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INTEGRATED STUDY MASTER'S THESIS

Prevention of Dislocation After Total Hip Arthroplasty Through Different Approaches: Surgical Considerations

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2 ABBREVIATIONS

THA = total hip arthroplasty

DLA = direct lateral approach

DAA = direct anterior approach

ITB = iliotibial band

SERs = short external rotators

TFL = Tensor fasciae latae

DMCs = Dual mobility cups

LL = leg length

3 SUMMARY

Total hip arthroplasty (THA) is a often performed and effective procedure for managing hip pathology. However, postoperative dislocation is one of the leading complications and cause for revision surgery, showing the importance of working prevention strategies.
This research explores different surgical approaches and techniques aimed at minimizing dislocation risk, based on a good understanding of hip joint anatomy, biomechanics and surgical steps.
The objective of this study is to examine key surgical factors that influence postoperative stability and assess how different approaches and techniques contribute to reducing dislocation rates.
A narrative review methodology was performed, evaluating current literature on surgical approaches (anterior, posterior, and lateral), capsular and soft tissue management, implant selection (head size, dual mobility systems), the influence of leg length and offset changes and the role of technological aids, like robotic-assisted surgery in decreasing dislocation rate.

Findings in literature show, that successful prevention begins with taking careful attention to the stabilizing structures of the hip. Techniques that preserve or reconstruct the joint capsule, ligaments, and periarticular musculature are consistently associated with lower dislocation rates.
The direct anterior approach, which limits soft tissue disruption, and posterior approach followed by a capsular repair, both show lower dislocation rates. Additionally, implant design has a drastic impact on stability. Larger femoral heads and dual mobility implants provide more stability through improved biomechanics lowering therefore successfully dislocation rates after (THA).
Surgeon experience and the integration of modern robotic-assisted techniques further help in correct component positioning, and therefore reduction of dislocation.
While restoration of leg length and femoral offset is important for functional outcomes, their role in dislocation prevention is considered supportive rather than primary.
In conclusion, the prevention of dislocation after total hip arthroplasty is a complex, multifactorial challenge.
The best results are achieved through a combination of well-defined surgical techniques, soft tissue handling, appropriate implant choice, and the use of modern technologies. Therefore, an approach that considers also patient-specific risk factors and surgical expertise is the way to provide long-term stability hence lower dislocation rates and an overall improved quality of life for the patient following (THA).

4 KEYWORDS

total hip arthroplasty, THA, surgical approach, posterior approach, direct lateral approach, direct anterior approach, dislocation, dislocation prevention, cause of dislocation, postoperative complications, dislocation rate

5 INTRODUCTION

The hip joint is one of the largest and stable joints in our body, playing a key role in supporting the weight of the upper body. Through its ball-and-socket configuration, the hip joint provides an exceptional balance between mobility and stability. This unique structure is essential for enabling the coordinated movement of the lower limbs. Consequently, optimal hip function is fundamental to maintaining balance, posture, and overall quality of life.

When the hip joint is functionally impaired by conditions such as osteoarthrosis, Osteoarthritis, or hip dysplasia, patients often complain about significant pain and furthermore an automatic decrease in mobility.
This disruption not only impairs everyday activities but also substantially reduces overall quality of life.

Consequently, when conservational treatments fail to provide adequate relief of the pain and show no effect in bringing back the original form of movement, surgical intervention is often considered as a final treatment option to restore joint function and alleviate the pain.
Therefore, total hip arthroplasty is an indispensable treatment option for malfunctioning hip joints, making it one of the ultimate therapeutic strategies and helping patients to return back to their original level of physical activity (1).

Total hip arthroplasty (THA) is recognized as a highly effective treatment for relieving pain, and restoring hip function, as well as enhancing the quality of life in patients with diseases such as advanced-stage hip osteoarthritis (2).
"Approximately 28% of the population ≥45-year-old suffer from hip arthritis and this prevalence is expected to increase in coming decades" (3).
This highlights the clear need for treatment options like total hip arthroplasty (THA).
In 2010, it was estimated that around 2.5 million individuals in the United States had undergone total hip arthroplasty (THA), with nearly 332,000 new procedures being carried out annually and prevalence increasing (4).
As our population continues to age and therefore the incidence of degenerative joint conditions such as osteoarthrosis, arthritis rise, the demand for effective treatment options will even increase.
"Internationally, the number of THAs is projected to increase by 170% by the year 2030"(5)
Therefore, Total hip arthroplasty becomes increasingly important as well as the correct handling und understanding of its complications.

The evolution of modern total hip arthroplasty (THA) can be traced back to the 1950s, when Sir John Charnley pioneered the concept of low-friction arthroplasty, introducing fundamental advancements in implant design, materials, and surgical techniques that laid the foundation for contemporary hip replacement procedures (6).
Nowadays (THA) is a widely performed procedure characterized by low revision rates, excellent patient-reported outcome measures (PROMs), and a low mortality rate (7). In general, you can say

that Total hip Arthroplasty has very promising results with an overall 10-year survivorship higher then 95% (8).

In recent decades, improvements in implant design and surgical techniques have shifted the focus beyond pain relief toward reconstructing the hip in a way that closely replicates the patient's natural anatomy and with an ambition to have a minimum of complications, including the prevention of dislocation after (THA).

Therefore, it is crucial to precisely restore the hip anatomy, including proper positioning and orientation, for achieving optimal hip function.
This involves maintaining the native anteversion, accurately positioning the femoral head center, and ensuring the correct leg length, all of which contribute to joint stability, biomechanics, and overall patient outcomes (9).

Despite the overall success of total hip arthroplasty (THA) in general management of pain and restoring function, dislocation remains one of the most concerning complications and also ranking as the second most common complication in (THA) (10) (11).

Therefore, a sufficient control and management of the rate of dislocation is crucial for the patient's outcome and to minimize the need for revision surgeries.
"The majority of dislocations occur early in the post-operative period and are due to either patient-associated or surgical factors".(11)
It is important to understand the various surgical approaches to identify those that are more prone to dislocation and those that yield better outcomes for patients.
In general, there are several techniques and approaches to performing a Total Hip Arthroplasty, each of which impacts patient outcomes as well as level of morbidity and dislocation rates differently.

„The most commonly used approaches for THA include posterior approach (PA), direct lateral approach (DLA), and direct anterior approach (DAA)".(3)
Total hip arthroplasty (THA) can also be done by using the anterolateral approach or also known as the Watson-Jones approach, as well as the two-incision technique. Additionally, in recent years, some surgeons have adopted the direct superior approach as an alternative method for THA (3).
Although these approaches are used less frequently compared to traditional techniques, they are increasingly acknowledged as viable options in certain clinical scenarios.

Nevertheless, this work will focus exclusively on the three main surgical approaches, the posterior approach (PA), the direct lateral approach (DLA), and the direct anterior approach (DAA), to determine which method most effectively reduces dislocation rates after a performed THA in patients.
This written work will not only analyze the initial choice of surgical approach but also examine various intraoperative decisions, that may influence dislocation rates.

Therefore, the aim of this review is to critically examine the impact of the three main surgical approaches and the influence of intraoperative decisions on the prevention of dislocation following total hip arthroplasty.

In the upcoming sections of this review, readers will encounter an overview of the methodology, how literature review was performed, and on how articles and research papers were gathered, selected, and analyzed.
Following this, the review will give an overview on the underlying anatomical structures that play an important role in understanding the different surgical approaches used in total hip arthroplasty, Followed by the mechanism of dislocation itself.
A detailed examination of the literature will follow, comparing the posterior, direct lateral, and direct anterior surgical techniques and their respective dislocation rates, as well as analyzing various intraoperative decisions ranging from size of the femoral head to meticulous capsular repair that influence the level of dislocation. The Discussion will bring the findings together and evaluate the existing controversies and highlight areas for future research.

6 METHODOLOGY OF THE LITERATURE REVIEW

6.1 SEARCH STRATEGY AND DATABASES

To ensure a detailed and systematic literature review on the topic "Prevention of Dislocation After Total Hip Arthroplasty through different approaches: surgical considerations", a well-defined search strategy was implemented. Major electronic databases, including PubMed and google Scholar, were searched for relevant studies.
These databases were selected because they offer extensive coverage of biomedical literature and have therefore a high indexing of very good peer-reviewed journals.

Search terms were carefully selected to capture the most relevant studies on total hip arthroplasty (THA) specifically focusing on dislocation as complication and further evaluating how the three primary surgical approaches, posterior approach, direct lateral approach, and direct anterior approach relate to dislocation risk.
In addition to the evaluation of the three primary surgical approaches, the literature review also incorporates intraoperative decisions and considerations that may have an influence on dislocation rates following total hip arthroplasty (THA). These include for example, precise acetabular component positioning, restoration of femoral offset and leg length, the use of larger femoral heads, correct soft tissue repair, and the adoption of implant designs like dual mobility systems.

For the following literature research following Key phrases were used and included “total hip arthroplasty,” “THA,” “dislocation prevention,” “surgical approach”. Additionally, more specific terms such as “posterior approach,” “direct lateral approach, and “direct anterior approach” “dislocation” “cause of dislocation”, “dislocation rate”,” postoperative complications” were used. Also, Boolean operators (AND, OR) were used to combine these terms effectively. Dislocation rate

For example, one of the primary search strings was:
("total hip arthroplasty") AND ("dislocation prevention" OR "surgical approach")
It was then ensured to capture the most important literature of both broad and narrow aspects of the topic.
Furthermore, the focus is on articles from current practices and recent advancements, however no limitations regarding the publication date was placed allowing a comprehensive inclusion of studies.

6.2 INCLUSION AND EXCLUSION CRITERIA

6.2.1 INCLUSION CRITERIA

After performing the initial search, the further step involved screening articles based on selected clear inclusion and exclusion criteria.
In this review, inclusion criteria were chosen to make sure that high-quality, relevant studies were implemented into the analysis.

Part of an inclusion criteria was that most of the studies should be published in peer-reviewed journals. This criterion was evaluated as essential because articles which have undergone peer review are automatically evaluated by experts in the field, who ensure that the data and drawn conclusion are both reliable and scientifically.

Furthermore, the focus of each paper was to draw out surgical techniques or approaches related to total hip arthroplasty (THA), with a relation on dislocation rates and their possible prevention.

This clear direction allows for a strict assessment of how different surgical methods and approaches influence postoperative stability of the Hip Prothesis.
Therefore, this study should be able to find out the effectiveness of various surgical approaches in reducing dislocation risk.
To do so the study design allowed to capture a broad variety of different study formats including randomized controlled trials (RCT), systematic reviews, observational studies, and systematic reviews, as long as they provided sufficient quantitative or qualitative data in accordance with the asked research question.
The goal of an inclusion of such multiple study designs is to review a broad variety of perspectives and to efficiently keep a balance between the strengths and limitations in each research approach.

6.2.2 EXCLUSION CRITERIA

Studies focusing only on non-surgical factors affecting dislocation, like correct preoperative planning or selection of patients, were excluded, as the primary aim of the research was to investigate the impact of surgical techniques and intraoperative decisions on dislocation rates.

