REVIEW ARTICLE

Dislocation Following Total Hip Replacement

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SUMMARY

Background: Hip replacement ranks among the more successful operations on the musculoskeletal system, but it can have serious complications. A common one is dislocation of the total hip endoprosthesis, an event that arises in about 2% of patients within 1 year of the operation. Physicians should be aware of how this problem can be prevented and, if necessary, treated, so that the degree of trauma due to hip dislocation after hip replacement surgery can be kept to a minimum.

Methods: The authors searched Medline selectively for pertinent publications and analyzed the annual reports of international endoprosthesis registries.

Results: The rate of dislocation of primary hip replacements ranges from 0.2% to 10% per year, while that of artificial hip joints that have already been surgically revised can be as high as 28%, depending on the patient population, the follow-up interval, and the type of prosthesis. Patient-specific risk factors for displacement of a hip endoprosthesis include advanced age, accompanying neurologic disease, and impaired compliance. Patients should scrupulously avoid hip movements such as bending far forward from a standing position, or internal rotation of the flexed hip. Operation-specific risk factors include suboptimal implant position, insufficient soft-tissue tension, and inadequate experience of the surgeon. Conservative treatment is justified the first time dislocation occurs without any identifiable cause. If a mechanical cause of instability is found, then operative revision should be performed as recommended in a standardized treatment algorithm, because, otherwise, dislocation is likely to recur.

Conclusions: The dislocation of a total hip endoprosthesis is an emotionally traumatizing event that should be prevented if possible. Preoperative risk assessment should be performed and the operation should be performed with optimal technique, including the best possible physical configuration of implant components, soft-tissue balance, and an adequately experienced orthopedic surgeon.

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Today, total hip replacement (total hip arthroplasty, THA) is one of the most successful surgical procedures in the field of orthopedic and trauma surgery (1). To patients with osteoarthritis of the hip, it offers significant pain relief, improved quality of life and increase mobility, in both the medium and long term (1). Yet complications after total hip replacement can be very challenging for both the patient and the surgeon. Complication rates after primary hip arthroplasty range from 2% to 10%, including (2):

- aseptic loosening (36.5%)
- infection (15.3%)
- THA dislocation (17.7 %).

Internationally, the number of THAs is projected to increase by 170% by the year 2030 – a figure likely to apply to Germany too. Along with this trend, the absolute number of revision surgeries and associated complications will also surge (3, 4). The purpose of this paper was to review the epidemiology and etiology of THA dislocation as well as the treatment algorithm for these patients based on a search of the literature in MEDLINE, using the search term “total hip arthroplasty dislocation”, and an analysis of the international arthroplasty registries.

Epidemiology of THA instability

The analysis of the register data showed that THA dislocation is one of the main reasons for revision surgery (5). Currently, approximately 8 to 12% of the annually performed hip surgeries are revision procedures; of these, 11 to 24% are performed to treat THA dislocation (5–7). In the international literature and registers, data on the annual rate of THA dislocations after primary THA vary between 0.2% and 10% (8, 9). Recent studies, including an analysis of the Scottish National Arthroplasty Registry with 14 314 THAs between 1996 and 2004, have documented a dislocation rate of 1.9% which appears to be realistic, considering modern implant technologies and biomechanical insights (10). Dislocation rates of up to 28% are reported after revision and implant exchange surgeries (2, 11). For a series of 10 500 primary total hip replacements, Woo and Morrey (12) reported that 59% (196 hips) of the dislocations occurred within the first three months after surgery and overall 77% (257 hips) within the first year. Another working group added that in their patient population (19 680 primary hip replacements) THA

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dislocations occurred in 513 cases, of which 32% manifested as late dislocations more than 5 years postoperatively; the recurrent dislocation rate among these patients was 55% (13). The cumulative risk of dislocation within the first postoperative month is 1% and within the first year approximately 2% (5, 14). Thereafter, the cumulative risk continuously increases by approximately 1% per 5-year period and amounts to approximately 7% after 25 years (14).

Etiology and classification

THA dislocation is defined as the complete loss of articulation contact between two artificial joint components. It represents the failure of those individual hip joint mechanics which are to be established by implanting the prosthesis. Here, the aim is to achieve optimum load transfer between pelvis and femur along with normal multiaxial mobility of the joint and optimum muscular function. These biomechanical requirements can technically be met by stable prosthesis positioning, reconstruction of cup inclination and anteversion, stem antetorsion, reconstruction of the rotational center of the hip, offset, and leg length (*Figure 1*), as well as by using a muscle-sparing surgical technique. If these biomechanical requirements are not met, mechanical dysfunction may result and lead to instability of the hip arthroplasty.

