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ORIGINAL ARTICLE

Efficacy and safety of a novel cost-effective suspension arthroplasty technique compared to traditional trapeziectomy with abductor pollicis longus arthroplasty Once Looped Around (OLA)/ Once Looped Inside (OLI) in basal thumb arthritis

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ABSTRACT

Aim Trapeziometacarpal (TMC) joint osteoarthritis is a common source of wrist pain, predominantly affecting women aged 45 to 70 years. While traditional surgical options like trapeziectomy with abductor pollicis longus (APL) arthroplasty are effective, their limitations in advanced disease stages have led to the exploration of alternative techniques. This study compares the clinical outcomes of conventional trapeziectomy with APL arthroplasty to a novel personalized suspensory arthroplasty technique.

Methods A retrospective analysis was conducted on 150 patients with Stage III-IV TMC osteoarthritis who underwent either the conventional APL arthroplasty (n=65) or the novel suspensory arthroplasty (n=85) in the period between 2015 and 2018. Outcomes were assessed using the Numeric Pain Rating Scale (NPRS), Disabilities of the Arm, Shoulder, and Hand (DASH) scores, thumb range of motion, grip strength, and patient satisfaction. Statistical analyses included t-test, χ^2 test, and repeated measures ANOVA.

Results Both surgical groups demonstrated significant pain reduction and functional improvement postoperatively. The novel technique resulted in lower NPRS and DASH scores, greater thumb metacarpophalangeal joint flexion-extension, and higher patient satisfaction compared to the traditional method. The prevalence of complications, particularly flexor carpi radialis (FCR) tendinitis, was also lower with the novel technique. Radiographic assessments indicated stable joint positions postoperatively in both groups.

Conclusion The novel personalized suspensory arthroplasty technique offers superior clinical outcomes compared to traditional APL arthroplasty, with enhanced pain management, improved function, and reduced complications. This approach represents a cost-effective and minimally invasive alternative for advanced TMC osteoarthritis, leading to better patient satisfaction and faster recovery.

Keywords: arthritis, arthroplasty, thumb

INTRODUCTION

Osteoarthritis affecting the trapeziometacarpal joint is a prevalent cause of wrist pain localized to the radial side. This condition predominantly affects females aged 45 to 70 years and accounts for 10% of all arthritic pathologies (1–5). Diagnosis relies on comprehensive clinical history, physical examination, and radiographic assessment, often utilizing Eaton's classification to categorize disease severity (6). Management decisions are based on both radiographic staging and symptomatology (6–10).

Non-surgical therapeutic modalities include lifestyle modifications, non-steroidal anti-inflammatory drugs, splinting, and corticosteroid injections (11). However, when conservative measures fail, surgical intervention becomes necessary. Traditionally, surgical options have included trapeziectomy or trapeziectomy with tendon-arthroplasty (12). However, the limitations of these approaches particularly in advanced stages of osteoarthritis, have prompted the exploration of alternative techniques (1,5,6,13–16).

The novel technique, which we have employed since 2019, involves trapeziectomy followed by a suspensory arthroplasty technique, establishing a dual ligament configuration between the first and second metacarpal bones.

The aim of this study was to compare the clinical outcome, including pain relief, functional improvement, and complication rate, between the conventional trapeziectomy with APL arthroplasty technique and the novel personalized suspensory arthroplasty technique, and to assess patient satisfaction and quality of life following each surgical procedure.

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PATIENTS AND METHODS

Patients and study design

A retrospective analysis was conducted on a cohort of 65 consecutive patients with trapeziometacarpal joint arthritis who underwent surgical intervention between 2015 and 2018 using the modified Weilby technique (Group A - APL arthroplasty) (13). Eligibility criteria included patients aged 55 years or older, presenting with Stage III-IV disease according to Eaton's classification (6), and possessing a minimum one-year follow-up post-surgery (T0: 1 month, T1: 2 months, T2: 6 months, T3: 1 year). Eighty five patients who underwent surgery between 2019 and 2023 utilizing the novel technique (Group B; Parrone procedure) were compared to those undergoing surgery using the modified Weilby technique (13) (Group A - APL arthroplasty).