7 THEORETICAL BACKGROUND AND FUNDAMENTALS IN THA

7.1 ANATOMY AND BIOMECHANICS OF THE HIP

A detailed understanding of the hip anatomy is essential for understanding the general principles of total hip arthroplasty and their different surgical approaches including posterior approach (PA), direct lateral approach (DLA), and direct anterior approach (DAA).
This also helps us understand the basic causes of dislocation and to be able to identify ways to prevent them.
Therefore, the knowledge of key anatomical structures and their biomechanical roles enables to identify vulnerabilities that may predispose the hip to instability and allows us to completely understand the mechanisms used for the total hip arthroplasty.

The following section provides an examination of the hip joint's anatomy and its contribution to overall joint stability.

„As the primary link between the trunk and the lower limb, the hip joint plays an important role in the generation and transmission of forces during routine activities of daily living and athletic activities” (12).
Therefore, the optimal functioning of hip anatomy is crucial for the performance of everyday activities.
“The hip joint has classically been described as a constrained articulation between the spherical head of the proximal femur and the concave socket of the pelvis called the acetabulum ”(12).
This ball-and-socket arrangement is fundamental to the hip's capacity to support the weight of the upper body while enabling at the same time a broad range of movement.
The hip is a diarthrodial joint and has its stability primarily through its bony architecture. (13)

General movement of the hip occurs around three major, perpendicular axes where the center of rotation is located at the femoral head. The transverse axis permits flexion and extension, the longitudinal axis facilitates internal and external rotation, and the sagittal axis allows abduction and adduction. (13) This multi-axial mobility, ensures a wide range of movements while also allowing the hip to sustain significant loads during daily activities.

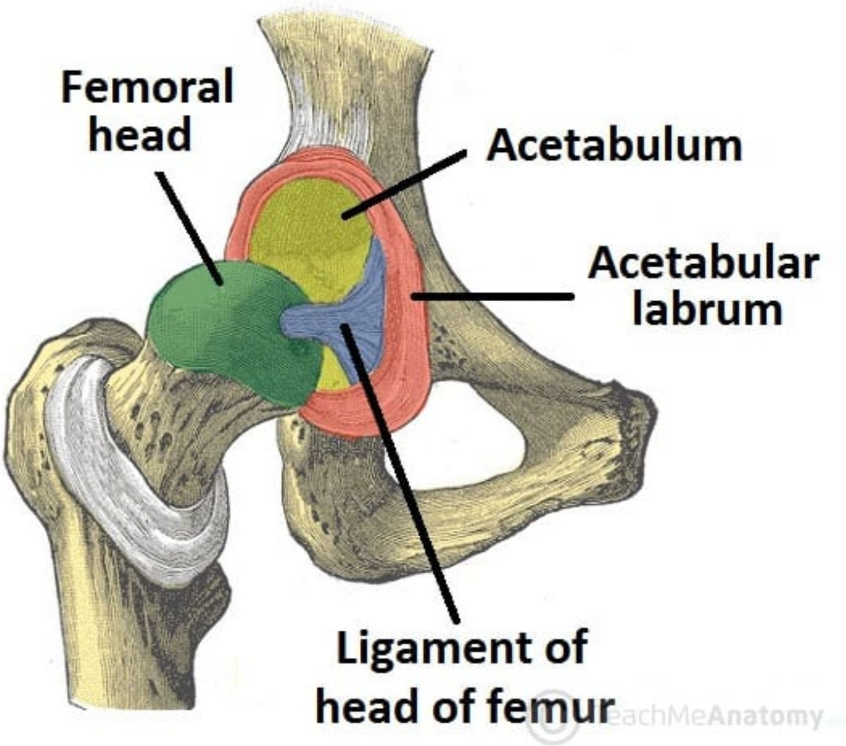

Figure 1: Anatomical overview of the articulating surfaces of the hip Joint

The acetabulum, (see **figure 1**), is situated at the junction where the ilium, ischium, and pubic bones converge.(12)

This surface is deepened by a fibrocartilaginous rim known as the labrum, which enhances joint stability by also increasing the surface area of contact. It "provides load transmission, negative pressure maintenance (i.e., the 'vacuum seal'), and regulation of synovial fluid hydrodynamic properties (13)".

The hip joint is surrounded by a tight capsule that is more restrictive in extension than in flexion. (13)

The iliofemoral, pubofemoral, and ischiofemoral ligaments are reinforcing the capsule.

"The iliofemoral ligament is the strongest ligament in the body and attaches the anterior inferior iliac spine (AIIS) to the intertrochanteric crest of the femur. The pubofemoral ligament prevents excess abduction and extension, ischiofemoral prevents excess extension, and the iliofemoral prevents hyperextension"(13).

Within the joint, the so-called ligamentum teres connects the head of the cotyloid notch to the fovea of the femoral head. Its vascular contribution is minimal in adults but carries the foveal artery a branch of the posterior division of the obturator artery that is essential for the blood supply of the femoral head in infants and children.

„Injuries to the ligamentum teres can occur in dislocations, which can cause lesions of the foveal artery, resulting in osteonecrosis of the femoral head" (13).

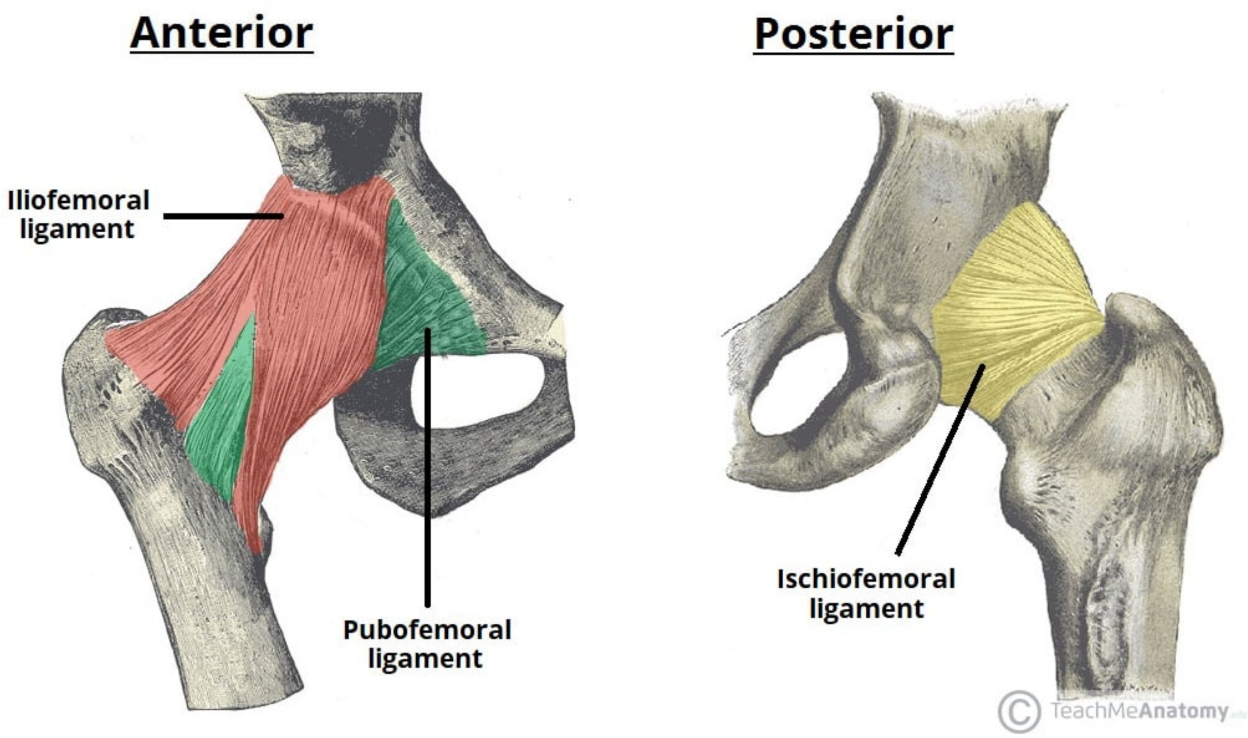

Figure 2: Supporting ligaments of the hip joint

The vascular supply of the hip predominantly derives from the medial and lateral circumflex femoral arteries, both branches of the profunda femoris artery, which itself is a branch of the femoral artery. (13)

The hip joint receives innervation “from the femoral, obturator, superior gluteal nerves”(13).
The femoral nerve supplies sensory and motor support to the anterior portion of the hip, therefore playing an important role in movement and sensation in this area.
The obturator nerve primarily innervates the medial site of the hip, playing a key role for proper joint positioning. Additionally, the superior gluteal nerve gives innervation to the lateral and superior regions of the hip, maintaining therefore stability and coordinating actions of the hip muscles.

The muscular support of the hip joint is important for the movement as well as the stability of the joint during both static and dynamic activities.
Therefore, the reader should have a broad understanding of the distinct functions of the different muscles of the hip, as disruptions of them can play an influence in the dislocation mechanism of the hip after total hip arthroplasty.

Flexion of the hip is performed by the psoas major and iliacus muscles. Extension is performed by the gluteus maximus and the hamstring group. Medial rotation works by the tensor fasciae latae as well as the anterior fibers of the gluteus medius and minimus. Lateral rotation is accomplished by the obturator muscles, quadratus femoris, and gemelli. Abduction is mainly controlled by the gluteus medius, which is the largest and most important hip abductor for joint stability along with the gluteus minimus, tensor fasciae latae, and sartorius. In contrast, adduction is carried out by the adductor longus, brevis, and magnus, supported by the gracilis and pectineus muscles. (13); (14)

Each surgical approach in total hip arthroplasty affects therefore different anatomical structures.
If the original anatomy is not carefully considered during the surgery, there can be an increased risk of postoperative dislocation.

In summary, the hip joint’s anatomy including bony structures, supportive labrum, robust capsule, ligaments, precise vascular supply, and coordinated neuromuscular control provides and ensures both stability and the range of motion of the hip essential for daily function.

7.2 THE THREE MAIN DIFFERENT SURGICAL APPROACHES ON (THA)

As already mentioned, Total hip arthroplasty (THA) is recognized as one of the most effective surgeries restoring original function in patients with hip joint pathology as well as achieving an adequate pain relieve.
The procedure involves replacing the affected hip joint with prosthetic components, thereby improving mobility, and enhancing quality of life.
The primary indications for a total hip arthroplasty (THA) include degenerative diseases such as osteoarthritis or rheumatoid arthritis. (3)
Other indications can be avascular necrosis, femoral neck fractures, as well as other degenerative conditions that result in persistent joint pain and unresponsiveness to conservative treatment.

The success of the surgery is closely linked to preoperative planning and choosing the correct surgical approach. "Despite advances in the design of implants and bio- materials, surgical approaches for total hip arthroplasty (THA) have remained relatively unchanged "(15).

Three main approaches currently dominate practice: the direct anterior approach (DAA), the posterior approach (PA) and the direct lateral approach (DLA), offering independently advantages and disadvantages regarding postoperative outcomes, disruption of anatomy and soft tissue handling.

