Operative Steps: The Dysplastic Hip

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Summary

In this chapter we will review the indications and problems of hip replacement in the presence of developmental dysplasia of the hip (DDH). The principles of total hip replacement for DDH are similar to those for routine total hip replacement; reconstruction of a near normal soft-tissue envelopes carried out to relieve pain. We are attempting to recreate normal joint biomechanics by restoring the centre of rotation, placing the trochanter lateral to the hip joint, thus improving the lever arm of the abductors, which will reduce the joint reaction force and Trendelenburg dip. We require small implant components and will attempt to insert the largest offset available. We should be able to perform acetabular augmentation and femoral osteotomy to restore the soft-tissue balance around the hip. We should be familiar with anterior and posterior approaches to the hip joint and comfortable with mobilising major neurovascular structures that may be encased in dense fibrosis due to previous surgery in childhood. We will present a system of assessment and reconstruction for the acetabulum and femur we have followed for 10 years (the results of which are recorded in later chapters chapters 8.7, 9.3), which can be used to resolve the many and varied problems.

Indications for Arthroplasty

Pain

For most patients with osteoarthritis secondary to developmental dysplasia of the hip, replacement is carried out for the same indications as for routine hip replacement, pain. However, often the pain radiates further down to the front of the knee and can be associated with a reasonable range of motion, particularly when the hip was completely dislocated.

Disability

In most cases, surgery is undertaken for pain. However, disability, reduced walking distance, difficulty dressing and mounting stairs can be a major feature in younger patients. Because developmental dysplasia predominantly affects young females, there can be other functional difficulties resulting from reduced abduction leading to problems with personal hygiene and sexual intercourse, particularly when the condition is bilateral.

Where there is significant leg length discrepancy or deformity (Fig. 2.37), long-leg arthritis can develop in the contralateral knee. In these circumstances, it is often wise to perform total hip replacement on the abnormal hip before undertaking total knee replacement in the more normal, longer leg because the knee replacement would work at a mechanical disadvantage; this would lead to premature failure of the knee replacement.

Occasionally patients with longstanding fixed adduction deformity of the hip will present with valgus OA of the ipsilateral knee. Knee replacement in these patients will accentuate their scissoring gate and lead to premature failure of the TKR if the adduction deformity of the hip is not addressed first.

Where leg-length discrepancy is longstanding and the patient has developed a compensatory scoliosis, it is important to ensure that the scoliosis is correctable (by examining the back sitting) before attempting to fully correct any leg-length discrepancy.

Gait

Many patients with osteoarthritis secondary to DDH, or DDH itself, present with a waddling gait (abductor lurch). Developmental dysplasia can be regarded as a field change around the hip that includes the soft tissues as well as the bony anatomy. By reconstructing near normal hip biomechanics with hip replacement, the waddling gait
will improve. However, even with perfect reconstruction of the hip, many patients will continue to waddle post surgery. All patients should be warned of the possibility of the abnormal gait continuing.

**Leg Length**

Most patients with unilateral DDH will have significant leg-length discrepancy and may feel this to be a cosmetic problem. When assessing leg length it is important to ensure that the leg-length discrepancy is entirely due to the dislocated hip or abnormal posture. Occasionally, particularly when previous surgery has been carried out, a limb will overgrow below a dysplastic hip such that if the normal hip anatomy is restored, the leg with be overlengthened. This can be disabling for the patient.

**Back Pain**

Many older patients will have walked for many years with a significant leg-length discrepancy developing secondary osteoarthritis in the lumbar spine. During clinical examination it is important to assess this by examining the sitting posture to ensure that the spinal deformity will be correct. While correction of leg-length discrepancy may improve long-term back problems in the dysplastic patient, this cannot be guaranteed. Over-correction of the leg length stressing the spinal deformity may lead to or increase back pain.

**Conservative Treatments**

Prior to considering surgery all conservative treatments, shoe-raises, simple analgesia, injection of steroids and – if insufficient – operative treatment including arthroscopic debridement of labral tears and realignment osteotomies, pelvic or femoral osteotomy (or both) should be considered. However, if these have been tried or are thought not suitable, then total hip replacement may be the only solution. These predominantly young patients present considerable technical problems. However, a successful, total joint replacement will relieve their pain and increase their mobility.

