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TOTAL HIP ARTHROPLASTY TECHNIQUES

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ABSTRACT

Introduction: *Total hip arthroplasty (THA) is one of the most effective and successful surgical interventions within the orthopedic specialty. THA offers consistent results for patients suffering from advanced degenerative osteoarthritis of the hip (OA), mainly by relieving pain, restoring function and improving overall quality of life.*
Objective: *detail current information related to total hip arthroplasty techniques, as well as anatomy, physiology, indications, contraindications, history, preparation, preoperative evaluation, technique, treatment and complications of total hip arthroplasty.*
Methodology*: a total of 42 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 30 bibliographies were used because the other articles were not relevant to this study. The sources of information were PubMed, Google Scholar and Cochrane; the terms used to search for information in Spanish, Portuguese and English were: hip arthroplasty, hip prosthesis, osteoarthrosis, osteonecrosis.*
Results: *analysis of the 30 articles reviewed reveals that the most commonly used surgical approaches for CTA are posterior, direct anterior (DA) and anterolateral, with the posterior approach being the most common, although it presents a slightly higher risk of postoperative dislocation. Wound closure technique plays a crucial role in preventing complications, and the use of barbed sutures and a sterile dressing is recommended to ensure stability and adequate recovery. Regarding deep vein thrombosis (DVT) prophylaxis, aspirin has proven to be an effective option, comparable to more traditional agents such as heparin. The most common complications identified in the studies were dislocations, periprosthetic fractures and wound-related problems, which require appropriate management during postoperative follow-up.*
Conclusions: *total hip arthroplasty (THA) is an effective and widely used procedure for the treatment of advanced osteoarthritis and other hip pathologies that do not respond to conservative treatments. Its evolution from its first applications in the 19th century to modern techniques has led to a significant improvement in clinical and functional outcomes, with a marked reduction in pain and improvement in patients' quality of life. Although the main indications for surgery include hip osteoarthritis and osteonecrosis, the technique should be tailored to the individual conditions and characteristics of each patient, considering factors such as anatomy, comorbidities and post-surgical expectations. A comprehensive approach during preoperative, surgical and postoperative management is essential to optimize outcomes and minimize complications.*
KEY WORDS: *arthroplasty, hip, prosthesis, osteoarthrosis.*

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INTRODUCTION

Total hip arthroplasty (THA) is one of the most effective and successful surgical interventions within the specialty of orthopedics. THA offers consistent results for patients with advanced degenerative osteoarthritis of the hip (OA), primarily by relieving pain, restoring function and improving overall quality of life. OA affects millions of people, with an incidence of approximately 88 symptomatic cases per 100,000 patients annually, making hip OA the leading diagnosis leading to CTA. Other associated diagnoses include osteonecrosis of the hip (ON), congenital malformations of the hip, and inflammatory arthritis. The underlying diagnosis causing the hip degeneration is a key factor, as it has been shown to influence the final outcome. Overall, total hip arthroplasty provides consistent pain relief in both the short and long term, with positive clinical and functional outcomes as reported by patients. Overall, total hip arthroplasty offers even more stable and reliable results than its equivalent procedure, total knee arthroplasty (TKA)(1-5).

METHODOLOGY

A total of 42 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 30 bibliographies were used because the information collected was not important enough to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar; the terms used to search for information in Spanish, Portuguese and English were: hip arthroplasty, hip prosthesis, osteoarthrosis, osteonecrosis.

The choice of bibliography exposes elements related to total hip arthroplasty (TC); in addition to this factor, anatomy, physiology, indications, contraindications, history, preparation, preoperative evaluation, technique, treatment and complications of total hip arthroplasty are presented.