As this work analyzes how surgical considerations can help prevent dislocation after Total hip arthroplasty, it is also crucial to be familiar with the three main approaches to be able to identify possible benefits and limitations to each technique regarding the dislocation rate.
The following section should only briefly describe how the three main different surgical approaches are performed, without comparing their effects on dislocation rates after total hip Arthroplasty.

7.2.1 DIRECT ANTERIOR APPROACH

The direct anterior approach (DAA) for total hip arthroplasty is a minimally invasive and muscle-sparing technique that provides access to the hip joint through an intermuscular and internervous plane between the tensor fasciae latae and sartorius muscles, therefore keeping the level of disruption of surrounding structures minimal as well as increasing postoperative recovery. (16) (3)
First described by Hueter in 1881 and later redefined in 1917 by Smith-Petersen it has gained more and more popularity over the recent years due to its tissue sparing technique and better postoperative outcomes.(17)

The surgery is performed in a supine position on a standard or fracture table which allows a good access to the limb. (3)
“When using a regular table, the patient is positioned with the pelvis located over the table break, which can be angled to allow hyperextension at the hip joint “ (16); see also (Figure 3 a).
A bump is then also often placed under the sacrum of the patient to lift the pelvis and allows the optimal exposure of the femur. (18)

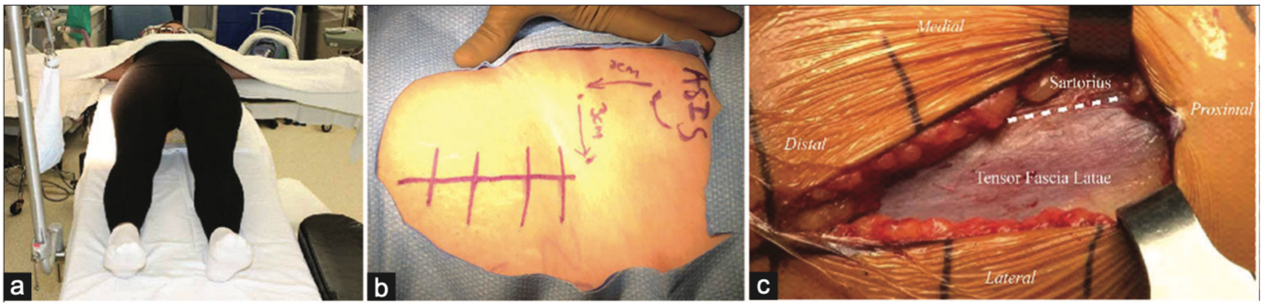

Figure 3: **3a** Positioning of the Patient on an operational table; **3b** landmarks of the skin incision on the patient; **3c** view on the anatomical structures after skin incision

Usually, the skin incision is performed by most surgeons obliquely, starting approximately 2–4 cm distal and lateral to the anterior superior iliac spine (ASIS) and moving toward the anterior edge of the greater trochanter. (16) (See Figure 3 b)
The incision then follows the axis of the tensor fasciae latae (TFL) muscle, which is an important anatomical landmark during orientation of the surgery. (17) (See Figure 3 c)
After the subcutaneous tissue are cut, blunt dissection follows, to minimize also damage to the lateral femoral cutaneous nerve. (3)

The intermuscular section between the Tensor Fascia Latae (TFL) and the sartorius muscle is dissected having the advantage that through this approach there is no detachment of muscle from bone. (17) “Dissection through the lateral (TFL) and not in the intramuscular portal may result in damage to the motor branch of the superior gluteal nerve”(16).
Specialized retractors are then used to hold back the (TFL) laterally and the musculus rectus femoris and musculus sartorius medially, leading to the exposure of the anterior hip capsule. (3)
After the exposure of the anterior hip capsule, a capsulotomy or capsulectomy is performed, pending on the surgeon`s preference and each showing different advantages. (16)
Once the surgeon opened the capsule, attention is turned to the femoral neck, where a double osteotomy is typically performed. (3)
The first one is made from the bony saddle at the superolateral neck to a point on the medial neck

1 cm superior the lesser trochanter, which is then followed by the second parallel osteotomy 1 cm proximal. (3)" Extraction of the central disk or "napkin ring" formed by the double osteotomy allows for subsequent removal of the femoral head with a corkscrew" (3).

After the removal of the femoral head, adequate acetabular exposure is reached by placing retractors around the acetabular rim in order to ensure good visualization, then acetabular reaming is performed, and the preparation of bone cup implantation is being prepared. (3) Fluoroscopy is sometimes being used intraoperatively for the confirmation of positioning and ensuring correct anteversion and inclination.(16)
After insertion of the acetabular component and verifying its placement "the leg should be adducted and externally rotated"(3).
The femoral canal is prepared, and the femoral stem is inserted.
After the insertion of the final acetabular liner and femoral head, the hip is reduced, and stability tests through a full range of motion are performed, to assess for impingement and proper leg length.
"After trailing and final component placement, the fascia overlying TFL is closed with either interrupted or running sutures followed by routine closure of the subcutaneous tissues and skin"(3).

These basic description of the surgical steps offers a comprehensive overview of the direct anterior approach for total hip arthroplasty (THA), which later is useful in assessing its relevance to the rate of dislocation and to compare it with the other surgical approaches.

7.2.2 DIRECT LATERAL APPROACH

The lateral approach, which is also known as the transgluteal or Hardinge approach, has as an advantage, the excellent exposure to both the acetabulum and the proximal femur, making it a very popular method for Total Hip Arthroplasty.(3)
Therefore "DLA is the second most common surgical approach used worldwide for THA" (3).

The patient is laying in either the lateral decubitus or supine position, allowing good access to the hip joint and possible dislocation of the hip during surgery. (3, 19)
"A longitudinal incision is made extending 3–5 cm proximal and about 5–8 cm distal to the tip of the greater trochanter " (19). (See **Figure 4**)

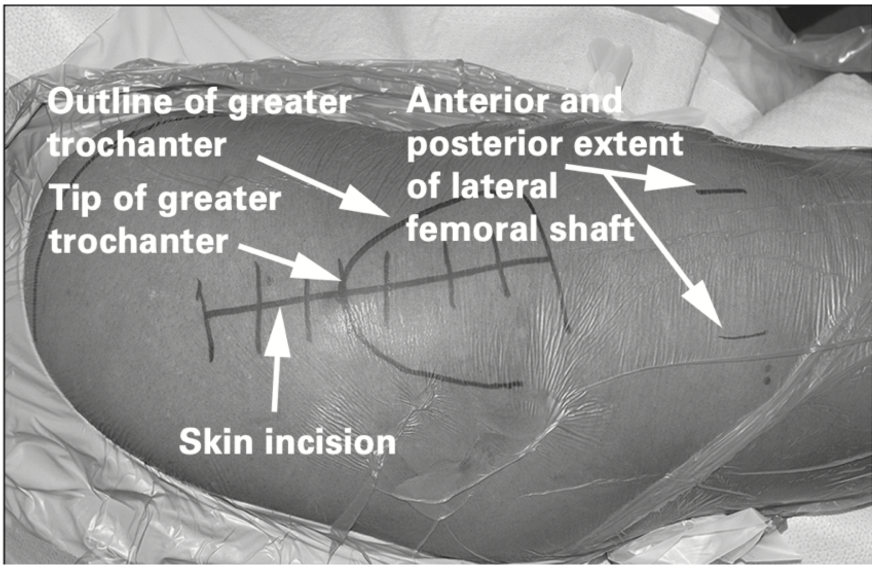

Figure 4: Anatomical landmarks in the direct lateral approach in (THA)

After incision of the skin, the fascia lata is exposed and incised longitudinally just anterior to the greater trochanter followed by the identification of the gluteus medius and vastus lateralis.(3)
"The tendon and muscle fibres of the gluteus medius are then visualized and split at the midway point between the most anterior and posterior extent of the muscle, or in a one-third anterior/ two-thirds posterior fashion"(19).
A cuff of the gluteus medius is preserved and important for later repair.
"The gluteus minimus and joint capsule are split either in line with the neck of the femur or in line with the tendinous fibres of the gluteus minimus"(19).

The next step differs from surgeon to surgeon, as some don't perform a capsulectomy and some do, facilitating an easier dislocation of the hip.
After Incision of the labrum the inferior femoral neck appears, and the hip is dislocated through external rotation, adduction and traction.(3)
In some cases, additional release of soft tissues is necessary to facilitate dislocation.
After the removal of the femoral head via osteotomy, the acetabulum is with the help of retractors exposed, prepared and reamed. Once the acetabulum is prepared and the cup is put into place, the surgeon continues with the femoral preparation.
"The leg is placed in a figure four position with the operative foot on the anterior portion of the contralateral knee and the ipsilateral knee flexed to 90°"(3). Extreme adduction and external rotation follow, which allows superior exposure of the femoral shaft and preparation until the desired implant size is achieved.(3)

After the trialing and final implant placement, the anterior flap, comprising of the gluteus medius, gluteus minimus, anterior capsule, and anterior portion of the vastus lateralis, is reattached to its anatomical position and closed in a single layer using both interrupted and continuous suturing techniques.(3)

The lateral approach in total hip arthroplasty (THA) allows a good femoral and acetabular exposure, but a good handling of the abductor muscles and precise soft tissue repair is important to minimizing complications and ensuring an optimal patient outcome.

7.2.3 POSTERIOR APPROACH

The posterior approach (PA) is also known as the “Southern” or “Moore” approach, “is reportedly the most common surgical approach used worldwide for THA”(3).
It is also so common because the abductor muscles during visualization of the acetabulum and the femur are being spared.(19) The following part describes the surgical steps of the posterior approach.
“Similar to the direct lateral approach, for the posterior approach the patient is placed in the lateral decubitus position”(19). The pelvis is stabilized and hold by using a padded peg-board along with the strategical placement of four padded posts, two anterior at the level of the chest and pubic symphysis, and two posteriorly at the sacral and scapular region, ensuring minimal movement during surgery. (3)
Before the surgery the operative hip is test on stability and maneuverability as well as securing the ipsilateral arm and preparing sterilization of the operating limb. (3)

Figure 5: Patient positioning and incision marking for the posterior approach in (THA)

“The skin incision begins 5 cm distal to the greater trochanter, centred on the femoral diaphysis”(19). (see Figure 5)
The incision is then extended beyond the greater trochanter and then either curves 6 cm toward the posterior superior iliac spine or continues in line with the femur when the hip is flexed to 90°. (19)

The skin and subcutaneous tissues are then cut in line with this marking until the fascia lata and iliotibial band (ITB) are reached, where A longitudinal incision in the fascia lata and ITB is made, splitting these structures along the natural fibers of the gluteus maximus. (3) (19)
Deep dissection follows with the leg placed in internal rotation where the surgeon identifies the short external rotators (SERs) as well as the piriformis and detaches them carefully from their insertion at the Greater trochanter.(3)
After these muscles retract, the posterior capsule becomes clearly visible. Additionally, this retraction helps protect the sciatic nerve. (3)
Next the T-shaped capsulotomy of the femoral head and neck follows, as well as dislocation of the hip through adduction, flexion, and traction. (3)
“If dislocation is difficult, additional release of the external rotators can help”(3).

