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The unstable total hip arthroplasty

Gösta Ullmark

- One of the most common causes for revision surgery following total hip arthroplasty (THA) is dislocation.
- Dislocation is associated with a considerable amount of suffering and risks for the patient, and extra costs for the health care system.
- Compared with degenerative arthritis, the dislocation rate is doubled for avascular necrosis and multiplied by three times for congenital dislocation, four for fracture, five for nonunion, malunion or a failed hip arthroplasty, and eleven times after surgery for prosthetic instability.
- In analysing instability the cause may be assessed as 1) locally caused within the hip with explanatory radiographic findings, 2) locally caused without explanatory radiographic findings or 3) non-locally caused, i.e. non-compliant patient, neuromuscular or cognitive disorders.
- Revision strategies for instability are typically directed to correct the underlying aetiology, but also to strive for an upsizing of the head and liner.

Keywords: Total hip arthroplasty; dislocation; instability; revision; dual mobility complication

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Introduction

Dislocation after total hip arthroplasty (THA) is a difficult problem for the patient, the treating surgeon, and is associated with a considerable extra cost for the health care system.[1] The true prevalence of post-operative dislocation varies as a result of different surgical, patient, and implant factors. Most reports from high-volume academic centres suggest a dislocation rate between 0.3% and 3% in patients treated with primary THA for osteoarthritis (OA).[2] THA dislocation highly compromises quality of life in affected patients. Kotwal et al[3] studied the complication using the Oxford Hip Score and the EuroQol-5 Dimension (EQ-5D) questionnaire. A control group of patients who had not incurred a dislocation had a mean Oxford Hip Score of 17.4 (12 to 32). The score was 26.7 (15 to 47) after one episode of dislocation at a mean follow-up of 4.5 years (1 to 20), 27.2 (12 to 45) after recurrent dislocation, 34.5 (12 to 54) after successful revision surgery and 42 (29 to 55) after failed revision surgery. The ideal solution to instability is prevention, achieved using optimal index surgery[4].

This article outlines the aetiology of hip dislocation and provides the surgeon with an algorithm for the management of this common complication (Fig. 3).

Aetiology

Incidence

A meta-analysis by Masonis and Bourne[5] involving 13 203 procedures found a dislocation rate of 3.23% after a posterior approach compared with 2.18% after an anterolateral, 1.27% after a transtrochanteric, and 0.55% after a direct lateral approach. Bigger head size and posterior soft tissue repair in posterior approach cases might diminish those differences.

Most dislocations occur in the period shortly after surgery. Bourne and Mehin[2] found that 60% of dislocations happen within the first five weeks. No further dislocation occured in two thirds of these patients. In the national Swedish hip register report 2010[6], 32% of revisions performed due to dislocations were carried out during the first year.

Patient risk factors

Important patient risk factors include prior surgery, neuromuscular disorders, dementia, being female, inability to comply with activity restrictions and alcohol abuse. The risk for dislocation has been studied in patients with neuromuscular and cognitive disorders such as cerebral palsy, dementia, muscular dystrophy, psychosis and alcoholism.[7] Those disorders were present in 13% of dislocating patients compared with 3% ($p = 0.003$) without dislocations. Woo and Morrey[8] found that compared with degenerative arthritis, the dislocation rate was doubled for avascular necrosis, three times for congenital dislocation, fourfold for fracture, fivefold for nonunion, malunion or a failed hip arthroplasty and eleven times increased for prosthetic instability. The national Swedish Hip Register[6] has reported an increasing risk for dislocation leading to revision surgery after repeated hip surgery. Dislocation resulting in revision was 8.7% after primary THA, 14.7% after first revision, 18.9% after second and 29.1% after more than two revisions. Wetters at al[9] found that 9.8% of patients dislocate after revision THA, with risk factors including abductor deficiencies and a history of previous dislocation.

Surgical risk factors

Surgical factors leading to dislocation include component malpositioning, failure to restore leg length or offset, preserving the abductor mechanism and capsule or using the posterior surgical approach.

Approach

In a meta-analysis involving 13 203 procedures, Masonis and Bourne[5] found a 3.23% dislocation rate for the posterior approach (3.95% without posterior repair and 2.03% with posterior repair) and 2.18% for the anterolateral approach.