**Grading and Planning**

A variety of grading systems can be used to try to define the extent of surgery necessary (and the possible problems and outcomes). Unfortunately, most documented grading systems are used to describe the combined acetabular and femoral deformities, e.g. Eftekhar’s elongated, intermediate, high, false, or no contact descriptions [3] and Crowe’s grading system [2] based on migration of the femoral head in proportion to the height of the pelvis. Crowe’s system is particularly difficult to apply routinely when limited views of the pelvis are taken. Perhaps clinically most useful is the grading system of Hartofilakidis [4] ([Figs. 2.38 to 2.40] describing the hips as

- **dysplastic**: those with an acetabular segmental defect that is contained with a large medial osteophyte as a consistent feature ([Fig. 2.38]);
- **low**: those with an overlapping false acetabulum resulting in reduced depth ([Fig. 2.39a]);
- **high**: a false shallow acetabulum, that is rim deficient and anteverted ([Fig. 2.39b]).

However, all three systems ignore femoral geometry and problems related to the reconstruction of leg length. They also fail to take into account the increased difficulty of surgery when previous femoral or pelvic osteotomies have been carried out.

To be useful, a grading system should predict surgical difficulties and long-term outcome. Hence, we use the following system to plan surgery.

![Fig. 2.37. Long-leg films showing knee arthritis, the presenting feature in this woman with surgically induced leg-length discrepancies](image-url)
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Dysplasia Type 1

Fig. 2.38. a Normal hip. b In dysplasia grade 1 an acetabular segmental defect is contained with a medial osteophyte as a consistent feature.

Dysplasia Type 2

Fig. 2.39a,b. Dysplasia type 2, i.e. low dislocation (a) with erosion of the superior roof. In contrast, in type 3 with high dislocation (b) note preservation of the acetabular roof and the large medial osteophyte, but good acetabular depth.
When considering the acetabulum and its problems alone these can be considered as

- **A I: Dysplastic acetabulum (The Good)** ([Figs. 2.38b and 2.39b]): Those with a small segmental defect, but the acetabulum is largely contained and often a medial osteophyte can be removed to increase depth. These reconstructions should have a normal survival compared with routine hip replacements as they will not require grafts.

  In the »high« type 3 Hartofilakidis group, the true acetabulum is nearly always dysplastic, perhaps with a small segmental defect but a large medial osteophyte that can be removed. Grafting is rarely required. After identifying the teardrop, the acetabulum can be excavated and the smallest dimension is the AP diameter of the acetabulum itself. Therefore, the Hartofilakidis »high« group can be regarded as dysplastic. This is evident from comparing [Figs. 2.38b and 2.39b], which show a good true acetabular roof and anterior and posterior walls, and [Fig. 2.41], which shows a high dislocation treated with a standard cup in the true acetabulum without graft. In his most recent paper Hartofilakidis [5] noted the acetabular results to be similar for these two grades and better than his type 2.

- **A II: Low dislocation acetabulum (The Bad)** ([Fig. 2.39a]): Dislocation where the head lies on and deforms the superior margin of the acetabulum, which results in an overlapping false acetabulum of inadequate depth or roof. This type will always require some form of graft or support. Clearly, this adds to the complexity of surgery and reduces the likelihood of long-term survival (see later). This group corresponds with the »low« Hartofilakidis group ([Fig. 2.42]).

- **A III: Post-surgical acetabulum (The Ugly)**: The postsurgical acetabulum can be extremely difficult. In these cases the soft tissues will be deformed increasing the risk of nerve damage, and the acetabular anatomy may be distorted. Therefore, detailed imaging may be necessary. This group should be subdivided into A IIIa post surgical that does not require grafting. This group will have higher complications perioperatively, but because the acetabulum does not require grafting, the long-term results will be similar to the type 1 dysplastic group. The A IIIb acetabulae will require grafting, the long-term results will be similar to the low dislocation type A II acetabulae.
On the femoral side, a similar grading system can be applied.

- **F I: Dysplastic femur (The Good):** Those with a degree of anteverision and up to 2 cm of apparent shortening, require no specific measures to be taken other than perhaps small-sized implants. These femoral components should have the same long-term results as routine hip replacement. See Fig. 2.39a and Fig. 2.43 with bad acetabulum, but good femur.

