

Developments in trapezium replacements

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Abstract

The purpose of this update is to report on a variety of topics related to trapezium implants that have been investigated during the past three years. The keyword *trapezium implant* was utilized to query the PubMed database of the U.S. National Library of Medicine. From the resulting list, papers published from the beginning of January 2012 through the beginning of April 2015 were reviewed. The twenty-three studies identified are reviewed here and referenced at the end of the review. Based on level of evidence criteria for therapeutic studies as adopted by the American Academy of Orthopedic Surgeons, the most frequent level of evidence for reviewed clinical studies was Level IV (13/19 studies), followed by Level III (4/19), and Levels II (1/19) and I (1/19).

Introduction: surgical treatment options for trapeziometacarpal osteoarthritis

The trapeziometacarpal joint is one of the most common sites of osteoarthritis in the human body, particularly in postmenopausal women.¹⁻³ Multiple surgical techniques exist to address this problem, including arthrodesis, implant arthroplasty, and trapeziectomy with or without ligament reconstruction/tendon interposition.² Trapeziectomy, first described by Gervis in 1949, has long been the classic surgical treatment for trapeziometacarpal osteoarthritis, and is effective for reducing pain but leads to longer functional recovery times and loss of strength.⁴ Trapeziectomy with ligament reconstruction is now considered by some to be the gold standard for treatment and provides both short- and long-term relief of pain, with one study reporting excellent pain relief in 23/24 patients at an average of 9.4 years follow-up.^{5,6} However, disadvantages of this procedure include proximal migration of the thumb metacarpal after trapezial resection, resulting in reduced pinch strength.⁷ Meanwhile, advancements in biomechanics and materials research have yielded new

implant designs over the past five decades⁸ and have challenged the gold standard of trapeziectomy, such as by calling into question the need for reconstructing the ligament.⁵ A prospective study comparing joint prostheses versus trapeziectomy with ligament reconstruction at 1-year follow-up reported reduced pain and improved strength and range of motion for implant arthroplasty patients.⁹ However, there is no current consensus that implant arthroplasty provides superior pain reduction or improved function compared to simple resection arthroplasty.¹⁰

Trapeziometacarpal arthrodesis

Arthrodesis remains a viable option for treatment of trapeziometacarpal osteoarthritis, but it is associated with decreased range of motion and transfer of force to proximal joints, and its primary complication is nonunion in approximately 13% of cases.^{2,7} Harston *et al.* investigated the outcome of a new surgical technique for arthrodesis described in 2010, involving the creation of a V-shaped osteotomy at the base of the first metacarpal and a matching osteotomy of the trapezium to provide a more stable fusion site.² The authors studied data from a 2-year follow-up of 21 patients treated with this technique, and reported an 83% complete fusion rate, along with improvement in range of motion and strength, with no infections or reoperations for reunion. 19 of 21 patients were satisfied with the procedure, and the authors conclude that arthrodesis using V-shaped osteotomy can be a successful, reproducible, and strength-preserving procedure with a low nonunion rate.

Trapeziectomy with ligament reconstruction/tendon interposition

Szalay *et al.* examined the utility of the Mini TightRope (Figure 1), which allows for suspension of the first metacarpal following trapeziectomy in a retrospective study with 31 patients.^{11,12} 74.2% of the patients obtained good or very good results, based on clinical and radiological examination as well as Buck-Gramcko scores. In 2 patients, the Mini TightRope had to be removed due to strong pain and proximalization of the first metacarpal, but the authors reported the procedure to be an overall success in the majority of patients.