DEVELOPMENT

Anatomy and Physiology

The hip is a synovial ball-and-socket joint. The stability of the hip joint is achieved by the dynamic interaction between the bony anatomical elements and the soft tissues. In this joint, the femoral head is almost spherical in shape and articulates with the hemispherical cavity of the facies lunata of the acetabulum. The surface of the articular cavity covers 50% of the area of the femoral head. The bony components comprise the proximal femur (head, neck, trochanters) and the acetabulum, which is formed from three distinct ossification centers (the ileum, ischium and pubic bones). The native acetabulum is oriented at an angle of 15 to 20 degrees of anteversion and 40 degrees of abduction. The femoral neck is oriented in a range of 15 to 20 degrees of anteversion and presents an angle of 125 degrees with respect to(6-9).

Indications

The most common indication for hip arthroplasty is end-stage symptomatic hip osteoarthritis. In addition, osteonecrosis of the hip, congenital hip disorders including hip dysplasia, and inflammatory arthritic diseases are common causes for hip arthroplasty. Osteonecrosis of the hip generally affects a younger patient population (between 35 and 50 years of age) and accounts for about 10% of annual hip osteoarthritis(5).

Contraindications

Hip infection or sepsis, active and continuous remote (i.e. extra-articular) infection or bacteremia, and severe cases of vascular dysfunction, among others specific to the individual.

History

Hip prosthesis models have undergone a process of improvement since the late 19th century, when Dr. Themistocles Gluck conducted a series of tests with various alternatives for joint replacements in preliminary animal trials. In 1890, one of the 14 total hip arthroplasty procedures reported by Dr. Gluck included a femoral head replacement using ivory in a human patient. In 1940, Dr. Austin Moore worked with orthopedic surgeon Dr. Harold Bohlman to design the first hip hemiarthroplasty (partial prosthesis) to treat displaced femoral neck fractures. In 1952, Dr. Moore created his renowned "Austin Moore prosthesis" as a globally available prefabricated joint replacement. In the 1960s, Sir John Charnley broke into the field by introducing the principle of "low friction arthroplasty" using a metal femoral stem and a small femoral head articulating with a cemented polyethylene acetabular component(10,11).

Modern Implants and Bearing Surfaces

Current hip arthroplasty techniques have progressed toward press-fit femoral and acetabular components. In general terms, femoral stems can be classified into the following main models:

- Press-fit, with proximal overlay and distal taper (can be double or single taper in the medial-lateral and/or anterior-posterior planes).
- Press-fit, fully overlapped, with diaphyseal coupling.
- Press-fit, modular stems: modular connection alternatives include: (1) head-neck, (2) neck-stem, (3) stem-sleeve, and (4) intermediate stem.
- Cemented femoral stems: cobalt-chrome is the preferred material for cement bonding(5,12,13).

Alternatives for Bearing Surfaces Include

- Metal on polyethylene (MoP): MoP has the longest track record of all bearing surfaces and is offered at relatively low cost.
- Ceramic on polyethylene (CoP): This option has gained increasing popularity.
- Ceramic-on-ceramic (CoC): CoC has the best wear properties of all bearing surfaces in total hip arthroplasty (THA).
- Metal-on-metal (MoM): Although disused, MoM has historically demonstrated superior wear properties compared to MoP. MoM exhibits lower linear wear rates and generates lower particle volume. However, the potential for the development of pseudotumors, as well as reactions associated with metallosis (delayed type IV hypersensitivity), has led to a reduction in its use. In addition, MoM is contraindicated in pregnant women, patients with renal insufficiency and those at risk of hypersensitivity to metals.

A hip arthroplasty prosthesis generally includes a press-fit acetabular component, a neutral polyethylene shell and a head/liner construction in MoP, CoP or CoC, depending on the patient's age and projected activity level. In addition, a

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cemented femoral stem option is often considered for patients with poor bone quality. This approach is especially relevant in the treatment of hip arthroplasty in active geriatric patients with displaced femoral neck fractures(5,14,15).