Soft tissue

Five independent studies of the posterior, posterolateral, and direct lateral approaches have reported equally good dislocation rates of less than 1% when the approach includes a definitive posterior soft-tissue repair.[10–14] Tarasevicius et al[15] presented a study using the posterior approach, a 28 mm head and a randomised approach to the repair, or non-repair, of soft tissue. The result was a 2% dislocation for repair and 5% for non-repair. Reattaching the capsule and piriformis tendon to the greater trochanter by intra-osseous stiches or to the gluteus tendon made no difference to stability.[16] Soft tissue repair may reduce or, together with a large head, even eliminate the disadvantage of the posterior approach with respect to instability.

Soft-tissue tension is affected by femoral offset. Fackler and Poss[13] found a dislocating group of patients had a notable loss of offset (at an average of 5.2 mm) compared to patients with stable hips (averaging 0.02 mm).

In the case of a deficient abductor mechanism, even an enlarged head size of 36 mm did not prevent the dislocation rate from reaching 30%.[17]

Implant factors

Several implant factors play an important role in dislocation. Factors that decrease the head-to-neck ratio will increase the risk for dislocation.

There are theoretical advantages in using larger head sizes with regard to stability. The improved head-to-neck ratio reduces component impingement and increases range of motion (ROM). The use of a skirted head component should be avoided, in order not to increase the tendency for impingement. Finally, larger heads are seated deeper within the acetabular liner, requiring greater translation before dislocation ('jump distance') (Fig. 1a and b).

Malkani et al[18] have shown that a shift to the use of larger head diameters of 32 mm and above, from one time period to next, reduced the risk for dislocation by 35-43%.

Nevelos et al[19] have found the highest jump distance for all positions and activities to occur with the dual-mobility bearing. The use of heads >32 mm has historically been limited by concerns about polyethylene wear. This shortcoming

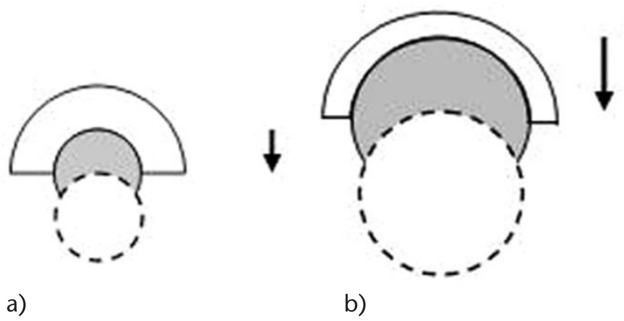

Fig. 1 A smaller femoral head may dislocate after only a short distance (a) and is therefore theoretically less stable. A larger head must travel a greater distance (b) before dislocating and is therefore more stable.

may be eliminated by using ceramic femoral heads on cross-linked polyethylene or ceramic heads on ceramic liner.

Larger heads will, however, transmit larger shear forces to the head–taper junction. This will increase the risk for mechanically-assisted crevice corrosion (MACC).[20]

Component positioning

WH Harris stated that "Cup anteversion should be 20° ± 5°, as measured about the axis of the cup (not the longitudinal axis of the body). To ensure proper positioning, close attention also must be paid to the orientation of the pelvis, especially when using a posterior approach. The pelvis of a patient in the decubitus position may be significantly adducted and anteverted relative to the table".[21] Positioning of both the femoral and acetabular components is an important factor in stability. Excessive abduction of the acetabular component may result in lateral dislocation. Excessive retroversion or anteversion may result in posterior or anterior dislocation respectively. For most cases, cup anteversion of 15° ± 10° and abduction of 40° ± 10° is considered to be the 'optimal zone' of lowest dislocation risk. Outside this optimal range, dislocation has been shown to increase fourfold (6.1% *versus* 1.5%; $p < 0.05$).[22] However in another report, proper cup positioning alone does not predict the risk for dislocation.[23] Proper component positioning is a hazardous task and post-operative radiographs may be a surprising experience. In a study by Wera et al,[24] 75 cases of repeat dislocation had a cup abduction angle varying from 20° to 90° and an anteversion of 50° to -10°. Even more surprising is that the angles after revision for dislocation varied substantially (abduction: 25° to 60°, anteversion: 0° to 35°). In a study by Biedermann et al[25] Einzel-Bild-Röntgen-Analyse was used to compare the cup angles of a group of patients that dislocated after primary THA with a control group. In the control group, the mean value of abduction was 44° and anteversion 15°. Patients with anterior dislocation showed significant differences in the mean angle of abduction (48°) and anteversion (17°), as did patients with posterior dislocation (abduction 42°, anteversion 11°). However, two other studies were unable to detect a significant difference in cup angles between a dislocating group and a control group.[26,27] Those results may simply be a reflection of the complex interplay of other factors involved in dislocation. A safe stem rotation has been considered to be 20° (anteversion ± 10°).[24]