- **F II: High femur (The Bad):** Those femora where the dislocation is greater than 2 cm or there is extensive anteverision (occasionally retroversion), which requires correction. This extreme rotational abnormality of the proximal femur is important to correct in order to improve the lever arm of the abductors, to reduce joint reaction force and improve gait by placing the trochanter lateral rather than posterior to the hip. This second group requires a rotational and/or shortening osteotomy. As with the type-2 acetabulum this increases surgical complexity and therefore the risk of complications (Fig. 2.44).

- **F III: Post-surgical femur (The Ugly):** Those that have undergone surgical intervention prior to the hip replacement (Fig. 2.45). These can be subdivided into:
  a: no malformation these can be regarded and treated as dysplastic type I femora;
  b: gross malformation which can be treated as type II femur;
  c: retention of metalwork: In this group the metalwork may be ignored or a major problem, however, it is difficult to categorise as each case will be different. In each case the complexity of surgery increases. Proper imaging including biplanar imaging is mandatory (Fig. 2.46).
Operative Treatment – Approach

The surgeon should be familiar with both anterior and posterior approaches to the hip joint. The exact approach used should take into account previous surgeries to the hip itself and the surgeons’ preference. Previous approaches or osteotomies may cause considerable scarring around the proximal femur and periarticular soft-tissue structures. It is particularly important to identify the sciatic nerve when pelvic osteotomies have been carried out as the nerve may be accidentally damaged by traction over the previous osteotomy site or bound down in dense scar tissue. A posterior approach gives the best opportunity to visualise the sciatic nerve, however, where previous surgery has been carried out, it is important to use an extensive incision and be willing to approach the hip from both front and back to facilitate dislocation and obtain good tissue balance.

Whatever approach is used, extensive release of adhesions to mobilise the hip will be necessary. Many authors have described a trans-trochanteric approach for DDH. We prefer to keep the vasto-gluteal sling intact and if necessary use an extended trochanteric osteotomy to approach the hip. While this may well reflect our experience with re-attachment of the trochanter, these are difficult cases and re-attachment is not reliable.

Our routine approach is a posterior one supplemented by anterior release either directly over the front or indirectly from the back through the hip. Intra-operative dislocation is usually posterior, however, occasionally anterior dislocation is necessary followed by a posterior approach.

2.3.1 Acetabular Roof Graft

Acetabular Considerations

John Charnley [1] noted that acetabular bone stock was best in the true acetabulum. However, in the high false acetabulum, while the superior cover was better high, the anterior and posterior aspects of the acetabulum were often formed by osteophytes. The depth of the false acetabulum is limited by the thickness of the wing of the ilium.

In the true acetabulum of the high dislocation category (in the Caucasian population), there is often sufficient AP width to insert an implant of 40 mm outside diameter with no need for superior rim graft. Crowe [2] pointed out that when the acetabulum is over-reamed to prepare an elongated false acetabulum then the anterior and/or posterior wall is reamed away leading to instability and early failure of the acetabulum. Therefore, it must be anticipated in most cases of DDH that small implants will be required, which are sized to the AP diameter of the true acetabulum (Fig. 2.47).
In this chapter, we will describe the technique we use to reconstruct the true acetabulum. The rationale for this choice is laid out in chapter 9.3.

The author's preferred technique is to augment the acetabular defect with bone from the patient's own femoral head by placing the graft back into the defect from which it came screwing the graft into position. Wolfgang [6] described the technique in 1990.

**Technique of Acetabular Roof Graft**

Pre-operative planning (and templating) for the type-A II defect will suggest that a roof graft will be required. It is often difficult to be sure of the degree of defect prior to surgery but at operation, once the acetabulum has been cleared and the true acetabulum identified with the transverse ligament and teardrop displayed, the encroaching anterior and posterior osteophytes can be removed with crank gouges. The true anterior and posterior walls should be identified and the acetabulum reamed usually to 40–44 mm AP diameter. By placing a trial cup in position (or last reamer in the correct orientation) the defect immediately becomes apparent (Fig. 2.48). The last reamer size corresponds to the given AP socket diameter and should be kept inferior at the level of the acetabular notch (Fig. 2.49b). This will reveal the full extent of the roof defect. Caution should be exercised at this stage as a false sense of cover can be obtained in »minor« cases by opening the cup too much, dislocation will occur.