Preparation

According to the most recent American Academy of Orthopaedic Surgeons (AAOS) guidelines for the management of symptomatic osteoarthritis of the hip or knee, strong or moderately strong level recommendations for nonsurgical treatment have been approved for the following modalities:

- Weight reduction programs
  Indicated as first-line treatment for all patients with symptomatic hip arthritis.
  This indication is emphasized in all patients with a body mass index (BMI) greater than 25.
- Physical activity and physiotherapy programs
  Aimed at improving joint function and reducing pain through specific exercises and rehabilitation techniques.
- Nonsteroidal anti-inflammatory drugs (NSAIDs) and tramadol
  Recommended for the management of pain and inflammation in patients with symptomatic hip and knee arthritis.
- Corticosteroid injections
  These can be both therapeutic and diagnostic for symptomatic patients. This modality is particularly useful in patients where low back pain and lumbar spinal stenosis, with or without radicular symptoms, can create clinical confusion in diagnosis.
- Use of a cane for walking
  A cane may be beneficial in decreasing the joint reaction forces generated at the hip. In patients with unilateral hip pain, cane use should be recommended in the contralateral upper extremity to improve load distribution and reduce joint stress.

Other symptomatic treatment modalities, which are not strongly supported but are considered reasonable alternatives for the control of symptoms secondary to hip arthritis, include, among others, acupuncture, hyaluronic acid injections (viscoelasticity), and glucosamine and chondroitin supplementation(5,19,20).

Preoperative Evaluation: Clinical Examination

Before hip arthroplasty is considered in any patient, a thorough history and detailed physical examination is essential. Patients should be asked about previous interventions and treatments, including joint replacements, arthroscopic procedures or other previous surgeries in the hip region. It is especially important to consider a history of intertrochanteric fractures, which are common in these patients, or open pelvic fractures, which are one of the most severe and life-threatening of musculoskeletal trauma injuries. These injuries are critical because previous surgical incisions or the presence of devices in the femur or acetabulum can significantly influence the planned surgery or the design of the prosthesis to be used.

Additionally, a comprehensive medical evaluation is necessary, including a review of the patient's general conditions, comorbidities and possible contraindications. It is recommended that medical clearance and risk stratification be obtained for all patients before surgery is considered, ensuring that they are fit to undergo hip arthroplasty(21-23).

Other considerations include the patient's body habitus, previous functional activity level, and post-surgical expectations and goals. It is also essential to evaluate the pattern of arthritic involvement and to review any history of previous trauma to the hip. The hip should be inspected for alterations in skin coloration, previous scars or injuries that may influence surgical planning. The soft tissues should be evaluated for signs of muscle atrophy, symmetry and overall hip stability.

Atypical leg pain and pain at rest are common symptoms of peripheral vascular disease (PVD). Although up to 50% of patients may be asymptomatic at the time of consultation, clinical suspicion of PVD may warrant a preoperative consultation with vascular surgery to assess surgical risk.

The physical examination should also include an evaluation of the mechanical axis and general alignment of the lower extremity. It is crucial to rule out or at least consider the possibility of spine or knee pathology before proceeding with hip surgery. In addition, any leg length discrepancy (LLD) that may affect the post-surgical outcome should be recorded.
It is essential to consider the impact of associated conditions that may influence hip mechanics, such as:

- Spinal conditions with hyperlordosis.
- Pelvic obliquity.
- Hip flexion contractures, which may prevent the patient from standing upright.
- Trendelenburg gait or Trendelenburg sign, which indicate gluteus medius weakness and may affect hip stability.

In addition, preoperative range of motion (ROM) should be assessed and recorded. Patients with end-stage osteoarthritis often present with a combination of adduction and flexion contractures of the hip, so it is crucial to document any appreciable flexion contracture greater than 5 degrees and lack of flexion beyond 90 to 100 degrees. Range of motion in the rotational arc, especially internal rotation, is often limited. The neurovascular examination should also include a straight leg raise test to assess neurologic function.

Preoperative Evaluation: Radiographs

Preoperative radiographs including an anteroposterior (AP) pelvis and an AP/lateral projection of the affected hip(s) are recommended. In cases of hip dysplasia, a false profile view is considered useful. For severe hip dysplasias and when custom components are contemplated, it is recommended that a preoperative 1 mm thin-slice computed tomography (CT) scan be obtained for a more detailed evaluation of the anatomy.