With THA dislocation, it is important to distinguish whether the triggering event constituted an adequate trauma or a rather an everyday and controlled movement. The latter is suggestive of inadequate tissue tension or component malpositioning. Information about when the implantation was performed helps to distinguish between early dislocation, i.e. within the first 6 months, and late dislocations which are frequently due to material failure. Basically, THA dislocation can be caused by 3 mechanisms or a combination of 2 mechanisms which are presented in the *Table* and supplemented by *Figures 2* and *3*.

Depending on the mechanical cause, 3 dislocation directions can be observed, even though dislocation direction and component positioning are not necessarily related (18) (*eFigure*):

- Cranial dislocation
 - Excessive inclination of the cup, abductor insufficiency, polyethylene wear
 - Dislocation along with adduction of the extended hip joint
- Dorsal dislocation
 - Insufficient anteversion or retroversion of the cup, joint hyperlaxity, primary or secondary impingement
 - Dislocation with internal rotation and adduction of the flexed hip joint or with deep flexion
- Anterior dislocation
 - Excessive combined antetorsion of stem and cup, joint hyperlaxity, primary or secondary impingement
 - External rotation and adduction of the extended hip joint.

Figure 1: Pelvic radiograph after total hip arthroplasty. To restore hip joint kinematics, implant positioning is characterized by secure bone support, reconstruction of cup inclination (1) and anteversion (2), antetorsion of the stem and reconstruction of the rotational center of the hip, offset (3), and leg length (4)

Risk factors for THA dislocation

Risk factors for THA dislocation can be assigned based on a time line (preoperative, perioperative, postoperative) or causal relationship. The latter allows for causal risk evaluation where risks can be attributed to the patient, the surgeon or the implant. At the same time, preventive and therapeutic approaches are based on the knowledge and consideration of specific risk factors.

Patient-related factors

One of the key factors contributing to joint stability is the muscular and capsular guidance for the replaced hip joint. Accordingly, a higher dislocation incidence of between 5% and 8% annually was observed in patients with neuromuscular conditions, such as cerebral palsy, muscle dystrophy and dementia, but also with Parkinson's disease (10, 19, 20). For the population of patients older than 80 years of age, an increased risk of dislocation has been described and attributed to sarcopenia, loss of proprioception and the increased risk for falls. Likewise, non-compliance is more prevalent in these patient populations, as dislocation-promoting hip movements, such as deep flexion or internal rotation of the flexed hip joint, are not strictly avoided. Consequently, dislocation may result even in the absence of procedure-specific mistakes.

There is some controversy in the literature whether or not female gender constitutes a risk factor for THA dislocation. Studies by Wetters et al. and an analysis of the data from the Scottish National Arthroplasty

TABLE

Mechanisms of THA dislocation

Cause	Consequence
Malpositioning or loosening of stem or acetabular component	No sufficiently stable contact between the articulating partners (<i>Figure 2</i>)
Contact between neck of the prosthesis and articular component subject to joint position	Primary impingement; the femoral head is levered out of the cup (<i>Figure 3</i>)
Contact between bony femur and bony pelvis	Secondary impingement; the femoral head is levered out of the cup (15, 16)
Hyperlaxity of the joint due to muscular insufficiency or lack of soft-tissue tension.	Possibility of an abnormally increased translational mobility of the femur (2, 17)

Registry collected between 1998 and 2003 did not find a significant increase in the dislocation rate among women, even though the overall THA rate was higher in women (2, 20). In contrast, high-impact factors contributing to the dislocation risk include anatomical variations of the hip, often occurring along with congenital hip dysplasia or metabolic bone disorders, rapidly progressive and inflammatory arthropathies, as well as necrosis of the femoral head (21).

Prior fractures or surgical procedures involving the hip significantly increase the risk of dislocation. Dislocation rates of up to 50% after prior femoral neck fractures have been reported in the literature (10). Revision total hip replacements after previous dislocation, periprosthetic fractures, and septic or aseptic loosening are associated with dislocation rates of up to 28% due to at times significant soft-tissue trauma, extensive scarring, heterotopic ossification, and acetabular or femoral bone loss.

During the preoperative risk assessment, the surgeon should pay particular attention to patient-specific risk factors and highlight these during the informed consent discussion.

Procedure-related factors

Procedure-specific risk factors for THA dislocation can be divided in:

- the surgical approach
- positioning of the acetabular and femoral component,
- soft-tissue tension, and
- the surgeon's experience.