“Once the osteotomized bone is removed, access is gained to the acetabulum and proximal femur”(19).
In general you can say that the height of the osteotomy depends a lot on correct preoperative planning with the lesser trochanter used as a landmark.(3)
With the aid of retractors, the acetabulum is visualized and reamed precisely, loose tissue is debrided, and the cup is properly positioned to achieve the correct inclination.(3)
“After cup placement, the leg is internally rotated, flexed, and adducted to deliver the proximal femur for preparation”(3).
With the knee flexed and the tibia positioned vertically, the leg serves as a reference for the surgeon during broaching and component implantation.(3)
Following trialing and final component placement, wound closure is performed, including reattachment of the posterior capsule and short external rotators as well as closure of the fascia lata, iliotibial band (ITB), and gluteus maximus fibers followed by subcutaneous tissues and skin closure. (3)

This approach is adopted internationally because of its reliability and the good exposure it provides for both acetabular and femoral reconstruction.

This chapter provided an overview of just the surgical steps for the three main approaches in total hip arthroplasty (THA), followed now by a comparison of their different dislocation rates as well as introducing further surgical techniques aimed at preventing dislocation after total hip arthroplasty (THA).
Therefore, it is also essential to understand the mechanisms of dislocation itself and the most common directions in which hip dislocations occur.

7.3 MECHANISM OF DISLOCATION IN TOTAL HIP ARTHROPLASTY (THA)

THA dislocation remains a leading cause of revision surgery, with a significant proportion of annual hip revision procedures being performed to address this complication. (5)
“In the international literature and registers, data on the annual rate of THA dislocations after primary THA vary between 0.2% and 10%”(5).
Since this work aims to present different approaches and compare techniques for reducing dislocation rates after total hip arthroplasty (THA), it is essential to first understand the mechanism of dislocation itself, as it remains one of the most common complications.

THA dislocation occurs when there is a complete loss of contact between the artificial components of a hip joint, indicating that there is a failure in the joint's mechanics that should have been maintained by the prosthetic implant.(5)
The goal of the implant is to ensure proper load transfer between the pelvis and femur while at the same time allowing natural movement in multiple directions and maintaining optimal muscle function reached successfully by correct positioning of the cup and stem, correct inclination and rotation angles, restoration of the hip's rotational center, and preservation of leg length and offset.(5)
When a dislocation occurs after a total hip arthroplasty (THA), the timing of the event plays an important role in assessment. Dislocations can therefore be classified into early and late postoperative dislocations.
While definitions regarding the classifications vary, many authors define early dislocation as occurring within 6 weeks to 6 months postoperatively, with the majority, around 75% of all dislocation cases, happening within the first 6 weeks.

Early dislocations generally have a more favorable prognosis, whereas late dislocations, beyond 6 months postoperatively, are significantly rarer and often present greater challenges in treatment and prevention.(20)
Whereas early dislocations are most often caused by insufficient tissue tension or improper component positioning, late dislocations are more frequently attributed to material failure.(5)
"Depending on the mechanical cause, 3 dislocation directions can be observed, even though dislocation direction and component positioning are not necessarily related"(5).
Dislocations are classified based on their direction into posterior, anterior, and superior dislocations.(20)

Although posterior dislocation is the most common type, the dislocation direction depends on the surgical approach.
A study by Woo and Morrey analyzing 10,500 hip prostheses found that with a posterior approach, 77% of dislocations were also posterior. In contrast, with an anterior approach, posterior and anterior dislocations occurred at almost equal rates (46% each) and with a lateral approach in (THA), 50% of dislocations were anterior, 34.6% were posterior, and 15.4% were superior.(20)

Dislocation typically occurs after various specific movements of the patient.
Posterior dislocation is commonly triggered by deep hip flexion combined with adduction and internal rotation, anterior dislocations tends to happen during hip extension with external rotation as well as excessive adduction, superior dislocations can happen when the hip is extended with extreme adduction and a highly vertically positioned acetabular component. (20)
In general you can say „a range of patient- and surgery-related risk factors can be associated with postoperative dislocations"(21).
Understanding different types and mechanisms of dislocation after total hip arthroplasty (THA) is unavoidable in developing effective preventive strategies and in understanding what risk factors there might be.

Following **Figures 6-8** show typical X-ray images of patients with posterior, anterior, posteriosuperior dislocation.

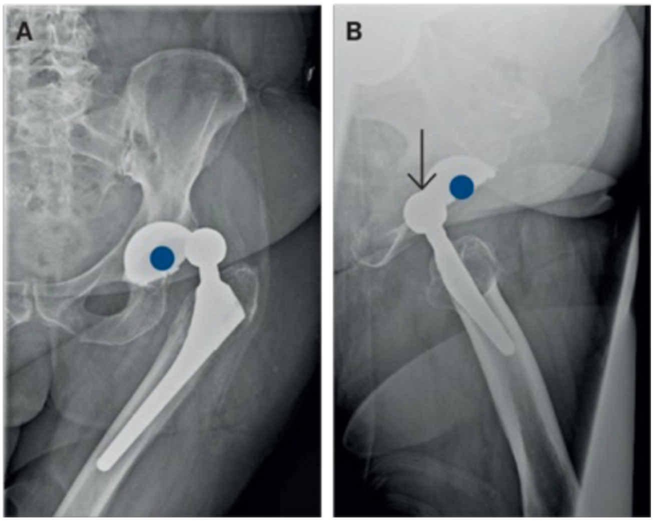

Figure 6: Radiographic image of a posterior dislocation after (THA) in anterior- posterior view; the center of the cup is marked with a blue dot.

Figure 7: Frontal X-ray of the pelvis; anterior dislocation of a left total hip replacement

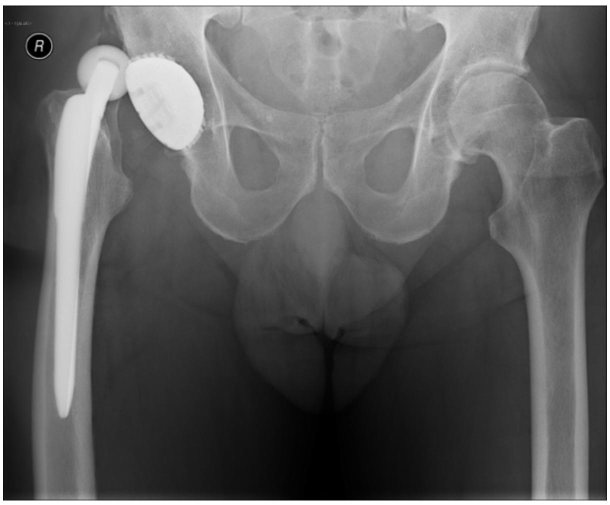

Figure 8: posterosuperior dislocation of a right hip

In general, you can say that the risk of dislocation after (THA) is influenced by multiple factors, each of which must be looked at and analyzed individually. Broadly you can classify into three main categories: preoperative, intraoperative, and postoperative risk factors, each playing a distinct role in determining joint stability and in the development of a dislocation after a total hip arthroplasty.

While the next chapter will provide a brief overview of preoperative and postoperative risk factors, as they also play an important role in the potential development of dislocation after THA the primary focus of this work remains on intraoperative surgical considerations which will be discussed afterwards.

7.4 PRE AND POSTOPERATIVE RISK FACTORS FOR DISLOCATION AFTER TOTAL HIP ARTHROPLASTY (THA)

The risk of dislocation after total hip arthroplasty (THA) is influenced by different factors, which as mentioned already, can broadly be classified into preoperative, intraoperative, and postoperative risks.

The table below provides an overview of the main preoperative and postoperative risk factors This chapter offers a summary of the most relevant factors in these two categories which are also important in the development of dislocation after (THA), but do not play a key role in this work.

Preoperative_and_Postoperative_Risk_Factors	
Preoperative Risk Factors	**Postoperative Risk Factors**
Prior hip surgery	Non-compliance
Prior Spine pathology as well as disturbed spinopelvic and hip-spine relationship	Inadequate positioning or movement of the leg
Female gender	Trochanteric fracture, pseudarthrosis, migration
Body weight	Interposition of soft tissue
Cerebral disorders	Multiple dislocations
Neuromuscular disorders	Fall prevention
Alcohol abuse	
Older age	
Anesthesiologic risk	

Avascular necrosis, femoral neck fracture, hip arthritis,	
Patient education	

Table 1: pre and postoperative risk factors for dislocation followed a (THA)

One of the highest risk factors for dislocation is a history of prior hip surgeries as studies have consistently shown that revision procedures have at least twice the dislocation rate compared to primary THA.(20)
This is likely due to progressive deterioration of soft tissues and bone loss associated with multiple surgical intervention, making correct anatomical reconstruction difficult and at the same time hard to achieve adequate joint stability.

Also, another risk factors for perioperative dislocation include the static spinopelvic parameters, concluding a lumbo-pelvic mismatch (>10°), a high pelvic tilt (>19°), and low sacral slope when standing. A high combined sagittal index >245° indicates increased anterior instability risk, while <205° suggests posterior instability.(22)

Gender has also been discussed as a potential risk factor.
"Female sex seems to have a higher (double) incidence of this complication compared to the male population" (23).
Although there are other reports in literature with no significant difference or even a greater occurrence in men. (20)
Body weight also plays a role, "obesity was found to increase the dislocation rate by 113.9% every 10 points of Body mass index (BMI) elevation" (23).
Also, the existence of neuromuscular and cognitive disorders, like for example Dementia, cerebral palsy, increases the risk of dislocation after Total hip Arthroplasty (THA).
A study from Stanford University reported that 13% of patients who experienced dislocation up to the first three months postoperatively, had brain dysfunction, compared to only 3% in the unaffected population.(23)
Alcohol abuse increases also the risk of dislocation after (THA).(20)
Advanced age is also one of the highest risk factors for dislocation after (THA), with rates ranging from 9.2% to 15.2% in patients over 80 years. This increased risk could be due to a higher prevalence of femoral neck fractures, reduced muscle function, impaired proprioception and neurological deficits, which can all contribute to joint instability. (20)

A higher anesthesiologic risk, ASA score of 3-4, is also associated with an increased risk of dislocation after (THA), with a 1.5-fold rise in risk per point. (23) "Mainly due to the difficulty of multi-pathological patients to correctly follow postoperative rehabilitation"(23).