BJA (basal joint arthritis) stage between the two randomized groups was similar according to Eaton's classification (6). A written informed consent was obtained from all patients.

Methods

Surgical Techniques. In 2014, a comprehensive review of surgical strategies for rhizarthrosis was disseminated providing an overview of prevalent preferences within the scientific community (5). Prior to 2019, our surgical approach primarily followed the technique initially described by Weilby (12) and subsequently modified by Ceruso and Catalano (5,13) (Figure 1). This technique, favoured among hand surgeons, has demonstrated favourable outcome for addressing various disease stages (13).

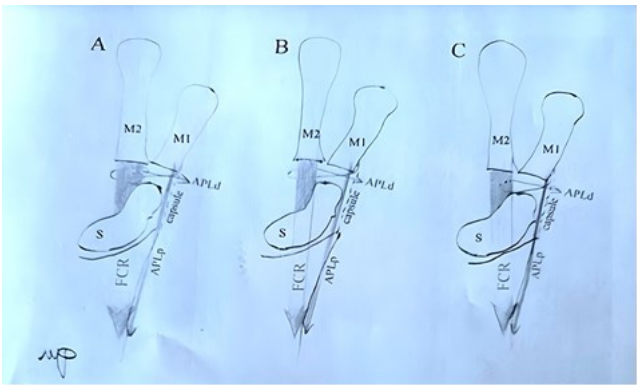

Figure 1. Weilby modified Ceruso-Catalano tecnique. A) Original technique; B) Once Looped Around (OLA) technique; C) Once Looped Inside (OLI) technique (De Vitis R., 2023) M1, first metacarpal; M2, second metacarpal; S, scaphoid; APLd, abductor pollicis longus distal; APLp, abductor pollicis longus proximal; FCR, flexor carpis radialis

Our novel technique (Parrone procedure) included several modifications. Firstly, the surgical approach is slightly more palmar-oriented to optimize exposure of the radial aspect of the first metacarpal base. A shorter incision, extending only to the scaphotrapezial region, eliminates the need for tendon procurement. Upon reaching the osseous plane, a small dorsal skin incision was made at the proximal third of the second metacarpal, and two trans osseous tunnels (parallel or intersecting) were created between the first metacarpal base and the proximal metadiaphysis of the second metacarpal. These tunnels were established using a widely accessible 14G cannula. A non-absorbable braided suture (Ethibond 0) was then threaded through the dual tunnel configuration, facilitating knot anchorage at the base of the first metacarpal. After trapeziectomy, the knot was tensioned conservatively to support the integrity of the newly created I-II metacarpal ligament without undue rigidity. Capsular closure was performed as feasible, followed by skin closure. The procedure concluded with a soft bandage that allows unhindered mobility of the first radius. Postoperative physiotherapy could have been initiated after an initial week of rest.

Outcome measures. Outcome assessment included subjective and objective parameters: pain assessment using the Numeric Pain Rating Scale (NPRS) and Disabilities of the Arm, Shoulder, and Hand (DASH) scores, evaluation of first ray range of motion, dynamometer-assessed grip strength (Kapandjitest), time to return to personal activities, and patient-reported satisfaction (17,18).

Numeric Pain Rating Scale (NPRS) is a widely used tool for assessing pain intensity. Patients self-reported pain level on a scale from 0 to 10: 0 meant "no pain" and 10 rated the "worst possible pain." NPRS is useful in both clinical and research settings for tracking pain over time and evaluating the effectiveness of treatments. It is especially valued for its simplicity, quick administration, and easy interpretation for both patients and healthcare providers.