On imaging, the hip joint should be evaluated for joint space narrowing, the presence of osteophytes, and subchondral sclerosis or degenerative cysts. It is important to pay particular attention to the planned center of rotation of the hip (COR) relative to the native COR, as this directly influences the placement of the prosthesis. The surgeon must take into account

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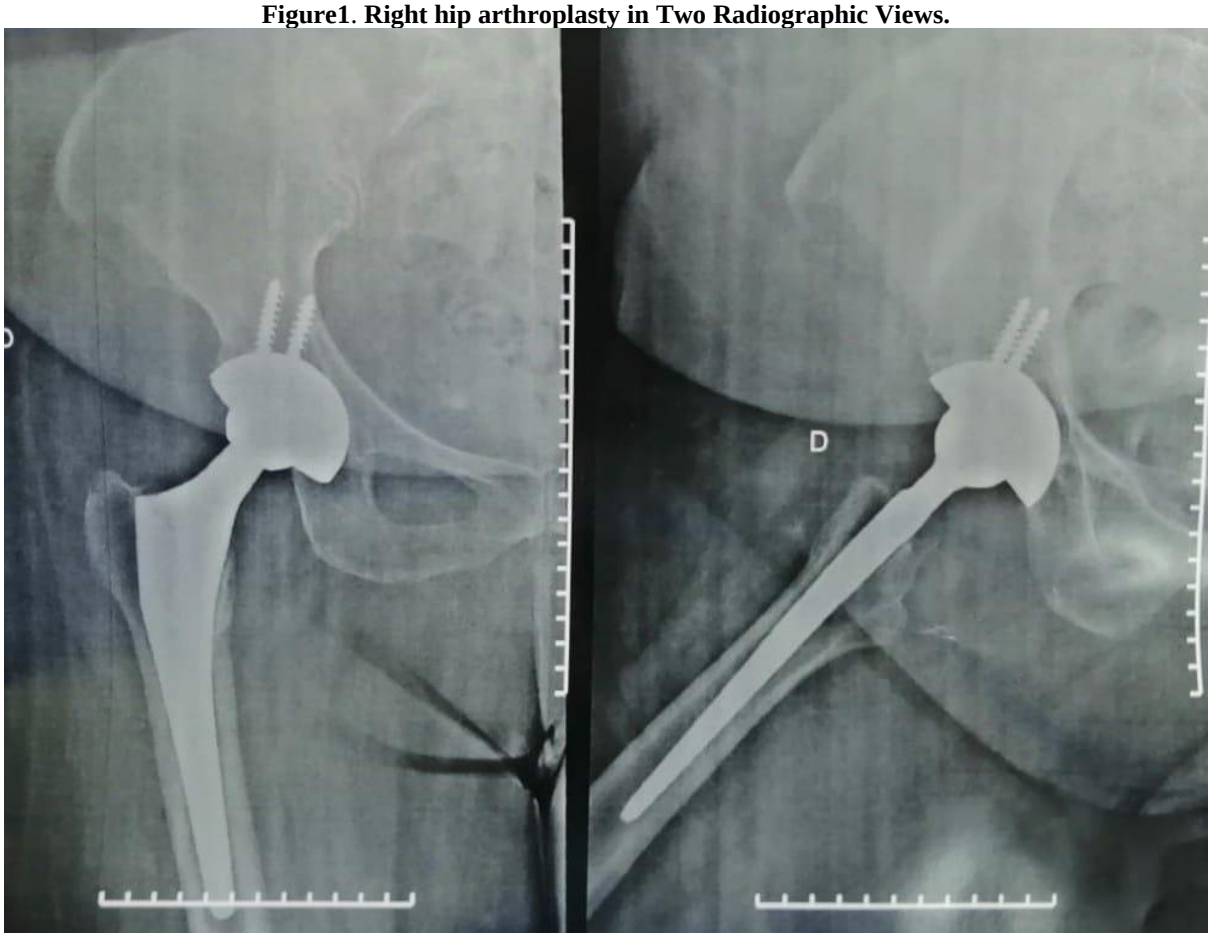
the planned medialization of the acetabular cup and the corresponding reaming necessary to ensure proper alignment and fit of the acetabular implant. In addition, any appreciable leg length discrepancy (LLD) can be calculated using a combination of the radiographic methods described(24).