The underlying diseases play also a preoperative risk factor for the development of dislocation after (THA). Based on a retrospective analysis by Berry et al., who examined 6,623 primary THA cases, Mazoochian et al. identified underlying pathologies such as hip arthritis, avascular necrosis, and femoral neck fractures as significant preoperative risk factors.(20)
Rheumatic hip arthritis is widely recognized as a very high risk factor in the development of hip dislocation after (THA), whereas congenital hip dysplasia does not appear to be associated with an increased risk of hip dislocation after total hip arthroplasty.(11)

Regarding patients' education, patients are often taught to avoid certain movements and are given assistive devices like raised chairs or toilet seats to prevent dislocation. However, this kind of education mostly happens after already a (THA) was performed and not preventionally preoperatively. Also, current research shows that the evidence to confirm these precautions to significantly reduce dislocation risk is not strong enough. Still, patient education and safe movement stays important in the guidance of the patient after a performed (THA).(24)

Therefore postoperative patient compliance is important in preventing dislocation after (THA), as adequate movement restrictions significantly impact joint stability and recovery.(20)
Without the correct compliance, patients are at a higher risk of developing severe complications such as trochanteric fractures, pseudarthrosis, migration, and interposition of soft tissue, all of which can ultimately lead then further to dislocation of the hip prothesis.
In one study approximately 4% of cases, where hip dislocation occurred, was because of direct trauma, such as a fall. Therefore, implementing fall prevention strategies after total hip arthroplasty is not in the main focus of prevention in regarding the lowering of dislocation rates but rather goes under the definition of correct compliance of the patient.(20)

In conclusion, understanding pre- and post-operative risk factors for dislocation after total hip arthroplasty is essential for identifying high-risk patients and in the development of targeted preventive strategies. While some of these factors, such as demographics and comorbidities, cannot be modified, optimizing surgical planning, patient education, adequate compliance minimizes the risk of dislocation and improving therefore long-term outcomes following Total hip arthroplasty (THA).

Having established the key pre-and post-operative risk factors for dislocation, it is now essential to shift the focus to intraoperative – surgical considerations, as this is the main part of this work. The following sections will explore critical surgical decisions, including the choice of surgical approach, prosthetic components, implant positioning and more, all of which influence joint stability and show different rates of dislocation prevention after total hip arthroplasty (THA).

8 RESEARCH RESULTS

8.1 SURGICAL APPROACHES IN TOTAL HIP ARTHROPLASTY: IMPACT ON DISLOCATION RATES

The choice of the surgical approach plays a big role in determining the stability of the hip prosthesis. Over the years, various approaches namely the direct anterior (DAA), lateral and posterior, have been developed and refined. The surgical steps for these three approaches have already been demonstrated earlier in this work. Now, a detailed literature review has been conducted to determine which approach has the most favorable impact on the dislocation rate after a performed total hip arthroplasty (THA).

The following table provides a brief overview of the key findings from the literature, summarizing the name, scope and design of the study, comparisons between different surgical approaches, use of capsular repair, and the main conclusions.

Author(s)	Study Details	Number of THAs	Surgical Approach compared	Capsular Repair	Key Findings / Conclusion regarding dislocation rate
Berry et al. (2005)	Large retrospective registry analysis	>21,000	Posterior, Anterolateral, Lateral	Not specified	Posterior approach had higher 10-year dislocation rate (6.9%) compared to anterolateral

					(3.1%) and lateral (3.4%)
Masonis & Bourne (2002)	Literature review	13,203	Posterior, Lateral	Yes, soft tissue repair reduces rate	Posterior: (3.23%) dislocation rate (increased to 3.95% without repair), Direct lateral: (0.55%) dislocation rate
Kwon et al. (2006)	Systematic literature review	4115	Posterior, Anterolateral, Lateral	Yes	Posterior without capsular repair: (4.46%), dislocation rate, with repair: (0.49%); Anterolateral: (0.70%), Lateral: (0.43%)
Docter et al. (2020)	Systematic review and meta-analysis Pro and retrospective	283,036	DAA, Lateral, Posterior	Varied	DAA and lateral had (50–75%) lower risk of dislocation than posterior
Huang et al. (2021)	Systematic review and meta-analysis	24,853	DAA vs Lateral	Not specified	DAA: (0.77%), Lateral: (0.18%) dislocation rate
Charney et al. (2020)	Retrospective database study	38,399	DAA vs Posterior	Not specified	DAA had lower dislocation and revision rate than posterior approach
Ang et al. (2023)	Systematic review and Meta-analysis	2010	DAA, Lateral, Posterior	Varied	No significant difference in dislocation risk;

					DAA better early recovery
Khatod et al. (2006)	Registry analysis	1693	posterolateral, anterolateral, transtrochanteric	Not specified	No significant difference found in dislocation rates regarding different approaches
Jolles & Bogoch (2006)	Cochrane review Systematic review, prospective	241	Posterior vs Lateral	Yes, posterior repair reduces risk of dislocation	No significant difference; trend toward lower rates with lateral and repaired posterior
Aggarwal et al. (2019)	Single-center study; retrospective	3574	Posterior vs Anterior	Not specified	Dislocation rates are similar (Anterior: 1.28%, Posterior: 0.84%); anterior had more other complications
Miller et al. (2018)	Systematic review prospective and retrospective studies	157,687	DAA vs Posterior	Not always	DAA: lower dislocation rate then in posterior, as well as lower infection, reoperation rate; higher nerve injury reported
Regis et al. (2024)	Literature review; observational study of the Swedish Hip	156,979	Posterior, Lateral, Anterior	Yes, posterior repair improves outcomes	Posterior still has the highest risk of dislocation (due to muscle damage); capsular repair

	Arthroplasty Register.				reduces risk drastically

Table 2: Summary: Surgical Approaches & Dislocation Risk

Historically, a lot of studies reported that the posterior approach has higher dislocation rates compared to lateral approaches. For example, Berry et al. analyzed over 21,000 primary total hip arthroplasties and found that the posterior approach had a 10-year cumulative dislocation rate of approximately 6.9%, which was higher than the rates observed for the anterolateral 3.1% and lateral approaches which had approximately 3.4%.(25).
Similarly, Masonis and Bourne reviewed the literature and reported in their work dislocation rates of 3.23% for the posterior approach overall, noting as well that when soft tissue repair was not performed, rates increased to 3.95%, whereas the direct lateral approach came along with a very low dislocation rate of 0.55%. (26)

In contrast, the evolution of surgical technique over recent years has led to improvements in outcomes with the posterior approach.
A systematic review and "meta-analysis of the posterior approach determined that there is a substantial increase in
relative risk of dislocation without a capsular repair"(27).
These specific meta-analyses demonstrated that the posterior approach without soft tissue repair had a dislocation rate of around 4.46%, but when a repair of the capsule and short external rotators was performed, the dislocation rate dropped drastically to approximately 0.49%. (27)
In the anterolateral approach the dislocation rate was 0.70%, and in the direct lateral approach 0.43%. (27)
This finding is interesting because it shows that the historically higher dislocation rate after (THA) while using the posterior approach can be effectively lowered by modern repair techniques, such as soft tissue repair, thereby closing the gap in levels of stability between the posterior and lateral approaches.

Another systematic review showed that when comparing the direct anterior (DAA) and lateral approach with the posterior group, the risk of dislocation was 50%–75% lower. (28)
Although these results depend also drastically on other factors such as implant positioning and soft tissue handling, especially the soft tissue repair in the posterior approach, a clear difference in dislocation rate between these surgical approaches is visible here. (28)

The direct anterior approach (DAA) is another surgical approach that gained popularity due to its muscle-sparing nature and potential for fast early recovery.
Huang et al. compared the direct anterior approach (DAA) with the lateral approach in a systematic review and meta-analysis involving 23,028 performed Total hip arthroplasties.
The direct anterior approach (DAA) showed a dislocation rate of 0.77% versus 0.18% in the lateral approach. (29)
This shows evidence that the dislocation rate in the direct anterior approach is significantly higher than in the lateral group.

Another study from 2020, which included the results of 38,399 Total hip arthroplasties and a follow up of 2 years, showed that the direct anterior approach in (THA) provided a lower risk of dislocation and fewer revisions for instability compared to the posterior approach. (30)

The literature also showed studies such as a metanalyses from 2023 which included a total of 2010 patients, which found no significant differences in risk of dislocation between the different approaches.(8)
These findings contrast with most previous studies that identified the posterior approach as having the highest dislocation risk. Although the (DAA) approach is superior in early functional outcomes and shorter hospital stays.(8)
In another study from 2006 with 1693 patients, researchers compared dislocation rates across the surgical approaches and found no statistical differences. They then contrasted their findings with a 1990 study, which reported that the anterolateral and trans trochanteric approaches showed lower dislocation rates then the posterolateral approach.(31)

The Cochrane review by Jolles and Bogoch, found also no statistically significant difference in dislocation rates between different surgical approaches.(32)
However, the data indicated that an additional capsular repair in the posterior approach significantly reduces the risk of dislocation and also showed a trend towards lower dislocation rates with the lateral approach compared to the posterior approach, but their evidence was not strong enough for final conclusions.(32)

Another study from a single large volume arthroplasty center with an inclusion of 3574 patients between 2011 and 2016 with a follow up of at least 2 years showed that the overall complication

rate was lowest with the posterior approach 5.85% and highest with the anterior approach 8.50%. (15)
Although the dislocation rates between the anterior approach with 1.28% and posterior approach with 0.84% were not significantly different, the higher overall complication rate with the anterior approach was driven by increased rates of wound drainage, deep infection, and periprosthetic fractures.(15)
This analysis suggests that even if dislocation rates appear similar between some approaches, other complications may detract from the overall benefit.

A systematic review from 2018 analyzed both prospective and retrospective studies with a minimum mean follow-up of one year. The review included five single-center comparative studies with 6,620 patients and four multi-center registries with 157,687 patients and compared the complication rates in relation to the different surgical approaches.
Their meta-analysis indicates that the anterior approach was associated with a lower risk of dislocation, infection, and reoperation compared with the posterior approach, although the anterior approach also carried a higher risk of nerve injury.(33)
That illustrates that even with a lower dislocation rate and early functional benefits with the anterior approach, the anterior approach still has other complications which also must be taken into consideration to be able to evaluate the overall outcome for the patient.

In another literature review, Regis et al. identified several factors playing a role in dislocation, including demographics of the patient, spinopelvic mobility, implant positioning, and the chosen surgical approach.
According to this review and through the analysis of the Swedish hip arthroplasty register, the posterior approach still has a higher dislocation rate than the anterior and lateral approaches of (THA), primarily due to greater damage to the external rotator muscles rather than component misplacement.(23)
But it is also stated again that the importance of a posterior capsule repair, can significantly increase stability and reduce dislocation rate bringing the rate close to the rate of the lateral approach.(23)

Nevertheless, the surgical approach still appears to play a role in the stability of a hip prosthesis and in preventing dislocation.
Historically, the posterior approach has been associated with higher dislocation rates compared to the anterior and lateral approaches. However, with modern soft tissue repair techniques, the dislocation risk shrinks to levels almost comparable to the other approaches. Conversely, some

studies with also a relevant number of patients have found no significant differences in dislocation rates among the anterior, lateral, and posterior surgical approaches. What remains consistent across the literature is that soft tissue repair in the posterior approach minimizes dislocation risk after total hip arthroplasty (THA). The relevance of these findings in the literature will be further explored in the discussion section of this work.

As demonstrated the choice of surgical approach plays an influence in dislocation rate after total hip arthroplasty (THA). Therefore, it is important to see that this factor is only one component of a multifaceted strategy to prevent dislocation after (THA). As mentioned, intraoperative decisions, such as performing a posterior capsular repair in the posterior approach, reduces the risk of dislocation significantly.

This shows a key example of how intraoperative considerations can directly influence surgical outcomes and contribute to a lower complication rate.

Therefore, other surgical considerations such as the selection of the prothesis, femoral head size, use of advanced technologies, head to cup ratio, skill of the surgeon and more play important roles in giving joint stability and decreasing the level of dislocation.

