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ADVANCES IN SURGICAL RECONSTRUCTION FOR TRAPEZIOMETACARPAL JOINT OSTEOARTHRITIS: FROM TRAPEZIECTOMY TO IMPLANT ARTHROPLASTY

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ABSTRACT Trapeziometacarpal (TMC) joint osteoarthritis (OA), a highly prevalent condition, severely impairs hand function and quality of life. The evolution of its surgical management reflects a continuous effort to optimize pain relief, preserve motion, and restore strength. This narrative review explores the spectrum of surgical interventions, ranging from established techniques like simple trapeziectomy and ligament reconstruction and tendon interposition (LRTI) to contemporary methods such as suture suspensionplasty and advanced implant arthroplasty. We detail the biomechanical rationale, clinical outcomes, and limitations associated with each approach. Emphasis is placed on comparing the long-term efficacy and complication profiles of these procedures, providing a structured overview for clinical decision-making.

KEYWORDS : Trapeziometacarpal osteoarthritis, Trapeziectomy, Arthroplasty, LRTI, Thumb arthritis.

INTRODUCTION

Osteoarthritis (OA) of the trapeziometacarpal (TMC) joint, often referred to as basal joint arthritis, is the second most common site for OA in the hand, following the distal interphalangeal joints (1). This condition predominantly affects postmenopausal women and is characterized by debilitating pain, progressive loss of pinch and grip strength, and ultimately, significant functional disability (2). The TMC joint's unique saddle shape provides a high degree of mobility, crucial for opposition, but this mobility also contributes to inherent instability and high contact stresses, predisposing it to degenerative changes (3). Initial management typically involves non-operative strategies, including splinting, anti-inflammatory medications, and corticosteroid injections (4). However, for patients with advanced disease, persistent pain, and functional decline, surgical intervention becomes necessary (5). The history of surgical treatment for TMC OA is a chronicle of evolution, beginning with simple joint destructive procedures and progressing to sophisticated joint-preserving and replacement techniques. This review provides a contemporary synthesis of the surgical landscape for TMC OA, detailing the biomechanical basis, clinical evidence, and comparative outcomes of current and emerging treatment modalities (6).

METHODS

This narrative review was compiled through an focused search across four principal databases: PubMed, Scopus, Embase, and Google Scholar. The search strategy incorporated key terms related to Trapeziometacarpal Osteoarthritis, Surgical Treatment, Trapeziectomy, and Implant Arthroplasty. We included articles published in English and Spanish, focusing on clinical trials, systematic reviews, and meta-analyses that addressed the surgical management, comparative outcomes, and complications associated with various treatment options for TMC OA. After a detailed screening of titles and abstracts, 15 highly pertinent publications were chosen for complete review and synthesis. The information extracted from these sources was qualitatively analyzed to describe the progression of surgical techniques, evaluate their respective evidence bases, and discuss critical considerations for optimal patient management (7). This selection process is outlined conceptually below (**Figure 1**).

Epidemiology and Clinical Presentation of Trapeziometacarpal Osteoarthritis

TMC OA affects up to 20% of the general population and is radiographically evident in as many as 33% of women over the age of 50 (8). The incidence of symptomatic disease requiring intervention is lower but still substantial. Clinical presentation is typically insidious, beginning with pain at the base of the thumb, often exacerbated by pinch activities, such as opening a jar or turning a key (2). As the disease progresses, patients experience a palpable prominence or subluxation of the first metacarpal base, reduced range of motion, and characteristic weakness in key pinch strength (9). Physical examination often reveals tenderness over the TMC joint and a positive "grind test." Radiographic classification systems, such as the Eaton and Littler classification, guide treatment by staging the severity of the disease based on joint space narrowing, subluxation, and osteophyte formation (10).

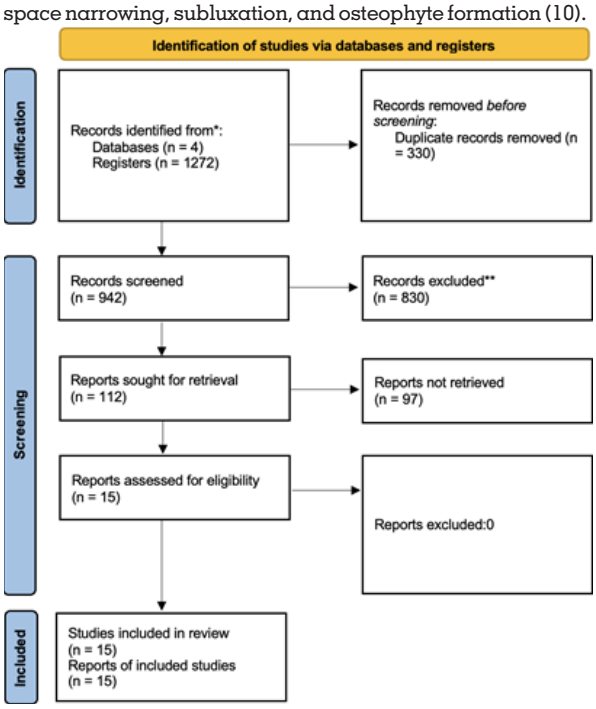

Figure 1. PRISMA.