Vandenbergh *et al.* sought to compare long-term outcomes of trapeziectomy with reconstruction/interposition versus implant

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arthroplasty using questionnaire results from 322 patients reporting their degree of pain, impairment, patient satisfaction, and disability.¹³ They found no significant difference in any of these measures, and recommended trapeziectomy over prostheses as the first choice of surgical treatment, citing the greater cost of prosthetic implants and the absence of data supporting their superiority in terms of outcomes. However, a study by Jager *et al.* found the opposite, reporting better short-term outcomes for the MAIA prosthesis compared to trapeziectomy-interposition.⁴ In a prospective analysis of two comparable cohorts of 47 (prosthesis) and 27 (trapeziectomy) patients, the authors found superior mobility, pain reduction, satisfaction, strength, and functional scores in the prosthesis group, as well as better improvement of pinch strength and correction of subluxation.

Prosthetic arthroplasty options

Although the advantage of using prostheses has not yet been clearly established, prosthetic arthroplasty can still provide some theoretical benefits compared to trapeziectomy with ligament reconstruction, including preservation of joint biomechanics and range of motion, avoidance of metacarpal subsidence, and immediate stability.¹⁴ Vitale *et al.* provided a summary of the trapezium prosthetic options that have emerged over the past 5 decades.¹⁴ First generation implants were primarily Swanson silicone prostheses, which

Zschock-Holle *et al.* and others have reported as preserving good range of motion and grip strength and minimizing pain.¹⁵ However, silicone synovitis, subluxation of the silicon implant, and bony abnormalities occurred in approximately 50% of patients, which has largely curtailed the current use of silicone implants in patients.

Vitale *et al.* describe more current implant models as utilizing synthetic materials (e.g. artelon), metal, or pyrocarbon, each with varying levels of use and data regarding their outcomes.¹⁴ Another element of variability with trapezium prosthetic implants is the use of cemented versus uncemented screw cups, which can contribute to prosthetic failure due to poor fixation. Hansen *et al.* compared the fixation of cemented and uncemented cups in a prospective, parallel-group, randomized trial involving 28 patients.¹⁶ There was no difference found between both cup designs in terms of fixation, 2-year total translation, grip strength, or pain, and the authors suggested the use of radiostereometric analysis as a clinically useful method of detecting loose implants to avoid cup failure and poor fixation in prostheses.

Synthetic polymer prosthetic implants

Vitale *et al.* found that synthetic spacers such as Artelon prostheses (Figure 2) resulted in inferior outcomes compared to more established procedures such as trapeziectomy.



Figure 1. Intraoperative image of final placement of the Mini TightRope. Figure reproduced from the Open Access paper: Shah A, Martin G, Thomson JG. A novel use for suture button suspension: reconstruction of the dorsal ulnar ligament to treat thumb metacarpal dislocation. *Case Reports in Plastic Surgery & Hand Surgery.* 2015;2(1):7-11. doi:10.3109/23320885.2014.997823.

my.^{14,17} These findings were supported in a study by Blount *et al.*, which compared outcomes and complications of Artelon implants versus traditional surgical treatment of trapeziectomy with ligament reconstruction/tendon interposition.¹⁸ Their retrospective chart review found no significant difference in function or quality of life measures, but significantly worse pain and satisfaction scores with the Artelon implant, and revision surgery with removal of the implant was necessary in 37% of patients. As a result, Blount *et al.* recommended discontinuing the use of Artelon joint spacers. Huang *et al.* further examined a patient with failure of an Artelon implant that required surgical excision of the implant, and found through gross and histological examination that a lack of articular resurfacing by hyaline ingrowth contributed to the implant failure.¹⁹

Semere *et al.* studied prosthetic implants using another synthetic biodegradable polymer, polylactic acid, and reported prolonged inflammation and immune foreign body reactions requiring surgical removal of the implant in 9 out of 68 cases.²⁰ However, in another prospective study following polylactic acid implants in 45 patients, Guinet *et al.* found no cases of infection or local inflammatory reaction.²¹ In addition, they reported good safety, pinch strength, and satisfaction rates, as well as low pain levels, and suggested that polylactic acid prosthetic implants could serve as a promising surgical option without the complications of tendon harvesting.