In the following chapters, these intraoperative factors and surgical considerations, contributing to reducing the risk of dislocation after total hip arthroplasty will be presented and discussed later.

8.2 THE IMPACT OF FEMORAL HEAD SIZE SELECTION ON DISLOCATION RISK IN TOTAL HIP ARTHROPLASTY

Among different factors influencing hip stability, the size of the femoral head has according to various studies, an effect on dislocation rate after total hip arthroplasty.

Several studies provided evidence that increasing the femoral head diameter improves stability by increasing the head neck ratio and jump distance, leading to lower dislocation rates.

Girard et al. proposed a classification of the size of femoral heads into small (22–28 mm), medium (28–36 mm), and large (>36 mm) heads.(34)

“Large head diameters after hip resurfacing have been proven effective in terms of reducing the dislocation rate”(34).

The group with a femoral head size larger than 36 mm had a significantly lower dislocation rate, with (0%) dislocations, compared to a 1.25% dislocation rate in the group with a head size smaller than 36 mm.(34)

“Increased head diameter goes hand in hand with an increased head/neck ratio, decreased risk of impingement, and improved range of motion”(34).

Another retrospective cohort study Included 2572 primary performed (THA) with a 28 or 32 mm diameter femoral head between 2002 and 2009.(35)
Their findings showed that the dislocation rate in the 28-mm group was with 3.1% higher than the 32-mm group with 0.4%. (35)
These results show that even a moderate increase in head diameter can have a positive effect on joint stability and lower dislocation rate.

Further support for the importance of the femoral head size comes from research data presented by Tsikandylakis et al., who analyzed the different use of 28-, 32-, and 36-mm heads femoral head showing that the 28 mm head had a 67% higher risk for revision surgery resulting from dislocation.(36)
The author concluded that the use of a 32-mm head has the best compromise between stability and the risk of other complications.(36)

Another study with a cohort of 726 patients focused on functional outcomes and dislocation rates after the implementation of different head sizes.(37)
Although their research found no significant improvement in overall functional scores with larger heads, it showed that the use of a 36-mm or even bigger heads was associated with a reduced dislocation rate. (37)
Their findings show that the primary advantage of larger femoral may be just in enhancing stability rather than improving other aspects of function. They concluded their work that “there appears little advantage in using a femoral head > 36 mm in all patients undergoing THA”(37).

Bistolfi et al. compared the use of a 28 mm and 36 mm femoral heads in an otherwise homogeneous patient group, analyzing their dislocation rates within the first year after surgery.(38)
They found an 8 -times higher risk of dislocation when using a 28-mm head compared with a 36-mm head.(38)

Conversely, another study with a cohort of 1,757 patients found no direct association between femoral head size and early dislocation.(39) Most femoral heads used, were 32 mm or 36 mm, suggesting that increasing the size from 32 mm to 36 mm may not provide a significant benefit in reducing the dislocation risk.(39)

The long-term effect of different femoral head size on dislocation rate is very nicely shown in a large study including 21,000 primary total hip arthroplasties with head diameters of 22 mm, 28 mm, or 32 mm and a mean follow-up time of 9.5 years (25) This large reliable study concluded that the risk of dislocation was highest with smaller heads (22 mm), intermediate with 28-mm heads, and lowest with 32-mm heads. (25)
Although this effect was most pronounced with the posterolateral approach, suggesting a potential interaction between the surgical approach and femoral head size in influencing dislocation risk.(25)

Mazoochian et al. argued in their research on hip dislocation after primary (THA), that smaller femoral heads, such as 22 mm, limit the range of motion and thereby has a higher risk of dislocation, while larger heads provide greater stability, an improved head-to-neck ratio, and a wider range of motion, providing therefore a lower dislocation rate.(20)

A review of the Dutch Arthroplasty Registry including 269,280 primary THAs stated that "Increasing femoral head size up to 36 mm reduces revision for dislocation and improves overall revision rates for all approaches"(40).

In summary, the analyzed literature states that increasing the femoral head size from 28 mm to 32 mm, and even to 36 mm, is associated with a significant reduction in dislocation risk in primary THA. This is due to an improved head–neck ratio and increased jump distance, enhancing joint stability and lowering therefore dislocation rate of the prothesis.

While this chapter demonstrated the importance of femoral head size in reduction of dislocation risk in total hip arthroplasty, other surgical considerations must also be considered.
Advances in implant design, such as the dual mobility cup, offer an additional strategy for improving stability, reducing impingement, enhancing the range of motion without increasing wear. In the next chapter, potential benefits of dual mobility cups in reducing dislocation rates will be analyzed based on existing literature.

8.3 THE ROLE OF DUAL MOBILITY CUPS IN REDUCING DISLOCATION AFTER PRIMARY TOTAL HIP ARTHROPLASTY

The beginning of Dual mobility cups (DMCs) can be stated back to the 1970s as an innovative design in total hip arthroplasty (THA) with a goal of reducing postoperative dislocation.(41)

The dual mobility cup aims to reduce dislocation risk by combining two articulating surfaces: a larger one between the metallic cup and polyethylene insert for stability and a smaller one between the femoral head and the insert for controlled movement.(41)

This allows an increase in jump distance and minimization of impingement thereby affecting joint stability positively.

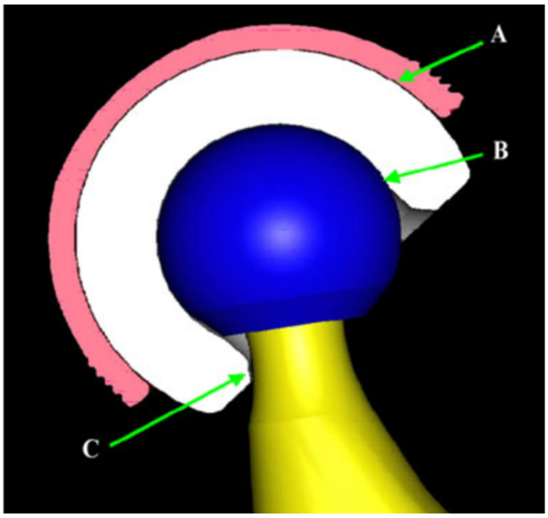

Figure 9: The dual mobility concept (A: The larger joint; B: The smaller joint; C: The third joint)

A research of 2010, analyzing 668 THA cases using Dual mobility cups with a mean follow-up of 16.5 years reported a dislocation rate of 1.15% in the long-term group demonstrating excellent long-term stability. (41)

In another study, total hip arthroplasties using a standard fixed polyethylene cup were compared to those with a dual mobility cup (DMC), including the analysis of 320 THAs with a minimum follow-up of ten years. (42)

A significant difference in dislocation rates was shown, it showed a 12.9% dislocation rate in the standard cup group versus a 0.9% dislocation rate in the dual mobility group.(42)

The rate of revision surgery due to recurrent dislocation was also significantly lower with the dual mobility cup prothesis, highlighting the effectiveness in reducing dislocation after THA.(42)

Chen et al. further assessed the performance of Dual mobility cups in a cohort of high-risk patients prone for dislocation. (43)

"Preoperative and postoperative pelvic tilt angles (PTA) and DMC orientation were prospectively collected for all patients"(43). The overall results showed a 1.0% dislocation rate, suggesting that DMCs provide strong stability even in elderly, high-risk patients.(43)

Although dual mobility cups show very good effectiveness in reducing dislocation risk, especially in high-risk patients, they are not routinely used in all primary (THA) procedures due to several reasons.

These include existing concerns over specific complications such as intra-prosthetic dislocation, of DM implants where the polyethylene liner detaches from the femoral head.
Additionally there is still a lack of long-term data, particularly in terms of younger, low risk patients group.(44)
Also concerns regarding fretting, corrosion, and long-term implant survival in younger patients receiving dual mobility THA remain.(45)
Therefore, further research is needed and for now the selection of a DM implant is reserved for selected cases with elevated risk for instability.

In summary, the literature states that the evolution of the dual mobility cup design significantly contributed to reducing dislocation rates following primary Total hip arthroplasty.
Through the effective head size enhancement with dual articulations, DMCs improves joint stability, minimize impingement and therefore decrease the level of dislocation in patients.

8.4 THE INFLUENCE OF CAPSULAR REPAIR ON DISLOCATION RISK IN PRIMARY TOTAL HIP ARTHROPLASTY

Capsular repair in total hip arthroplasty is an often-discussed topic among surgeons regarding its influence on the complication rate.
Since in 1979 Charnley advised against resecting the hip capsule to maintain better joint stability several studies have investigated the role of capsular management in reducing dislocation rates.(46)
A big part of literature and studies performed about total hip arthroplasties, now supports the fact, that preserving and repairing the capsule significantly decreases the risk of postoperative dislocation.

In a retrospective case-control study, 1972 cases of primary THA performed between 2002 and 2009 were investigated. Two distinct surgical techniques were compared: one group (n = 992) underwent a total hip arthroplasty with preservation and reconstruction of the hip joint capsule, and the other group (n = 980) a complete capsule resection was performed. (46)
The results were drastically, as the group with capsular repair had a dislocation rate of only 0.3% compared to 2.55% in the resection group, which approximated a reduction in dislocation risk of 88%. (46)

Preservation of the acetabular origin of the capsule is therefore essential and helps to restore the anatomy of the hip joint and increases joint stability in the early postoperative period.
As dislocations mostly occurred within the first six postoperative weeks in cases where a capsule resection was performed, the protective role of an intact and repaired capsule until a stable, scarred neocapsule is formed, is very important. (46)

In another systematic review from 2021 by Miranda et al. outcomes of capsular repair and capsulectomy in Total hip arthroplasty across 17,272 patients were compared.(47)
Patients undergoing capsular repair had a markedly lower dislocation rate 0.65% to those who underwent capsulectomy 3.06%, therefore proofing the effectiveness of a capsular repair.(47)
The study showed that performing a capsular repair in any surgical approach dislocation rates fall. In the anterior approach, dislocations decreased from 3.7% with capsulectomy to 0.69% with capsular repair, in the posterior approach from 2.4% to 0.64%, and in the lateral approach from 3.89% to approximately 0.64%. (47)

8.5 THE INFLUENCE OF SURGEON EXPERIENCE ON DISLOCATION RATES AFTER THA

As dislocation risk after total hip arthroplasty is a multifactorial event where a lot of different factors play a role, the surgeon's experience and the case volume of each surgical center should also be considered as a contributing factor which could cause dislocation.
In this chapter, the impact of surgeon experience on dislocation rates after THA is being reviewed by analyzing the literature on this topic.