If the defect is less than 10% this can be safely ignored and the acetabulum dealt with in the usual manner for a primary implant. If the defect is up to 20%, again this can be dealt with in the usual manner, but the author’s preference is to use a flanged cup to cover the defect. Where the defect is greater than 20%, graft augmentation would be required using block autograft from the femoral head.

Having mobilised the femur (and cut the femoral neck), identified the anterior and posterior walls of the acetabulum and reamed the true acetabulum to its maximum AP diameter, the defect is identified and any pseudocartilage removed from the defect area. The femoral head is then placed back in the defect which it created and the section of the femoral head which fills the defect marked either with a sterile marker pen or with diathermy.

This often amounts to an orange segment shaped wedge after preparation (Fig. 2.50). Prior to cutting the...
wedge, the fibro-cartilage is removed with the saw acting as a rasp such that there is no fibro-cartilage left on the head (the subchondral bone is preserved). The orange segment wedge is then cut. It is wise to cut a thicker wedge than required at this stage and trim after insertion of the definitive cup. Attempts to make the correct size at this stage will result in graft fracture when drilling or tapping the graft.

Prior to application of the graft, 3 small pits are created into the true acetabulum, one into the ischium, one into the pubic ramus and one up behind the cortical plate at the level of the defect into host bone. Acetabular reamings from the true acetabulum are then gathered together and compressed in a swab to remove all excess blood and marrow (Fig. 2.51). This gives a very firm, soft, collection of fine bone fragments which can be pressed over the acetabular defect, to which the wedge-shaped graft is applied.

Good apposition and conformity can be obtained. Other techniques previously described have taken the femoral head and applied cancellous bone to the defect rather than cortex to cortex described here. The author has no experience of this, but good results have been reported. Once the orange segment femoral head wedge has been placed in position, a wire is drilled in centrally to temporarily hold the wedge in position (Fig. 2.49).

The surgeon should identify the sciatic notch and sciatic nerve as it passes into the pelvis at this stage to orientate the direction for his screws (Fig. 2.49c). With a large 4.5 mm drill bit the graft is over-drilled, then with a 3.2 mm drill the host pelvis is drilled to take the definitive cancellous screw. Drilling is performed using a gentle balloting technique to ensure that the drill does not penetrate the pelvis unexpectedly or deeply. Before measuring screw length the graft should be countersunk to subchondral bone. Screw length can vary considerably and great care should be taken particularly when screw length appears to be greater than 70 mm. The hole is tapped for a large cancellous screw and the definitive screw inserted but not over-tightened. A second screw is similarly inserted. Counter sinking is used to obtain good grip on the sub-chondral bone and place the screw-heads away from the maximum diameter of the acetabulum. This is such that when the reamer is inserted to complete the preparation, it does not get damaged by the screw-heads (using this technique washers are usually not required to spread stress).

With the graft in place and held by 2 screws, the K wire is removed and the screws tightened. Any residual blood in the morcellised graft when placed between the block wedge graft and the pelvis, will squeeze out. Originally 3 screws were used, however, this often caused fracture at the anterior or posterior edge and now 2 screws are used routinely.

The true acetabulum is then reamed with a one size smaller reamer than the final reaming then, using the definitive sized reamer, the true acetabulum is reamed down to the original position (Fig. 2.49b). This final reaming resharps the inside of the wedge graft to give an almost perfect finish to the internal surface. The surgeon can now more accurately estimate the amount of graft cover created.

It is important to maintain the graft at quite a large size at this stage to prevent fracture. Further trimming can be done after the acetabulum has been cemented in place.

The new acetabulum is now cleaned and dried in the standard manner and standard modern cementing techniques are used with the insertion of an All-Poly acetabular component (Fig. 2.52).

Definitive trimming of the outer surface of the graft can now be carried out without fear of splitting the construct. Post-operatively, the patient is encouraged to mobilise partial weight-bearing for 6 weeks and then mobilise full weight-bearing thereafter.
2.3.2 Femoral Reconstruction

Femoral Considerations

The principal aims of femoral reconstruction are

- to restore anteversion and thus reduce the risk of dislocation,
- to reposition the trochanter in a lateral position,
- to restore offset (to improve the abductor lever arm and reduce joint reaction force),
- to restore leg length. To attempt to improve cosmesis and function.