Figure1. **Right hip arthroplasty in Two Radiographic Views.**



Source: The Authors.

Technique or Treatment

There are several methods for performing total hip arthroplasty (THA), and the three most common approaches are as follows:

Posterior Approach

The posterior approach is the most commonly used in both primary and revision hip arthroplasty cases. This approach does not use a true internervous plane. Dissection begins with a blunt dissection of the gluteus maximus fibers and a sharp incision of the fascia lata distally. The deep dissection includes meticulous exploration of the short external rotators and joint capsule, taking special care to protect these structures while repairing posteriorly to the proximal femur via transosseous tunnels.

A notable advantage of this approach is that it avoids section of the hip abductors. Other advantages include excellent exposure of both the acetabulum and femur and the possibility of extensible conversion in either the proximal or distal direction. However, historical studies comparing this approach with the direct anterior (DA) approach have cited higher dislocation rates with the posterior approach. Although this finding remains controversial and inconclusive, especially when the posterior technique includes adequate soft tissue repair at the end of the operation.

Direct Anterior Approach (DA).

The DA approach has gained popularity among hip arthroplasty surgeons because of its purported benefit in reducing postoperative dislocation rates and preserving the abductor musculature. The internervous interval is located between the tensor fascia latae (TFL) and the sartorius (femoral nerve) in the superficial layer, and between the gluteus medius and rectus femoris in the deep layer.

Disadvantages of the DA approach include a significant learning curve, with a decrease in reported complications once the surgeon has performed more than 100 cases. In addition, this approach has increased wound complications in obese patients with large abdominal panniculus, difficulties in femoral exposure, the risk of lateral femoral cutaneous nerve paresis (LFCN), and a higher rate of intraoperative femoral fractures. Many surgeons require access to a specialized operating table and trained staff, which also involves a considerable learning curve.

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Anterolateral Approach (Watson-Jones).
The anterolateral approach (AL) is less commonly used than the previous approaches because it involves the hip abductor muscle, which may result in a postsurgical limp in exchange for a theoretically lower dislocation rate. The dissection interval in this approach involves the anterior thoracic ligament musculature and gluteus medius, which affects abductor function.

Steps of the procedure.
Once the surgical approach has been made, the next step is the osteotomy of the femoral neck. Generally, a reciprocating saw is used, starting approximately 1 to 2 cm proximal to the lesser trochanter and advancing in a proximal-lateral direction toward the base of the greater trochanter. After completion of the osteotomy, the femoral head and neck are freed from the soft tissue attachments and removed.

Visualization of the acetabulum is facilitated by the use of retractors. Some surgeons prefer to place the anterior retractor at 2 o'clock (right hip) or 10 o'clock (left hip), and the bent Hohmann retractors are positioned at 12 o'clock and 8 o'clock (right hip) or 4 o'clock (left hip). The blunt Hohmann retractor is placed in the extracapsular position at the level of the transacetabular ligament (TAL). The remnants of the round ligament and fibroadipose pulvinar should be excised to expose the acetabular tear and remove the labrum (if present), allowing proper use of the acetabular reamers.

Reaming methods should start small (usually a 44) and focus on proper medialization of the cup, exposing the medial wall without protrusion. Once medialization is accomplished, sequential reaming is performed to place the acetabular cup in the proper position, which is usually between 35 to 40 degrees of inclination and 15 to 20 degrees of anteversion. After completion of reaming, the press-fit acetabular component is inserted, followed by insertion of the appropriate acetabular liner.

The femur is then prepared using specific drills or instrumentation systems until provisional stability is obtained by press-fit. After placement of the trial femoral stem, the hip is reduced and assessed for stability using a combination of trial implants or progressively displaced neck stems. The femoral head can also be adjusted depending on the implant system used. Most systems offer various head size options (“plus” and “minus”) to add or subtract length and ensure hip stability.