Impingement is another cause for dislocation. When the prosthetic femoral neck impinges against an osteophyte, scar tissue, liner, cement, or heterotopic ossification a risk for dislocation is present. Components with higher head-to-neck ratios impinge less readily.

Liner profile

A liner may cover more or less than 180° of the prosthetic head. A high degree of coverage means that there is, theoretically, more range of movement before the head dislocates. At the same time, the tendency for impingement of the prosthetic collar against the rim of the liner increases. The latter phenomenon counteracts hip stability. There are also liners with a posterior-oriented elevated rim. Those liners posteriorly have a greater contact portion of the femoral head than do standard neutral liners. A study comparing neutral liners with 10° elevated-rim liners[28] reported respective probabilities of dislocation of 3.85% and 2.19% ($p = 0.001$). A disadvantage of the design, however, is increased impingement against the rim in extension and external rotation. Liner rim impingement may lead to liner wear, osteolysis and loosening.

Management

The cause for instability may be either 1) locally caused with explanatory radiographic findings, 2) locally caused without explanatory radiographic findings, or 3) non-locally caused, i.e. non-compliant patient such as in neuromuscular or cognitive disorders or combinations of the three.

Post-dislocation patient assessment

A dislocation shortly after THA surgery has less chance of recurrence compared to a later dislocation. Khan et al[29] reported that dislocations occurring before five weeks had a 39.3% chance of recurrence compared with 58.3% for later dislocations ($p < 0.05$). Woo and Morrey[8] found that patients without recurrence dislocated at an average of 54 days after surgery, whereas patients with recurrent dislocation had their first episode at an average of 122 days ($0.05 < p < 0.10$).

In analysing the cause of dislocation, the history should include details of the current episode as well as any previous episodes of instability. The physical examination should include both lower extremities, with particular attention paid to position and leg length, neurovascular integrity, ROM, gait, and strength (particularly of the abductor muscles). Imaging should begin with plain radiographs, including an anteroposterior (AP) view of the pelvis, an AP view of the hip and a lateral view (horizontal ray) of the hip. Computed tomography is also useful for assessing the version of the stem when used with software to reduce metallic artefacts.

When no obvious circumstances for instability are visible on radiographs, manipulation under fluoroscopy is valuable for mapping out the direction and position of instability.

Reduction

When closed reduction is attempted, fluoroscopy is helpful in achieving and confirming reduction. The proper muscular relaxation of the patient is also helpful, and documentation of the fluoroscopic result concerning position for instability (lift out) is valuable, should a later revision for dislocation become necessary. Post-reduction radiographs and a neurovascular examination are always indicated.

Following the successful reduction of a posterior dislocation, the patient should be reminded of the need to avoid provocative positions (a combination of > 90° flection, adduction and internal rotation). For non-compliant patients, an orthosis may be used for some weeks post-dislocation to prevent such positions. However, its use involves inherent discomfort and a risk of skin complications.

Between 3% and 6% of dislocations are not reducible using closed manoeuvres and require open reduction.[8,13,30] If open reduction is planned, preparedness for revision must be present.

Revision

The failure and complication rate after surgery for THA instability is known to be high. Wera et al[24] found the incidence for repeated dislocation after surgery for dislocation to be 14.6% at a mean of 12 months, and 21% at a mean of 60 months post-operatively. They found the failure frequency to be even higher for both pre-operative diagnosis abductor insufficiency and for using a constrained acetabular component, especially in relation to the locking ring type. The same study verifies the known high rate of deep infections (10%) after this type of surgery. The total complication rate was 24% after two years.