Type F I (The Good)

In these femora it is important to have a variety of stem sizes that will fit the femur. Pre-operative assessment will often reveal significant disparities in the AP and mediolateral dimensions of the femur. Careful pre-operative planning may suggest that one of the reduced stems currently available for the Asia-Pacific countries may be suitable for the conventional DDH in the Caucasian population. These have the benefit of short-stem length, but relatively reduced offset to improve the lever arm and the ready availability of implants. These small implants should be available when attempting to do any surgery in a patient with DDH as the curvature of even a normal looking femur may be such that it precludes insertion of a routine implant. Minor degrees of shortening (less than 3 cm) or rotational abnormalities can be dealt with, by simple positioning of the femoral component and perhaps a low neck cut.

Type F II (The Bad)

In these femora the abnormalities will fall into two categories: length and rotation. Where there is considerable leg-length discrepancy due to a high riding femur (greater than 3 cm), it may be necessary to remove a considerable section of the femur to bring the trochanter down and tension the abductors correctly and yet not overstretch the structures leading from the pelvis to the knee (neuromuscular bundles and adductor muscles.). In high dislocations the abductor mechanism has often been displaced posteriorly and at least the anterior fibres of gluteus medius and minimus will be lengthened. Therefore, bringing the trochanter down, unless there has been previous surgery causing scarring, is not usually an issue. Despite removing a subtrochanteric section of bone, this procedure will often lengthen the leg considerably, if not fully, and improve the patient’s disability. Severe rotational abnormalities, particularly in the high dislocations should be corrected to reduce dislocation post surgery and restore the lateral position of the greater trochanter.

Type F III Post-Surgical Femur (The Ugly)

Where the femur has been subjected to previous surgery there may be considerable deformity. True bi-planar films should be obtained of the proximal femur in all cases where femoral surgery has been performed around the hip (Fig. 2.53).

Type F IIIa (No Persisting Deformity)

Following investigation and imaging, the surgeon may be able to insert a standard hip replacement, particularly when all met-

**Fig. 2.53a,b.** Pre- and post-operative radiograph of the high femur type FIII post-surgical femur (The Ugly)
alwork has been previously removed and there has been no gross displacement (Fig. 2.54). These femora should have the same results as the type-I femur.

**Type F IIIb (Persisting, Post-Surgical Deformity)** In these situations, osteotomy should be carried out at the site of maximum deformity (Fig 2.55). Often there will be a degree of size mismatch when the deformity has been corrected, particularly if large rotational abnormalities are corrected.

**Type F IIIc (Retained Metalwork)** It is often stated that metalwork should be removed as a separate procedure to reduce the risks of fracture and infection. Unfortunately, if plates have been inserted and not removed in childhood, these may become overgrown and migrate within the medullary canal. Removal of these incarcerated implants will lead to loss of almost half the cortical structure of the femur; at the time of later hip replacement, these defects have not always healed.
It is not always necessary to remove the superficial plates, if the screws can be removed and an implant inserted the plate can be left in situ (Fig. 2.56). Occasionally, the screws may have been placed eccentrically and can be ignored. Some screws are notoriously difficult to remove and may fracture on removal due to poor head design or the use of titanium for the implant, which then becomes ingrown. Experience would suggest that when over-drills (tube saws) have been used to remove screws with a broken head, this creates a large cortical defect that does not fill in with time. There may be a number of these large defects leading to a series of holes that can act as a significant stress riser leading to periprosthetic fracture at a later date.

Where necessary, our plan is to remove obvious metalwork, then perform a subtrochanteric osteotomy and remove any residual problematic screws from within the femur using a carbide burr under direct vision. Plates that are encased in the cortex can be cut during osteotomy in situ using carbide discs and left rather than guttering the femur. It is recommended that screws should be removed prior to the attempted osteotomy as this makes stabilisation of the work easier for screw removal.

**Technique of Shortening Osteotomy**

Although a number of authors recommend a sub-trochanteric osteotomy prior to preparation of the acetabulum, we find that acetabular preparation and insertion should be carried out before the osteotomy as this gives easy control of the femur for acetabular preparation.

The proximal end of the femur is prepared in the standard way to accept the implant prior to osteotomy. With the exception of rasping, much preparation is carried out manually, which can be difficult in a small proximal fragment once sectioned.