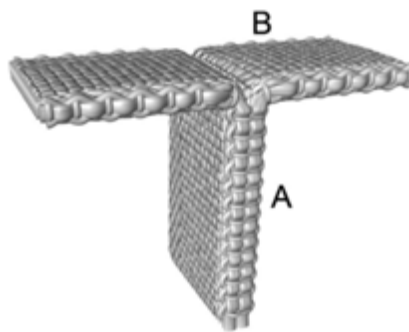


Figure 2. Artelon synthetic spacer, composed of a vertical spacer (A) and 2 horizontal wings (B). Figure reproduced from the Open Access paper: Nilsson A, Wiig M, Alnehill H, et al. The Artelon carpo-metacarpal spacer compared with tendon interposition arthroplasty: A randomized, controlled, multicenter study of 109 patients with osteoarthritis followed for 1 year. *Acta Orthopaedica.* 2010;81(2):237-244. doi:10.3109/17453671003635835.

Metal prosthetic implants

Goubau *et al.* conducted a prospective cohort study of functional outcome following total replacement of the trapeziometacarpal joint with the metal Ivory prosthesis in 22 patients.²² They found that the 5-year overall survival of the Ivory prosthesis was 95%, and that the implant led to high patient satisfaction, restored range of motion, pinch and grip strength, and overall function, while decreasing pain with only one patient requiring surgical revision due to polythene wear of the implant. As a result, the authors concluded that the Ivory prosthesis is a reliable option with good functional benefits and long-term success.

Pritchett *et al.* studied another metal joint prosthesis, the BioPro Modular Thumb, in a prospective single-cohort study with 124 patients.³ Their follow-up studies were conducted using clinical and radiographic assessments between 3-10 years postoperatively, and the authors reported excellent Buck-Gramcko functional scores, 94% implant survivorship 6 years postoperatively, and pain relief and improved function in 98% of cases. As a result, Pritchett *et al.* suggested the continued use of the BioPro implant due to its positive clinical and functional outcomes. Chug *et al.* also reported good outcomes with the Elektra implant (Figures 3 and 4), another metal prosthesis consisting of titanium and chrome-cobalt steel.⁷ The authors' retrospective study analyzed follow-up data 2



Figure 3. Elektra prosthesis with ball-and-socket joint design, consisting of titanium stem for insertion into the first metacarpal and chrome-cobalt steel cup which screws into the trapezium. Figure reproduced from the Open Access paper: Chug M, Williams N, Benn D, Brindley S. Outcome of uncemented trapeziometacarpal prosthesis for treatment of thumb carpometacarpal joint arthritis. *Indian J Orthop. Medknow Publications;* 2014 Jul;48(4):394-8. doi: 10.4103/0019-5413.136270.

years after surgery, and found an improvement in hand function and pain level based on patient-rated wrist evaluations and Michigan Hand Questionnaire Scores. Implant loosening was only observed in 1 out of 16 joint prostheses, and the authors concluded that the Elektra implant provides good short-term results in terms of function and pain relief. However, Hernandez-Cortes *et al.* reported contradictory findings, as their longitudinal cohort study of 19 Elektra prostheses found signs of failure in 9 of 19 implants only 2 years after surgery.²³ The poor outcomes included pain at the trapeziometacarpal joint and radiographic osteolysis, and the authors subsequently were unable to recommend use of the Elektra implant for future patients.

Pyrocarbon arthroplasty

More recently, with the advancement of small joint implant material technology,

several pyrocarbon implant models have been introduced.¹⁰ Woodward *et al.* describe the practical and theoretical benefits and drawbacks of pyrocarbon implants compared to traditional trapeziectomy, including improved range of motion, decreased postoperative pain and stiffness, and earlier recovery of strength, as well as an increased risk of subluxation of the implant.²⁴ However, long-term data on pyrocarbon implants is limited, and current studies have not exhibited clear improvements over simple resection arthroplasty. Szalay *et al.* examined 60 patients at an average follow-up of 2 years after trapezium replacement with a pyrocarbon spacer, and found good or very good results in 83% of cases based on Buck-Gramcko assessment scores.²⁵ Although short-term results were generally encouraging, 9% of the implanted pyrocarbon spacers became dislocated, and the authors noted the high cost of the implant and lack of knowledge about long-term outcomes as potential concerns.