Numerous studies have shown that the posterior approach to the hip, involving detachment of the external rotators and the posterior joint capsule, is associated with a higher dislocation risk compared with the lateral, anterolateral or anterior approaches. A meta-analysis including more than 13 000 primary total hip arthroplasties with a follow-up period of at least 12 months calculated a dislocation rate of 3.23% for the posterior approach, while the rates for the lateral transgluteal approach and the anterolateral approach were 0.55% and 2.18%, respectively (22). However, the dislocation rates for the posterior approach can be significantly reduced to rates as low as 0.7% by anatomical repair of the posterior capsule and the external rotators combined with increased anteversion of the cup component (22, 23). In contrast, the lateral transgluteal approach to the hip joint is associated with an increased risk of functional weakening of the abductor muscles resulting from partial detachment of the gluteus medius muscle or fracture of the greater trochanter. This mechanism is assumed to account for approximately 36% of THA dislocations (17).

The alignment of the implants during hip replacement surgery is of special importance for the stability of the artificial joint. Even though both acetabular and femoral cup positioning is guided by individual anatomic requirements, the dislocation-stable cup position with an inclination of $40 \pm 10^\circ$ and an anteversion of 10 to 20° as published by Lewinnek is internationally considered desirable (24). In a study, Wines et al. (25) asked surgeons to intraoperatively estimate the alignment of the acetabular and femoral components and

Figure 2: Radiograph of a THA dislocation on the left side, resulting from loosening of the acetabular component. In this case, prosthesis infection led to loosening of the acetabular component and secondary dislocation

compared these estimations with postoperative CT scan measurements. It was found that when surgeons estimated intraoperatively an acetabular component anteversion between 10° and 30°, only 45% of components actually were within this target range. In case of the femoral component alignment, the surgeons intraoperatively estimated the antetorsion in 93% of cases between 15° and 20°, while CT scan measurements ranged from 15° retrotorsion to 45° antetorsion and 71% of prosthesis stems were in the target range. While a component position which increases the risk of THA dislocation is an procedure-related factor and can potentially be avoided, it is influenced by intraoperative positioning, the patient-specific anatomical situation, periarticular contractures, malpositioning of the lumbosacral junction, and obesity as well as considerably by the surgeon's experience. Studies have shown that with increasing volume of procedures performed by a surgeon, the risk of THA dislocation significantly drops (26).

Implant-related factors

A wide range of acetabular and femoral components as well as sliding pairings are available for primary and revision arthroplasties. The service life of these components and the abrasion of various sliding pairings are the main factors influencing late dislocation by material wear. In addition, implant design may contribute to instability, especially when the use of over-hemispheric acetabular and inlay components or extended prosthetic heads—intended to increase the stability of the prosthesis—cause primary impingement, i.e. early contact of the femoral component with the acetabular component (Figure 3).

The head-to-neck ratio is of special importance for the stability of the prosthesis and the impingement-free range of motion. Larger femoral heads (e.g. 36 mm) allow a wider mechanical range of motion compared with smaller head diameters (e.g. 28 mm) before the neck of the prosthesis strikes the rim of the acetabular component (27). In addition, the distance a larger femoral head has to move away from the center of the acetabular component ("jumping distance") before it can dislocate over the rim of the cup is longer. Thus, a larger head diameter offers better protection against dislocation (28, 29). These advantages are contrasted by the following disadvantages: inlay thickness has to decrease with increasing head diameters; increased abrasion along the head-neck plug connection; the stabilizing effect is lost in case of abductor insufficiency (30); and the increased range of motion promotes secondary impingement with resulting contact between proximal femur and pelvic bone. For these reasons, femoral heads with diameters of more than 36 mm are not normally used.

Management of unstable hip arthroplasties

The treatment algorithm for hip prosthesis instability has not yet been comprehensively standardized and randomized controlled studies comparing the outcomes

Figure 3: Extended prosthetic heads. Extended prosthetic heads are used to improve the soft-tissue tension of a total hip arthroplasty and thereby its stability. They feature a shoulder (arrow) in the area of head-neck junction which can – subject to the position of the acetabular component (cup) and the extent of motion – cause the shoulder to collide with the rim of the cup, thereby promoting the levering of the prosthetic head out of the cup

of non-surgical and surgical management are not available in the literature. THA dislocation always requires medical intervention as self-reduction or reduction by a layperson without anesthesia is not possible. Thus, immediate admission to a hospital, preferable where arthroplasties are performed, is crucial. On physical examination, the affected leg is shortened and shows malrotation. When taking and documenting the history, the patient should be asked about any adequate trauma or the sequence of motions that led to the dislocation. In addition, it should be explored whether the event represents a first or recurrent dislocation and how long ago the primary arthroplasty was performed. Ideally, the patient has a so-called prosthesis pass which identifies the components of the prosthesis. In this case, a copy of it should be added to the patient's medical records.