Revision strategies for instability are typically directed to correcting the underlying aetiology. In cases of an obscure cause of instability, fluoroscopy while performing provocative hip movements is most valuable. Anaesthesia is not necessary. The manoeuvres should be done by the surgeon, looking for positions where the prosthetic head starts to lift out of the cup. In analysing the cause of instability and planning revision surgery, even if one of the three reasons mentioned above are found, it is important to continue to analyse and roll out each of the other two. Even when such a procedure has been followed, the surgeon should pre-operatively analyse additional causes for hip instability and be prepared to also attend to those.

All revisions for instability should also strive for an upsizing of the head and liner to accomplish a proper soft tissue tension regarding offset and leg length, despite other surgical measures in place to attend to the cause of instability. Soft tissue tension can be achieved by the exchange of modular components, capsulorrhaphy or trochanter advancement.[31] These procedures must be weighed against the possibility of leg lengthening or altering hip kinetics. The posterior capsule might be incomplete or missing at the time of revision surgery. A posterior pseudocapsule with preserved attachment to the lateral acetabular rim can sometimes be shaped from intra-articular posterior scar tissue. This flap of the pseudocapsule can be attached to the posterior aspect of the major trochanter. Alternatively, a facia lata flap with preserved attachment to the greater trochanter can be mobilised and attached to the lateral rim of the acetabulum. If impingement exists, osteophytes or cement should be resected and components exchanged to improve head-to-neck ratio.

A worn cemented cup or liner should be exchanged. A flat design can be exchanged for one with an elevated posterior rim. If a well-fixed, uncemented metal shell is seated with an improper angle or a worn liner, a minor angle correction can be achieved by cementing in a new liner to the metal shell if careful preparation of the substrate of the liner and the shell, accurate sizing of the liner and good cement technique is used.[32]

Component positioning

When malposition of the acetabular or femoral component is the cause of instability, the component should be revised to a proper position. The prognosis of revision for this cause is relatively good.[33]

Dual mobility cups

There are several reports of good results using dual mobility cups[34–38] (Figs 2a and b). The dual mobility cup has an elevated lateral rim and an outer jumbo head resulting in a high lift-off distance. The components have become increasingly popular and are an alternative to a constrained cup. A disadvantage can be large articulating polyethylene (PE) surfaces, including one which is convex with potency for increased wear. The use of cross-linked PE may diminish this disadvantage, but may also make the polyethylene more brittle. Another disadvantage is the risk for dissociation between the inner and outer heads.[39]

a) b)

Fig. 2 In a dual mobility socket, the femoral component head is pressed into the larger polyethylene head using a screw clamp before insertion into the patient (a). When properly coupled inside the polyethylene head, the smaller head moves freely (b).

Constrained cups

The use of constrained components for the unstable THA may be a solution.[40] The constrained cup is an acetabular component that uses a mechanism to restrain the femoral head within the liner. A constrained design inhibits range of motion (ROM) and transmits significant forces to the bone–prosthesis interface, which may lead to loosening. When dislocations do occur with a constrained design, they can be difficult to manage. Surgery is required in most cases to reseat a disengaged locking ring, replace a broken one, or address a displaced liner or cup. Williams Jr, Ragland and Clarke[41] reported a mean rate of dislocation following revision with a constrained liner and a mean follow-up of 51 months of 10%. The mean re-operation rate for reasons other than dislocation was 4%. There is, however, a recent report of inferior results using constrained cups.[42]

Girdlestone resection

The last resort for salvage is Girdlestone resection arthroplasty. The remaining tissues form a scar, leaving the patient with a shortened limb and a significant limp.

Summary

Dislocation after THA is a complex problem which places considerable extra cost on the healthcare system. It is one of the most common causes of re-operation. Revision surgery for dislocation is combined with a high incidence of both failure and deep infection.

Since prevention is the best approach, it is important for surgeons performing primary THA to have a strong knowledge of instability. An increased head-to-neck ratio will diminish the risk. The posterior surgical approach has a higher risk for instability, but a definitive posterior soft-tissue repair will, however, considerably reduce the risk. Since the individual patient risk factor may vary by a factor of 11,[8] it is important to assess the individual risk before each primary surgery.