Maru *et al.* retrospectively compared short-term outcomes of 18 cases of traditional trapeziectomy with 18 cases of pyrocarbon implant arthroplasty, and found no identifiable benefit in terms of pain and functionality parameters.²⁶ 33% of patients with the pyrocarbon implant experienced complications requiring operations, usually for dislocation or subluxation of the implant, and the implant led to significantly higher Disability of the Arm, Shoulder, and Hand (DASH) scores compared to trapeziectomy. Cheval *et al.* performed total trapeziectomy and suspensoplasty with a pyrocarbon spacer (23 patients) or without (23 patients) to see if adding a pyrocarbon implant would increase strength and better maintain the trapezial space.²⁷ Although the pyrocarbon spacer did improve trapezial height and better correct hyperextension of the MCP joint, no difference was found in terms of pain, mobility, or strength, and the spacer led to an increased DASH score and a greater risk of dislocation and subluxations.



Figure 4. Intraoperative images of anteroposterior and oblique views of carpometacarpal joint, demonstrating osteoarthritis (A); post-operative anteroposterior and oblique views of Elektra prosthesis *in situ* (B). Figure reproduced from the Open Access paper: Chug M, Williams N, Benn D, Brindley S. Outcome of uncemented trapeziometacarpal prosthesis for treatment of thumb carpometacarpal joint arthritis. *Indian J Orthop.* Medknow Publications; 2014 Jul;48(4):394–8. doi: 10.4103/0019-5413.136270.

Postoperative management

The majority of studies on trapezium implants focus on the description or comparison of surgical techniques, but less is known about how to optimize postoperative management after treatment of trapeziometacarpal osteoarthritis. Wolfe *et al.* performed a systematic review of 19 studies to determine what postoperative immobilization and therapy guidelines were used, and when patients were allowed to return to full activity.²⁸ A postoperative period of immobilization in a cast or splint was described in all but one of the studies. However, the duration of immobilization ranged from 2 to 8 weeks, without any specific time frame corresponding to a particular surgical technique. Similarly, time for return to full unrestricted activity was only mentioned in 5 of 19 studies and ranged from 5 to 12 weeks, with variability in recommended exercise and therapy protocols. As a result, the authors recommended future studies randomizing patients to different lengths of immobilization and postoperative exercise and therapy protocols, to help determine the optimal regimen for minimizing immobilization time, maximizing tissue healing, and restoring function.

Conclusions

Although trapeziectomy with ligament reconstruction is thought to be the standard of care for surgical treatment of trapeziometacarpal osteoarthritis, replacement of the joint through implant arthroplasty may potentially offer benefits including decreased pain and stiffness, avoidance of thumb shortening, and more rapid recovery of strength.^{9,24} Recent comparative studies discussed in this review reported similar or improved outcomes for implant arthroplasty compared to trapeziectomy with ligament reconstruction; Jager *et al.* reported improved analgesia, mobility, patient satisfaction, strength, and functional scores for prostheses, while Cheval *et al.* found improved conservation of trapezium space height and better correction of MCP joint hyperextension with a pyrocarbon implant.^{4,27} However, both Maru and Vandenberghe *et al.* found no significant difference in pain, patient satisfaction, and disability scores between the two procedures, and rates of revision surgery were as high as 33% (6/18) for patients receiving prostheses, typically due to dislocation or subluxation of the implant.^{13,26} Taken together, although implant arthroplasty generally yields satisfactory clinical outcomes,

its higher associated costs and complication rates suggest that trapeziectomy with ligament reconstruction may continue to serve as the first line of treatment.

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