Methods to Assess Intraoperative hip Stability

1. Shelling test to release any interposed soft tissue and assess stability with axial traction.
2. Equal leg lengths, comparing the patella and heels to the contralateral extremity by direct palpation.
3. With the hip in 0 degrees of extension, externally rotate to check for posterior impingement.
4. The hip should be in abduction and external rotation to ensure no posterior impingement or anterior subluxation.
5. The hip should be brought to 90 degrees flexion with additional adduction and internal rotation of approximately 70 to 90 degrees, ensuring stability.

Direct Lateral Approach (Hardinge)
The direct lateral approach (also known as the transgluteal approach) does not use an actual internervous plane. Superficial dissection involves the fascia lata to access the gluteus medius, with the risk of injury to the superior gluteal nerve when performing proximal dissection, which can result in a post-surgical Trendelenburg gait. However, this approach has been shown to have the lowest dislocation rate (0.55%) compared to the posterior (3.23%) and anterolateral (2.18%) approaches(25,26).

Wound Closure
Proper wound closure after hip arthroplasty is critical to prevent postoperative complications and ensure optimal recovery. Special attention to detail should be paid during closure, using a meticulous approach. For repair of the joint capsule and short external rotators to the proximal femur, a sterile, braided, nonabsorbable ethylene terephthalate surgical suture is used. This technique is performed through two transosseous tunnels.

A recommended protocol includes the use of unidirectional or bidirectional barbed sutures for the deep fascia, deep fat and dermal/subcutaneous layers. For the skin, staples or polyglecaprone can be used. Some surgeons prefer to opt for a continuous polyglecaprone-based barbed suture, supplemented with a mesh dressing and glue closure for the skin. After the closure is completed, a sterile dressing is applied and left in place unchanged for the first seven days.

It is crucial to place an abduction pillow on the patient's hip to avoid excessive movements that may compromise the stability of the implant. In addition, clear instructions should be provided to the patient regarding hip flexion precautions and activity restrictions during the early postoperative period. Topical application of tranexamic acid (TXA) is also recommended prior to pulsatile saline lavage, which may help reduce bleeding during the procedure and promote faster recovery.

Pharmacologic Modalities for DVT Prophylaxis
Prophylaxis of deep vein thrombosis (DVT) and venous thromboembolic events (VTE) is a major concern in patients undergoing hip arthroplasty because of the increased risk of clot formation after surgery. Although the choice of the most effective agent remains a matter of debate, many surgeons have opted for aspirin because of its proven efficacy and similar results in preventing symptomatic pulmonary embolism (PE) in certain groups of total joint patients. Aspirin has been shown to be an appropriate and well-tolerated option, especially in comparison with other prophylactic agents, such as low-molecular-weight heparin (LMWH).

The use of these drugs should be individualized, taking into account each patient's risk of developing VTE and their safety

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profile. In addition, treatment should be complemented with physical measures, such as early mobilization and the use of compression stockings to reduce the risk of thromboembolic complications(27,28).

Complications

- THA dislocation
- Periprosthetic THA fracture.
- Wound complications
- Aseptic loosening of THA
- Prosthetic joint infection (PJI)
- Venous thromboembolic events (VTE)
- Sciatic nerve palsy
- Vascular injury
- Leg Length Discrepancy (LLD)
- Iliopsoas impingement
- Heterotopic ossification(29,30).

CONCLUSIONS

Total hip arthroplasty (THA) is an effective and widely used procedure for the treatment of advanced osteoarthritis and other hip pathologies that do not respond to conservative treatments. Its evolution from its first applications in the 19th century to modern techniques has led to a significant improvement in clinical and functional outcomes, with a marked reduction in pain and improvement in patients' quality of life. Although the main indications for surgery include hip osteoarthritis and osteonecrosis, the technique should be tailored to the individual conditions and characteristics of each patient, considering factors such as anatomy, comorbidities and post-surgical expectations. A comprehensive approach during preoperative, surgical, and postoperative management is essential to optimize outcomes and minimize complications.

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