Revision strategies for instability are typically directed to correcting the underlying aetiology. In that respect, a sufficient analysis of the causative factor or factors must be performed before surgery. An upsizing of the head and liner is recommended as a complement to other surgical procedures undertaken for correcting the cause of instability.

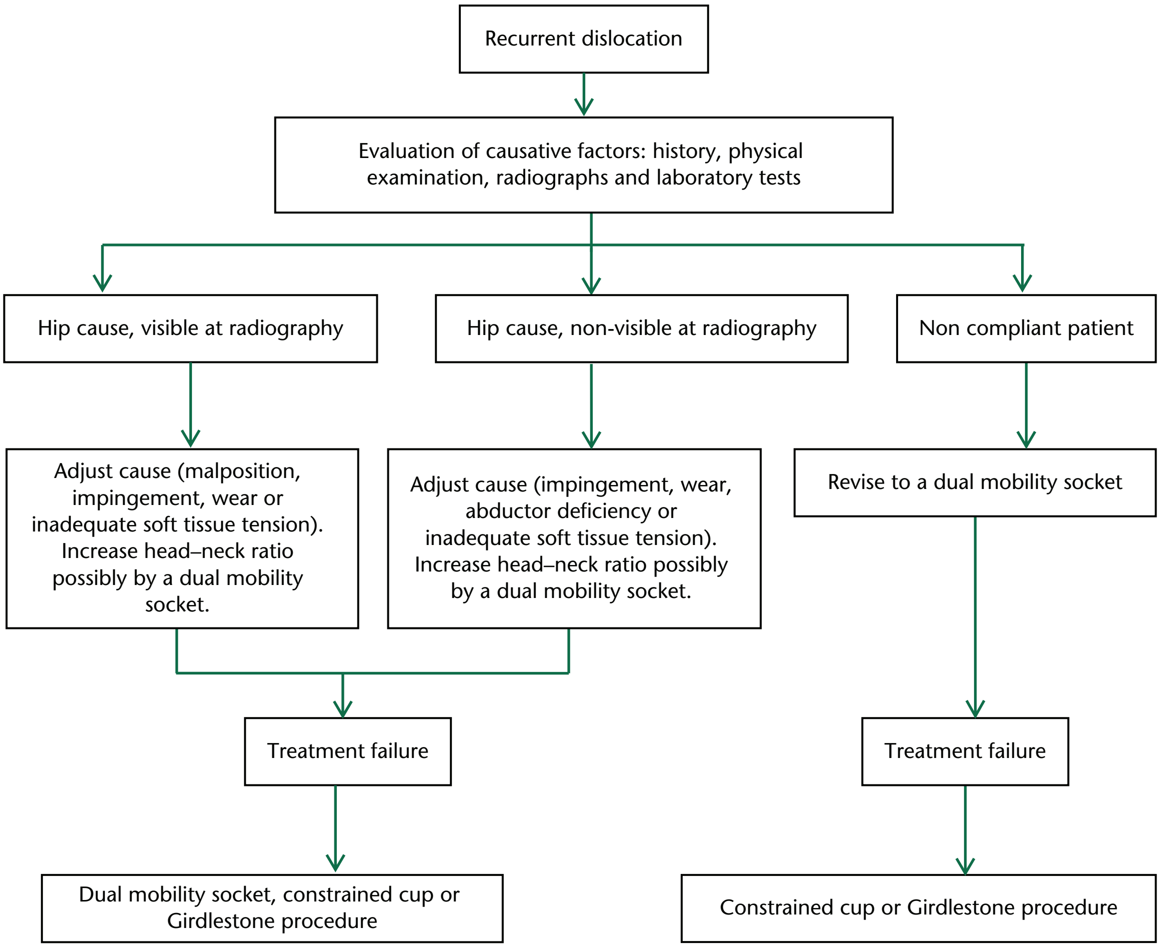

Fig. 3 Algorithm on the aetiology of hip dislocation.

The use of a dual mobility cup may therefore be a feasible alternative in revision THA for instability.

AUTHOR INFORMATION

Länssjukhuset i Gävle, Sweden.

Correspondence should be sent to: Gösta Ullmark, Orthopedic Department, Länssjukhuset i Gävle, 80187 Gävle, Sweden.
Email: gosta.ullmark@lg.se

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