure 7. Intraoperative photo for a right hip surgical dislocation with the head neck junction is inspected using head sizer before (a) and after (b) performing osteochondroplasty to create an optimized waist at the femoral head-neck junction.

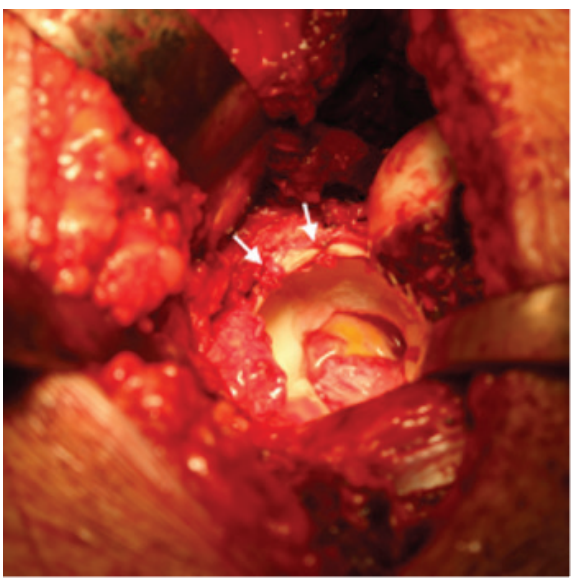

Figure 8. For acetabular over-coverage, the labrum was detached from the acetabular rim, the rim trimmed, and the labrum re-fixed using 2 to 5 bone anchors (white arrows).

Technical Pearls

Equivalent positioning system provides an easy, fast and reliable method for lateral positioning of the patient.

Gibson approach is recommended in females with weak subcutaneous tissue to avoid saddleback deformity and improve the cosmetic appearance.

It is recommended to pre-drill the greater trochanter before doing the osteotomy which is helpful in obtaining anatomical repair.

A trochanteric osteotomy with a maximal thickness of about 1.5 cm is made along this line with an oscillating saw.

If the sciatic nerve is bifid and the piriformis tendon passes between its divisions, partial release may reduce traction risk.

A Z-shaped stepped trochanteric osteotomy has been described by Bastian et al[57] to minimize risk of mal-union and non-union.

Complete the posterior limb of the Z-shaped capsulotomy using inside-out technique to avoid injury of the labrum.

During the exposure the articular cartilage is constantly irrigated with normal saline solution to prevent drying and alteration in its morphology.

What to Avoid

Too thin of trochanteric fragment i.e. less than a 1cm.

Going intra-capsular with the trochanteric osteotomy (Ideally, the thickness of the trochanteric fragment 1-1.5 cm).

Extensive retraction of the Gluteus medius lead to development of heterotopic ossification.

Care should be taken to avoid excessive adduction of the leg as it hangs over by placing a bump underneath the knee not to tension the lumbar plexus.

Retinacular vessels damage i.e. The retinaculum protecting the terminal branches of the MFCA to the femoral head is clearly visible on the posterosuperior aspect of the neck as a mobile layer of connective tissue.

Water-tight capsular repair may create tension on the retinacular vessels leading to a drop in the perfusion of the femoral head.

Using 3.5mm screws for fixation of the greater trochanteric fragment as the screw heads can easily break at time of removal. However, the disadvantage of the 4.5mm screws being with large head to be irritating i.e. trochanteric bursitis.

Complications and Salvage

In review of previous literature regarding SHD, complications were difficult to collectively evaluate due to reporting inconsistency[61]. In a systematic review performed by Clohisy et al.[61], graded the complications into major, moderate, and minor categories. Major complications were defined as avascular necrosis, femoral head/neck fracture, loss of fixation resulting in reoperation, trochanteric nonunion, failure of labral refixation, inadequate osteochondroplasty requiring revision, deep infection, and symptomatic heterotopic ossification. Moderate complications include symptomatic hardware (with or without removal) and minor complications consisted of asymptomatic or minimal heterotopic ossification and a miscellaneous category (urinary tract infections, postoperative fevers, etc.). Among six studies included in this review, the major complication rate varied from 0% to 6%. There were no minor complications that were noted.[61]