A community-based joint registry analysis evaluated risk factors for dislocation after THA, including also surgeon volume, but found no association between a high-volume surgeon (>30 cases/year) and low-volume surgeons, contradicting Katz et al. who found higher dislocation rates in surgeons performing <5 THAs annually 4.2% compared to those performing >50 1.5%.(31)

In contrast, a study from 2024 clearly indicates that surgeons with at least 30 cases per year tend to have lower dislocation rates.(48)

They categorized surgeons into three groups based on annual case volume (<30, 30–60, and >60 cases/year) and found that surgeons performing fewer than 30 DAA-THAs per year had the highest overall complication rates, including dislocations. (48)

Supporting the importance of experience, D'Angelo et al highlighted that less experienced surgeons have almost double the dislocation rates compared to experienced colleagues.(49)
Also noting that if a threshold of approximately 30 THA procedures is surpassed, the dislocation rates of less experienced surgeons begins to approach those of experienced surgeons. (49)
This statement was supported by Mazoochian et al. who also stated that surgeons with THA procedures of less than <30 a year, had higher dislocation rates, then those with more experience.(20)

Controversially a few studies mentioned that "Dislocations were not more common in THAs placed by less experienced surgeons"(50).
To summarize this chapter, it seems that most studies state that surgeon experience appears to influence dislocation rates after THA in a positive way.

8.6 THE INFLUENCE OF LEG LENGTH AND OFFSET CHANGES ON DISLOCATION RISK AFTER PRIMARY TOTAL HIP ARTHROPLASTY

Part of total hip arthroplasty's goal is to restore native hip biomechanics. Leg length and offset are generally also considered as critical parameters to optimize soft tissue tension and joint stability, making it essential to understand their impact on dislocation risk.

In fact, the discrepancy in the literature regarding this topic is quite high, while some studies say that leg length and offset changes play an influence on dislocation risk after primary total hip arthroplasty, others do not support this point.

Although "Historical perspectives noted a positive correlation between decreased offset and dislocation"(51),a large retrospective study from 2025 with 12 582 Patients found no statistically significant association between leg length or offset changes and dislocation risk.(51)
The findings of this study therefore showed that millimeter-level differences may have less impact on reducing dislocation risk after THA than assumed in earlier studies.(51)
"These results may also suggest that surgeons do a good job of restoring native LL and offset for patients, which may mitigate their analyzed impact"(51).

This statement is being supported by Leichtle et al. who also found no association between dislocation occurrence and femoral offset.(51)

Nevertheless Heckmann et al. observed that insufficiently restored hip offset was often found in hips that had a pervious dislocation after a total hip arthroplasty.(52)
Another author argumented that “restoring femoral offset is more critical for THA stability than achieving LL equality or optimal acetabular component position”(51).
In general, you can state that there are some studies who align with the theory that leg length difference plays a role in postoperative hip dislocation, although many studies lack credibility and evidence that there is an association between Leg length and dislocation risk.(51)

8.7 THE IMPACT OF PROPER PROSTHETIC COMPONENT POSITIONING ON DISLOCATION RISK AFTER THA

The correct positioning of prosthetic components in total hip arthroplasty (THA) is highly important in providing postoperative stability, long-term implant survival and to minimize the risk for a dislocation of the hip after the surgery.
Since Lewinnek et al. introduced in 1978 the “safe zone” for acetabular cup placement (40° ± 10° inclination and 15° ± 10° anteversion), the field evolved to understand that to look only at static positioning alone may not be enough and the functional position of the patient should also be taken into consideration, suggesting an inclination between 35° and 40° and anteversion of 45°.(23)

Even though the safe zone proofed to have lower dislocation rates, 1.5% when the cup was within the safe zone compared to 6.1% outside it, research demonstrated that functional pelvic dynamics play a crucial role, especially in patients with rigid or hypermobile pelvises.(23)

Also, the correct alignment of both the femoral stem and acetabular cup is essential in reducing dislocation risk after total hip arthroplasty. Specifically done by achieving a balanced anteversion. Therefore, a correct orientation of both components, with targeting a standing combined sagittal index between 205° and 245°, optimizes joint stability, particularly in patients with altered spinopelvic mobility reducing the risk of dislocation.(22)

Advances and better technology in imaging, computational modeling, and even robotic assistance enables surgeons nowadays to optimize both acetabular and femoral component alignment, finding the right angle and thereby efficiently reducing dislocation risk.

8.8 THE EFFECT OF ROBOTIC TECHNOLOGY ON DISLOCATION RATE

Robotic assistance in the medical field has gained a lot of popularity over the recent years due to the fast advances in technology and in AI.
There has also been a change in approach in total hip arthroplasty (THA), where robotic assistant technology helps the surgeon to place the component of the prothesis more precisely.
"Since 1994, more than 17000 THAs have been performed with the Robodoc Surgical Assistant System (Sacramento, CA, United States), with controversial results"(23).

Although the robotic assistance with Robodoc significantly improved stem positioning leg length equality compared with manual surgery, it showed a drastically higher dislocation rate, 18% compared to 4% in conventional procedures.(23)
The increased dislocation rate resulted due to intraoperative muscle damage from the robotic milling system, highlighting potential limitations in early robotic systems.(23)

In contrast, further advancements in robotic technology have led to even newer systems which showed improved accuracy and safety profiles.
The MAKO robotic-arm-assisted system, integrates preoperative computed tomography into its planning and showed promising results regarding the dislocation rate.(23)
Research showed a 71% improvement in the accuracy of component positioning along with a significantly lower dislocation rate, 0% versus 3%, in patients followed for at least two years postoperatively. (53)

"In a meta-analysis and systematic review performed by Chen et al in 2018 involving 522 robotic-arm and 994 conventional THAs, better cup and stem placement, and global offset occurred in the first cohort"(23).
These results suggest that through the better placement of the cup and stem there is also a lower dislocation rate with the use of a robotic arm during total hip arthroplasty.

An additional advantage of robotic technology is the minimal learning curve surgeons need to make more precise component positioning, especially important for patients with a higher risk of instability, such as reduced spinopelvic mobility.(23)

In summary, while early robotic systems such as the used Robodoc are associated with increased dislocation rates due to intraoperative soft tissue trauma, more recent systems like the MAKO robotic-arm-assisted system showed improvements in placement accuracy and clinical outcomes.

8.9 PATIENT-REPORTED SATISFACTION FOLLOWING DISLOCATION AFTER PRIMARY TOTAL HIP ARTHROPLASTY

If a Dislocation after a primary total hip arthroplasty (THA) happens, this comprises as a significant complication that not only affects immediate postoperative recovery but also has long-term effects on the patient's well-being and overall satisfaction.
Before we discuss and sum up all the surgical considerations a surgeon can do to prevent dislocation after total hip arthroplasty, the reader should get an understanding how actually dislocation after (THA) impacts the well-being of the patient.

A large-scale, cross-sectional study choosing its data from the Danish Hip Arthroplasty Register, compared patients who experienced at least one dislocation after primary THA with a matched control group without dislocation, evaluating how dislocation after (THA) impacts both health- and hip-related quality of life.(54)

1,010 patients with dislocation and 2,008 matched controls with a follow-up period of an average of 7.2 years after the index surgery and 4.9 years from the latest dislocation were included and two established questionnaires about the overall health status, and the hi-specific Hip disability and Osteoarthritis Outcome Score (HOOS) were collected.(54)

The results showed that patients in the dislocation group showed drastically inferior outcomes. "Both health- and hip-related QoL were markedly and persistently reduced among dislocation patients compared with those in controls, for several years"(54).
Patient satisfaction was also affected negatively.
When asked to compare the current status of the operated hip with the condition before the surgery, nearly 90% of control patients described their hip as "much better" than before surgery, whereas only 70% of patients who had experienced a dislocation felt the same, and a smaller proportion (59%) rated the overall outcome as "excellent" or "very good" compared with 85% of controls.(54)
Also, only 80 % of the patients in the dislocation group would choose to undergo the primary THA again showing an even higher decrease in patient satisfaction among patients who required revision surgery, with 44% of these patients reporting a poor overall result.

These findings show that even a single dislocation after (THA) leads to a clinically relevant decrease in health-related issues and patient satisfactory.
“Therefore, the most important aspect must be to avoid the first episode of dislocation, since the full relieving potential for this THA never seems to be achieved, even after many years of follow-up”(54).

In summary, the study by Hermansen et al. gives significant evidence that dislocation after primary THA has a lasting negative impact on patient-reported satisfaction and outcomes, emphasizing the importance of surgical considerations aiming in preventing even the first episode of dislocation after total hip arthroplasty.

9 DISCUSSION

This work addresses one of the most challenging complications after hip arthroplasty, dislocation, by focusing on surgical considerations aimed to prevent such an event.
Throughout the review, each chapter tried to give distinct insights in the findings of the literature, how surgical considerations, techniques, intraoperative decisions, and modern technology combine to minimize dislocation risks after (THA) at its best.

Therefore, the reader received at the beginning an overview of the anatomy and biomechanics of the hip which is crucial to understand and think of strategies to prevent dislocation after (THA).
As explained in the anatomy section, the hip’s ball-and-socket configuration, reinforced by the capsule, ligaments and muscles provide essential stability for the hip joint.
Any disruption of these structures whether by muscle detachment or incorrect soft tissue handling can result in the prothesis to dislocate.
This anatomical base emphasizes the reader that every surgeon who performs total hip arthroplasties must carefully plan the intervention in order to restore not only the mechanical alignment and original anatomy but also to restore the physiological integrity of the hip, while at the same time trying to keep the level of complications, like dislocation of the hip, at a minimum.

To be able to fully understand and grasp the importance of the surgical approach on dislocation rate, the review of the three principal surgical approaches posterior, direct anterior, and direct lateral gave the reader an overview over the different surgical steps.
The literature shows different findings, which approach has the lowest rate of dislocation.

Historically, the posterior approach was thought to carry an increased risk of dislocation due to the damage of the short external rotator muscles and the posterior capsule, which play an important role in maintaining hip stability.

However, recent studies demonstrated that when soft tissue repair is performed with the posterior approach, specifically, the repair of the posterior capsule and reattachment of the external rotators, the dislocation rates drop to levels as with the anterior and lateral approach.

This evolution is important as it shows that prevention of dislocation is not only dependent on the correct selection of the surgical approach but also on correct intraoperative decisions, like as mentioned the repair of the posterior capsule, which has a significant effect on lowering dislocation rates after (THA).

The direct anterior approach, famous and known for its muscle-sparing nature and fast recovery uses an intermuscular and internervous plane which minimizes disruption to the surrounding soft tissues, therefore leading to reduced postoperative pain and a low dislocation rate. Nevertheless, some studies indicate that the dislocation rates with the (DAA) are slightly higher compared to the lateral approach, 0.77% versus 0.18% possibly due to factors such as implant positioning and the learning curve associated with the technique.

The overall advantages of muscle preservation and rapid early recovery still have made the (DAA) an important approach for many surgeons, especially in centers where the technique is well established.

Similarly, the direct lateral approach offers very good access to the hip joint, facilitating precise implant placement and in combination with a good abductor muscle handling minimizing the risk of dislocation after (THA).

Consequently, the literature states that the direct lateral approach remains a good method for lowering dislocation rates.

In summary, the choice of surgical approach in (THA) still plays an important role in reducing dislocation risk.

While the posterior approach used to have a higher risk of dislocation, careful soft tissue repair drastically lowered the dislocation rate. Both direct anterior and direct lateral approaches offer their own unique benefits, whether through muscle-sparing techniques or good joint capsule exposure both showing low dislocation rates with the lateral slightly below the (DAA). Nevertheless, a combination of choosing the appropriate approach and making precise intraoperative decisions is unavoidable in reducing dislocation rates and therefore optimizing patient outcomes.