**Femoral Osteotomy Rasping Proximal Femur**

The vasto-gluteal sling should be kept intact, but the psoas and all soft tissue and capsule attached to the femoral neck proximal to the psoas should be removed. The osteotomy is carried out perpendicular to the true shaft of the femur just below the lesser trochanter and proximal to any deformity as a planar osteotomy.

The proximal fragment preparation is then finished and the preparatory rasp inserted through the proximal fragment, but not into the distal fragment (Fig. 2.57).

A trial reduction of the proximal fragment is carried out to ensure that the abductors allow normal positioning of the femoral component. With the trial component in situ, through the proximal fragment, the distal femoral shaft is then pulled into normal alignment parallel to the proximal fragment and the femoral resection marked with a sterile pen or diathermy (Fig. 2.58), based on the overlapping segment.

**Note:** The resection length will often be one half the distance between the existing centre of rotation and the true (desired) centre of rotation of the femoral head as evidence on the pre-operative X-ray, though this may vary due to scarring from previous surgery. It is always wise to remove slightly less bone in the first instance and the cut should be made perpendicular to
If reduction is possible, the osteotomy is examined for its planar qualities and if it is thought not to be correct, further trimming of the osteotomy can be planned to obtain two planar surfaces. Leg length, abductor tension, tension in the sciatic nerve can then be all assessed.

With the preparatory rasp in situ the osteotomy is usually held very firmly (Fig. 2.59b). Clearly, when this is removed, for purposes of cementing and insertion of the definitive implant, the osteotomy will displace. This is prevented by placing a uni-cortical plate, usually a 5-hole semi-tubular plate, on the posterior aspect of the femur with the proximal screws going lateral to the rasp through two cortices in the trochanter and uni-cortical distally (Fig. 2.60). This will give some rotational stability and the plate is further held with two bone-holding forceps. The anteversion of the femoral component is checked to ensure that the trochanter has been placed laterally and the preparatory broach is removed.

Some surgeons then attempt to perform internal impaction grafting of the osteotomy site. In our series, we have ignored the osteotomy and proceeded with standard cementing techniques (pulsatile lavage, gun and pressurization) with the insertion of a standard CDH cemented stem to bridge the osteotomy site. The position is then held until the cement is completely set. The osteotomy is then examined (after allowing the cement to set and removing the assistant’s finger from around it!) and with a sharp osteotome excess cement is cracked off. This usually removes most of the cement from the site of the osteotomy. Residual cancellous bone graft from the femoral shaft of the femur, where possible parallel to the first cut on the proximal fragment. Before preparing the distal segment, the correct distal rotation should be checked and the rotational alignment noted.

The distal femoral fragment is then prepared with the true normal 10–15° of anteversion. This can sometimes be difficult because of abnormality in the shape of the femur at this level. Occasionally, high-speed burrs may be used to improve the internal morphology of the femur. The rasp is removed from the proximal fragment and used to finish preparation of the distal fragment in the correct degree of anteversion (Fig. 2.59).

A cement restrictor is placed down the distal fragment and a trial reduction carried out by placing the rasp through the proximal fragment into the distal fragment, closing the osteotomy and reducing the hip. If reduction is not possible, a further section of bone can be removed from the distal fragment.

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The femoral osteotomy is held in position by the assistant’s finger curling round the femur and the plate (occasionally a second plate may be used to obtain full stability, but the second 2-hole plate should be removed).

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head is then placed around the osteotomy site. The Vastus lateralis is placed back down onto bone and reduction of the hip carried out.

The uni-cortical plate is usually left in situ, the wound is closed in the standard manner and the patient is asked to mobilise partially weight-bearing for 8 weeks.

It is important to note that a femoral osteotomy reduces adductor tension but improves abductor function. It corrects mal-rotation of the femur at the site of deformity and may be performed in the sub-trochanteric region to correct length problems. Where plates have been inserted and cannot be removed without cortical osteotomy, the femoral osteotomy should be carried out through the proximal screw hole to allow internal removal of distal screws. The vasto-gluteal sling should be retained throughout the procedure.

**Take Home Messages**

- The indications for surgery following DDH are the same as for total hip replacement for other conditions. However, the implications for adjacent joints are more important.
- The aim of reconstruction is to create normal biomechanics.
- Acetabular roof graft and femoral osteotomy should be familiar to the surgeon.
- Reconstruction following previous surgery requires special care and consideration.
- Extensive planning and equipment (e.g. for metal removal) will be necessary, including small implants.
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