Despite precise knowledge of the anatomy of the hip and the surgical technique, surgical dislocation has inherent risks. In their initial experience of over 200 cases, Ganz et al.[1] reported a "major" complication rate of 3.3%. The major complications reported in this initial series of patients by Ganz et al.[1] included two cases of partial sciatic neurapraxia (0.9%), three cases of trochanteric nonunion (1.4%), and two cases of Brooker grade III heterotopic ossification (0.9%) that was along the acetabular rim and required excision due to motion loss. The two patients with sciatic neurapraxia had complete resolution without residual deficits 6 months postoperatively, which was attributed to previous surgery and scarring around the nerve. The overall incidence of heterotopic ossification was 37%; however, 86% of these patients were classified as Brooker grade I. A retrospective, multicenter analysis of complications was performed by the Academic Network for Conservational Hip Outcomes Research (ANCHOR) Study Group [62]. Trochanteric nonunion was noted in 1.8% of hips, which were all treated successfully with revision open reduction and internal fixation. There were two cases of deep vein thrombosis in the calf and one case of deep infection that was treated with irrigation and debridement. One patient suffered complete sciatic nerve paralysis that partially resolved, however with residual numbness and pain at final follow-up. Trochanteric nonunion has been sporadically reported with wide ranges (1.9–20%) [63-65]. The higher rate of nonunion has not been previously reported and is likely due to surgeon inexperience, improper fixation technique, or insufficient protection postoperatively [65]. The use of a z-shaped osteotomy cut to provide improved stability of the trochanteric fragment after reduction and refixation may reduce this risk.

Dudda et al [66] investigating pain at the lateral hip noted 46% of patients with pain at the greater trochanter after surgical dislocation[66]. The presence of greater trochanteric pain, however, had no influence on the overall clinical outcome scores. Some studies have demonstrated improvement of trochanteric pain with subsequent removal of hardware [43,63,67]. Recently, intra-articular adhesions between the femoral neck and joint capsule have been identified as a cause of persistent postoperative pain.[68] These adhesions form between the joint capsule and the area of prior resection from the femoral head-neck junction, which may lead to intra-articular impingement.[68] Three percent of 750 patients who underwent a

previous open osteochondroplasty were thought to have residual pain secondary to adhesions, which were also confirmed on MR arthrogram [66]. Adhesions were noted during arthroscopic treatment in all suspected patients at the anterior and anterolateral position of the femoral head–neck junction and the femoral neck, on average 19 months after the index procedure. Lysis of these adhesions resulted in resolution of hip pain in 86% of patients (Table 2).

Post-Operative Care

For the first 6 weeks, toe-touch weight bearing is recommended, with hip flexion limited to 90°, no active abduction, and avoidance of passive adduction. Stretching of the quadriceps and isometric muscle training of quadriceps and hamstrings were encouraged. Nonsteroidal anti-inflammatory drugs, if not contraindicated, received for 14 days to prevent heterotopic ossifications.[69] In case of radiographic

Table 2. Complications and salvages for SHD

Complications	Salvages
Avascular necrosis (AVN)	Early detected: arthrodiastasis with a hinged frame and drilling. Late AVN and collapse: arthroplasty or arthrodesis
Femoral head/neck fracture	Open reduction and internal fixation
Loss of fixation/trochanteric non-union	Use of a z-shaped osteotomy cut to provide improved stability. Open reduction and revision fixation (possible bone grafting)
Symptomatic heterotopic ossification	Nonsteroidal anti-inflammatory drugs prophylactic in high risk patients. Treatment according to the grade and symptoms, surgical resection.
Inadequate osteochondroplasty	Revision after exclusion of other causes for FAI
Symptomatic hardware/lateral hip pain	Recommended use 3.5 mm screws not 4.5 mm screws to avoid irritating large head. Hardware removal only if symptomatic
Wound complications and infection	Antibiotics; irrigation and debridement when indicated.
Failure of labral repair	Revision arthroscopic repair for the labrum
Intracapsular adhesion (intraarticular impingement)	Arthroscopic lysis of the adhesions
DVT	Prophylactic anticoagulant Vascular surgeon consultation
Nerve injury (most common sciatic neuropraxia)	Prophylactic: Piriformis tendon might be released when being sandwiched between the 2 roots of the sciatic nerve to avoid traction injury during dislocation.
Miscellaneous category (urinary tract infections, postoperative fevers, etc.)	Treatment of the cause

and clinical evidence of stable consolidation of the trochanteric osteotomy at the first follow-up evaluation at approximately 6 weeks post-surgery, the patients (assisted by the physiotherapists) started full weight-bearing and strengthening of the abductor muscles.

Abbreviations

SHD: Surgical dislocation of the hip

FAI: Femoroacetabular Impingement

MFCA: Medial Femoral Circumflex Artery

SCFE: Slipped Capital Femoral Epiphysis

HA: Hip arthroscopy

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None to state.

DECLARATION OF INTEREST

None to state.

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