Another important surgical consideration to prevent dislocation or reduce dislocation rates, is the selection of femoral head size.

The literature consistently argues that larger head sizes increase joint stability by also increasing the head–neck ratio and jump distance. Several authors report that transitioning from 28 mm to 32 mm and even to 36 mm significantly reduces dislocation risk.
However, the benefit appears to stop beyond a certain size, suggesting that the optimal head diameter must be balanced against other risk factors and potential complications.
This understanding underscores that surgical considerations for dislocation prevention are multifactorial and that there actually is not only one decision that can entirely prevent the hip from dislocating after a performed (THA).

Another part of the multifactorial aspect in the prevention of dislocation is the choice of the prothesis and the incorporation of dual mobility cups (DMCs), which represent another innovative surgical strategy to reduce dislocation risk after a performed total hip arthroplasty.
The dual mobility design works by combining two articulating surfaces, therefore increasing the functional head diameter and reducing impingement.
The Literature research demonstrated that (DMCs) are particularly important in high-risk populations, as they drastically lower dislocation and revision rates compared to standard fixed cups. In all analyzed studies, the implementation of a dual head prothesis resulted in a significant decrease of dislocation rates after performed (THA).
(DMCs) are not used in all cases of (THA), due to concerns about complications like intra-prosthetic dislocation, limited long-term data, especially in younger, low-risk patients, and potential issues such as fretting, corrosion, and implant longevity.
As a result, they are currently used for patients with higher risk of instability.

As already stated, capsular repair states another cornerstone of successfully lowering the dislocation rate after (THA).
The literature reviewed shows that preserving and reconstructing the hip capsule significantly lowers early postoperative dislocation rates, no matter which surgical approach the surgeon choses.
Therefore, capsular repair helps to maintain the natural biomechanical function of the hip joint and provides stability during the critical early healing phase, where most dislocation happens. Whether the surgeon chooses a complete preservation or selective reconstruction of the capsule, the key message remains that careful soft tissue handling is highly important and can lower dislocation rates up to 88%.
In general, you can say that the surgeons aim should be to reach the basic native anatomy of the patient to provide the highest stability for the hip joint.

As the title of this work is the prevention of dislocation after THA, surgical consideration, it should also be a surgical consideration if the volume of performed THA operations and the collected work experience of the surgeon, plays a role in successfully lowering dislocation rates.
The literature analyzed, suggests that high-volume surgeons in general have lower complication rates, including dislocation rates. Throughout the literature results showed, that if a general threshold of 30 performed (THA) procedures is surpassed, the dislocation rates begin to sink. Although one study found no significant decrease in dislocation rates in less experienced surgeons, most of the literature agrees with the influence of surgical experience on dislocation rates and in general it makes sense that the more experienced surgeons have lower complication rates,

Furthermore, the additional use of technologies such as robotic-assisted surgery systems (e.g., MAKO systems) demonstrated improved accuracy with up to 71% in the placement of the prothesis, which therefore increases joint stability.
Although the literature stated that early robotic systems like the Robodoc had higher dislocation rates, the further development in technology showed a significant change in dislocation rate with the use of advanced placement assisted systems, also due to the fast learning curve of the surgeon with these systems.

An often-debated question in literature is the impact of leg length and offset restoration on dislocation risk after total hip arthroplasty.
While some historical studies showed a correlation between inadequate restoration of leg length and instability - dislocation, recent large studies showed no correlation between these parameters. Therefore, the study with over 12 000 patients argues that modern surgical techniques already largely succeed in restoring these parameters within acceptable ranges therefore eliminating the measurable impact of leg length discrepancy on dislocation rate after (THA).
The correct positioning of prosthetic component, particularly in relation to Lewinnek's safe zone, has showed to have also an effect on the stability of the joint and decreasing dislocation rates. With modern imaging, preoperative computer-assisted planning, and even robotic guidance, surgeons can achieve nowadays an almost optimal component alignment.
However, it is also shown that the placement of the cup in the "safe zone" is not an absolute guarantee of stability as other factors such as pelvic tilt and patient activity level play a role in dislocation risk.

The ongoing discussion in literature regarding correct positioning strategies, surgical approaches, and operative techniques highlights that effective dislocation prevention relies on a combination of already established surgical principles and innovative technologies.
Therefore, rather than a singular solution, reducing dislocation rates requires a multifactorial approach.
Based on the review of the literature, recommendations for managing high-risk patients undergoing total hip arthroplasty emphasizes a multifactorial approach as well, to minimize dislocation risk. This includes selecting either the direct anterior approach or the posterior approach with capsular repair, depending on the surgeon's experience and volume of surgical center.
Furthermore, the use of a dual mobility (DM) cup is strongly advised in these patients, as it provides additional stability in high risk patients. Equally important is correct patient education focused on postoperative precautions and movement control, especially during the early recovery phase.

The necessity of identifying the correct multifactorial approach is reflected in patient-reported outcomes and satisfaction data, which shows the clinical relevance of these surgical considerations. As stated in studies, Dislocation after THA is associated with a persistent decline in quality of life. Furthermore, a reduced patient confidence, and an increased need for revision surgery was found. Even a single episode of dislocation following a total hip arthroplasty can initiate a downward spiral from which the patient may never fully recover, having a significant influence on the life of the patient and increasing the risk for further comorbidities.
Therefore, each element discussed, from the choice of approach and implant to the precise reconstruction of soft tissues, contributes to the overall reduction of dislocation and therefore improved quality of life for the patient.
In summary, the discussion of the different chapters, ranging from the fundamental biomechanics of the hip to different surgical techniques and approaches, consistently leads back to the title of this literature review: Prevention of Dislocation After Total Hip Arthroplasty through different approaches: surgical considerations.

Therefore, each surgical decision, whether it involves the selection of the approach, the sizing of the femoral head, the use of dual mobility implants, or the execution of capsular repair, is an integral part of a multifactorial strategy aimed at enhancing joint stability and reducing dislocation after a performed total hip arthroplasty.

Nevertheless, it is also important to emphasize that dislocation risk is influenced not only by intraoperative decisions but also by pre- and postoperative factors.
As highlighted earlier, preoperative risks, such as a history of hip surgery, female gender, obesity, advanced age, neuromuscular and cognitive disorders, and higher anesthesiologic risk, set the stage for potential complications. Postoperative factors, including patient non-compliance, improper leg positioning, and complications like trochanteric fractures or soft tissue interposition, further compound this risk.
Acknowledging also these non-surgical determinants, which are not the focus of this literature review, supports again the understanding that effective dislocation prevention after total hip arthroplasty requires more than only surgical considerations.
That's why a truly effective strategy in lowering dislocation rate must adopt a comprehensive, multilevel approach.

10 CONCLUSION

A good dislocation prevention strategy in total hip arthroplasty (THA) begins with a detailed understanding of hip anatomy and biomechanics.
Therefore, the preserving and sometimes necessary, the reconstruction of stabilizing structures, such as the capsule, ligaments, and surrounding musculature is essential and plays a difference between failure and success regarding dislocation rates.

Soft tissue management remains highly important in dislocation prevention, regardless of approach. Therefore, a meticulous capsular repair has been associated with reduced dislocation rates.
Surgical approaches that minimize disruption to these structures, such as the direct anterior approach or a well-executed posterior approach with reliable soft tissue repair, also significantly reduce dislocation risk.

Implant-related factors also play a key role.
Increasing femoral head size improves joint stability by enhancing the head–neck ratio and jump distance therefore lowering dislocation rates.
The use of dual mobility cups, especially in high-risk patients, reduces impingement and improves also overall stability through a dual articulation mechanism significantly reducing dislocation rates after (THA).

Surgeon experience and the integration of modern robotic-assisted techniques further help in correct component positioning, and therefore reduction of dislocation.

While the restoration of leg length and offset remains important, these factors appear secondary in preventing dislocation.
In summary, dislocation prevention in (THA) is a multifactorial event and there are no definitive recommendations to avoid any specific surgical approach. Each approach, whether anterior, lateral, or posterior, has its own advantages and disadvantages, not only in terms of dislocation risk but also with respect to other outcomes such as soft tissue preservation, other complication rates, and postoperative recovery.

Success depends on the integration of anatomical understanding, surgical technique, implant choice, soft tissue management, and technological support, working all together to achieve lasting joint stability, decreased dislocation rates and improved patient outcomes.

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ANNEXES

FIGURES

Figure 1: Anatomical overview over the articulating surfaces of the hip Joint ; TeachMeAnatomy; Link to the Website https://teachmeanatomy.info/lower-limb/joints/hip-joint/#section-67af2b993a727

Figure 2: Supporting ligaments of the hip joint; TeachMeAnatomy;
Link to the Website https://teachmeanatomy.info/lower-limb/joints/hip-joint/#section-67af2b993a727

figure 3: **3a** Positioning of the Patient on an operational table; **3b** landmarks of the skin incision on the patient; **3c** view on the anatomical structures after skin incision;
Moretti VM, Post ZD. Surgical Approaches for Total Hip Arthroplasty. Indian J Orthop. 2017;51(4):368-76.

Figure 4: Anatomical landmarks in the direct lateral approach in (THA)
Petis S, Howard JL, Lanting BL, Vasarhelyi EM. Surgical approach in primary total hip arthroplasty: anatomy, technique and clinical outcomes. Can J Surg. 2015;58(2):128-39.

Figure 5: Patient positioning and incision marking for the posterior approach in (THA)
Moretti VM, Post ZD. Surgical Approaches for Total Hip Arthroplasty. Indian J Orthop. 2017;51(4):368-76.

Figure 6: Radiographic image of a posterior dislocation after (THA) ; the center of the cup is marked with a blue dot.
Hermansen LL, Viberg B, Overgaard S. [Not Available]. Ugeskr Laeger. 2024;186(43)

Figure 7: Frontal X-ray of the pelvis; anterior dislocation of a left total hip replacement
Di Schino M, Baudart F, Zilber S, Poignard A, Allain J. Anterior dislocation of a total hip replacement. Radiographic and CT-scan assessment. Behavior following conservative management. Orthop Traumatol Surg Res. 2009;95(8):573-8.

Figure 8: posterosuperior dislocation of a right hip
Case courtesy of Sajoscha A. Sorrentino, Radiopaedia.org, rID: 16116
Link to Website: https://radiopaedia.org/cases/joint-dislocation-after-total-hip-replacement

Figure 9: The dual mobility concept (A: The larger joint; B: The smaller joint; C: The third joint)
Vielpeau C, Lebel B, Ardouin L, Burdin G, Lautridou C. The dual mobility socket concept: experience with 668 cases. Int Orthop. 2011;35(2):225-30.

TABLES

Table 1: pre and postoperative risk factors followed a (THA);

Input for the table:

Mazoochian F, Pietschmann MF, Hocke S, Fottner A, C VS-P, Jansson V. [Hip dislocation following THA]. Orthopade. 2007;36(10):935-8, 40, 42-3.

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Table 2: Summary: Surgical Approaches & Dislocation Risk

Input for the table:

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