Initial radiography should include an anterior-posterior view of the pelvis and, where possible, a second plane to rule out implant loosening or periprosthetic fracture (Figure 4). Apart from radiography, laboratory tests for inflammation should be performed with every THA dislocation to rule out prosthetic joint infection; in addition, joint aspiration plus cell count should be performed, especially with late dislocation, because of the higher coincidence with septic loosening.

Where conventional radiography findings are inconclusive with regard to implant malpositioning or loosening, a CT scan is indicated to enable 3-dimensional evaluation of component positioning. If the CT scan is not suggestive of malpositioning or loosening or can only be undertaken with a delay, reduction should be performed under short anesthesia in the operating room during the fasting interval. In case of concomitant compression of blood vessels and nerves, immediate reduction is essential. Subsequently, the sufficiency of

FIGURE 4

Diagnostic and therapeutic algorithm for THA dislocation. a.p., anterior-posterior; THA, total hip arthroplasty; CT, computed tomography; yrs, years

the pelvis-trochanter soft tissues and the dislocation mechanism are evaluated under dynamic fluoroscopy. A femoral head with distractibility of more than 1 cm is indicative of pelvis-trochanter insufficiency (17).

Where movement stability is achieved after reduction, conservative treatment with occupational therapy and physiotherapy can be initiated, initially on an inpatient basis. The efficacy of commercially available orthoses, primarily limiting flexion and adduction, has not yet been supported by scientific evidence (31). Nevertheless, these devices offer both the patient and the doctor a certain degree of security; therefore their use can be openly discussed with the patient.

Patients in whom dynamic fluoroscopy reveals instability should undergo revision surgery. Whether definite revision surgery is attempted in the acute dislocation situation or a two-stage approach is favored will depend on the structure of the hospital. In patients with soft tissue insufficiency, soft tissue tension can be increased without extending the leg by increasing the offset, the distance between the femoral stem and the hip

joint rotation center. In addition, techniques, such as capsule suture, fascial tightening and the use of attachment tubes, as well as a combination of these techniques are available. The head-neck ratio should always be optimized.

In patients with recurrent dislocations, the option of surgical revision should generally be considered. In case of component malpositioning, it is necessary to perform a component exchange. In patients with muscular or coordination deficits, tripolar head systems may be used which allow movement of a mobile polyethylene cup both in the bone-anchored socket and along the head of the prosthesis. This design enables recentering of the joint with shifting of the inlay in the acetabular component when the neck of the prosthesis gets in contact with the polyethylene inlay (32, 33). The French literature reports about the successful use of tripolar cup systems as primary treatment in patients with increased dislocation risk; however, because of the lack of adequate data from abrasion behavior studies and the possibility of intraprosthetic dislocation (disconnection

of head and inlay), this method has not been generally adopted (34). In hip revision surgery, this implant has the disadvantage that it offers limited modularity and does not allow screw augmentation for cup anchoring (35). Due to their high failure rates, constrained inlays or snap-in cups with circular, over-hemispheric enclosure of the head are rarely used (36).

Conclusion

Dislocation following total hip replacement can be extremely traumatizing for patients. They lose confidence in their artificial joint, completely move away from the aim of a „forgotten joint“, and may reproach the surgeon for this outcome. Thus, dislocation prophylaxis is essential. Apart from preoperative risk assessment, this includes proper surgical technique with optimized alignment of the components, soft-tissue balancing and head-neck ratio, as well as adequate surgical experience. Treatment of instability after total hip replacement should follow a standardized algorithm.

Conflict of interest statement

The authors declare that no conflict of interest exists.

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KEY MESSAGES

- The risk of dislocation after primary total hip arthroplasty is approximately 2%.
- Dislocation rates of up to 28% are found after revision and implant exchange surgeries.
- Patient-specific risk factors include advanced age, concomitant neurological disease and limited compliance.
- Relevant operation-specific risk factors include implant malpositioning, inadequate soft-tissue tension, and little surgical experience.
- Treatment of instability after total hip replacement should follow a standardized algorithm.

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REVIEW ARTICLE

Dislocation Following Total Hip Replacement

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eFigure: Directions of dislocation after total hip arthroplasty.

- a) In cups opening excessively towards anterior (anteversion),
- b) external rotation and adduction of the extended hip joint may lead to dislocation.
- c) In case of excessively steep cup positioning (inclination) and abductor insufficiency,
- d) adduction of the extended leg may lead to dislocation.
- e) In cups opening excessively towards dorsal (retroversion),
- f) internal rotation and adduction of the flexed hip joint may lead to dislocation