Pathophysiology And Biomechanics Of The TMC Joint

The TMC joint functions as a versatile saddle joint, offering two degrees of freedom: flexion-extension and abduction-adduction, allowing circumduction and critical opposition (3). This expansive range of motion is achieved at the expense of inherent stability, which is primarily maintained by a complex network of periarticular ligaments, most notably the anterior oblique ligament (AOL) (11). The root cause of primary TMC OA is debated but involves a combination of factors: repetitive high-load stresses during pinch, laxity or rupture of the AOL leading to dorsal subluxation of the metacarpal base, and a resultant increase in cartilage contact pressure (12). This chronic instability leads to a destructive cycle of cartilage wear, synovitis, osteophyte formation, and eventual joint

collapse. The biomechanical goal of any surgical procedure is to interrupt this cycle, either by removing the painful, arthritic surfaces or by stabilizing and resurfacing the joint (11).

Traditional Surgical Approaches

Simple Trapeziectomy

Simple trapeziectomy, the surgical removal of the entire trapezium bone, is the historical gold standard for advanced TMC OA (13). It is a joint-destroying procedure that relies on the resulting formation of a fibrous scar or pseudarthrosis in the void to relieve pain. This technique is technically straightforward, offers reliable pain relief in a majority of patients, and has a low complication rate (13). However, a significant drawback is the potential for proximal migration of the first metacarpal, leading to shortening of the thumb ray, weakness in pinch grip, and occasional abutment pain (14).

Ligament Reconstruction And Tendon Interposition (LRTI)

LRTI, introduced to mitigate the issues of simple trapeziectomy, involves excising the trapezium and then using a portion of a local tendon, often the flexor carpi radialis (FCR) or palmaris longus, to reconstruct the de-stabilized ligaments and interpose soft tissue into the space (15). The interposition acts as a cushion (arthroplasty), reducing the risk of proximal metacarpal migration and bone-on-bone impingement, theoretically offering better long-term strength and stability compared to simple trapeziectomy (14). LRTI remains one of the most widely performed procedures, though evidence suggests its functional outcomes may not be vastly superior to simple trapeziectomy alone (14).

Emerging Surgical Techniques

Suture Suspensionplasty

Suture suspensionplasty represents a modification of LRTI, aiming to provide comparable stability without the morbidity of harvesting a large tendon strip. This technique involves using strong, non-absorbable suture material or specialized anchors to suspend the first metacarpal base from the second metacarpal, maintaining the trapezial space after trapeziectomy (1). It is faster, less invasive, and avoids the complication risks associated with tendon graft harvesting (1). Early results are promising, showing functional and strength recovery comparable to LRTI, but long-term data on suture longevity and failure rates are still accumulating (1).

Hematoma Distraction Arthroplasty

Hematoma distraction arthroplasty is essentially a simple trapeziectomy with the addition of temporary immobilization and distraction via K-wire fixation for several weeks (7). The goal is to maintain the trapezial space, allowing a stable, vascularized hematoma to mature into a fibrous pseudarthrosis. This procedure is the least invasive of the excision arthroplasties, as it avoids tendon transfer or suture implantation (7). While effective for pain relief, its superiority over simple trapeziectomy in preventing shortening or improving strength remains unproven (7).

Arthroscopic-Assisted Procedures

Arthroscopy has been employed for early-stage TMC OA (Eaton stages I and II) to perform debridement, synovectomy, and release of the AOL (10). For more advanced stages, arthroscopy assists in partial or complete trapeziectomy, often followed by interposition arthroplasty (10). The perceived benefits are reduced soft-tissue damage, faster recovery, and better visualization. However, the procedure is technically demanding, requires specialized equipment, and the clinical outcomes for advanced OA are generally not superior to open techniques (10).

Implant Arthroplasty

Implant arthroplasty involves replacing the diseased joint surfaces with a prosthetic device, similar to hip or knee replacement, with the primary goal of restoring anatomical alignment, maintaining joint length, and providing a stable, painless range of motion (5).

Silicone Implants

Early attempts involved silicone spacers, which act as a simple volume replacement after trapeziectomy (5). Unfortunately, these prostheses had high failure rates due to silicone synovitis, fragmentation, and instability, leading to their decreased use (5).

Metal And Pyrocarbon Prostheses

These are true joint replacement systems consisting of a cup component cemented or press-fitted into the trapezium (or retained trapezial surface) and a stem component anchored in the first metacarpal (6). They are designed to replicate the native joint's kinematics (6). **Pyrocarbon** prostheses are biologically inert and have an elastic modulus similar to bone, making them a popular choice (6).

Surface Replacement Implants

Surface replacement, or hemiarthroplasty, involves replacing only the metacarpal base surface with a small, metallic component, leaving the trapezium intact (15). This procedure is typically reserved for early-stage disease with good trapezial bone stock and aims to be bone-sparing. However, it requires a healthy trapezial cartilage to articulate against, and its longevity is dependent on the absence of subsequent trapezial OA (15).

Complications And Revision Considerations

Complications of implant arthroplasty include component loosening, dislocation, polyethylene wear, and osteolysis (6). While initial results for pain and function are often excellent, revision surgery, typically to trapeziectomy or LRTI, may be required at a higher rate than for excision arthroplasties (6).

Rehabilitation Protocols And Functional Recovery

Post-operative rehabilitation is crucial for maximizing functional recovery regardless of the technique used. Protocols generally involve a period of immobilization followed by a staged progression of passive and active range-of-motion exercises, and finally, strengthening exercises (1). Initial immobilization typically lasts 4 to 6 weeks. Procedures involving tendon transfer (LRTI) or suture suspensionplasty often necessitate longer periods of protected motion to allow soft tissue healing (1). Patients undergoing implant arthroplasty may benefit from an accelerated protocol due to the initial joint stability provided by the prosthesis (5). Full recovery of grip and pinch strength can take up to 6 months to a year (9).

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