The Disabilities of the Arm, Shoulder, and Hand (DASH) score (17) is a standardized questionnaire used to measure physical function and symptoms in individuals with upper extremity conditions. The DASH score assesses the impact of injuries or musculoskeletal disorders affecting the arm, shoulder, or hand on a person's ability to perform daily activities and participate in social and occupational tasks. It consists of 30 questions, covering aspects like pain, weakness, and the ability to perform specific tasks. Each item is rated on a 1-to-5 scale, and the overall score ranges from 0 (no disability) to 100 (most severe disability). The DASH score provides clinicians and researchers with a reliable and validated tool to evaluate outcomes in patients with various upper limb issues, helping guide treatment plans and track recovery progress.

The first ray range of motion was evaluated with Pulp pinch strength (kg), Hand grip strength (kg), Metacarpal shift (mm), and Grinding (%).

Pulp Pinch Strength refers to the force exerted in a pulp pinch grip, where the thumb and the tip of one finger (usually the index) press together to hold an object, such as a small item. Measured in kilograms (kg), this strength indicates the maximum amount of force an individual can apply in this grip. It is commonly assessed in clinical settings or hand strength evaluations, as it reflects fine motor strength and is critical for tasks requiring precise, controlled pinching or gripping. Normal values vary by age, gender and hand dominance, and lower measurements can indicate hand weakness or issues related to nerve or muscle health (3).

Hand grip strength, measured in kilograms (kg), is a common metric for assessing the force exerted when gripping an object with one's hand. It serves as an indicator of overall muscle strength and can be a predictor of various health outcomes, including physical function, mobility, and even certain long-term health risks. Hand grip strength is typically measured using a dynamometer, where an individual squeezes the device as hard as possible, and the force generated is recorded in kilograms. This measure is widely used in clinical and fitness settings to monitor strength, evaluate recovery, and assess age-related muscle decline (3,10).

Metacarpal shift refers to the measurement of the horizontal or vertical displacement of the metacarpal bones (the long bones in the hand that connect the wrist to the fingers) from their normal anatomical alignment. This measurement (in millimetres), is used to assess shifts in bone position due to injuries, deformities, or conditions like fractures. It helps in diagnosing the extent of misalignment and planning for treatments, such as surgery or physical therapy, to restore proper hand function and structure (10).

The Grinding measurement quantifies the percentage (%) of joint surface or cartilage area affected by grinding, which is a sign of joint degradation or abnormal contact between bones, often due to conditions like arthritis or injury. This measurement helps assess the extent of wear and tear on a joint guiding treatment options by indicating the level of joint damage or the need for interventions like physical therapy, joint injections, or surgery (3,10).

The dynamometer-assessed grip strength (often associated with the Kapandji test in hand assessments) is a test used to evaluate hand strength, specifically the ability to grip, which is an indicator of both hand and overall upper body muscle strength. This assessment is typically performed using a handheld device called a dynamometer that measures the maximum force exerted when a person squeezes the device. In a clinical or physical therapy setting, grip strength is tested with the patient's elbow at a 90-degree angle or fully extended, depending on the testing protocol. This measure is valuable because reduced grip strength is associated with conditions like arthritis, tendon injuries, nerve compression syndromes, and age-related muscle degeneration. The Kapandji scoring system complements the dynamometer strength by grading thumb opposition (thumb's ability to touch each fingertip and certain points on the hand), giving a score that reflects fine motor skills and functional range of motion. This combination of dynamometer strength and Kapandji score provides a better picture of hand function, often used in occupational therapy, rehabilitation, and sports medicine (3,10).

Time to return to personal activities measures the duration it takes for an individual to resume everyday tasks or hobbies following an injury, surgery, or treatment. This metric is typically evaluated in weeks or months and is determined through patient self-reports or follow-up assessments by healthcare providers. The patients were asked when they can comfortably and independently perform specific daily activities (e.g., dressing, cooking, or driving). Tracking this time helps in assessing recovery progress, treatment effectiveness, and predicting outcomes for similar cases (17,18).

The patient-reported satisfaction metric reflects a patient's personal assessment of their experience and outcome following a medical treatment, surgery, or therapeutic intervention. This was gathered through Michigan Hand Outcomes Questionnaire (MHQ) questionnaire (18), where patients rate their satisfaction on aspects like pain relief, functionality, appearance, and overall quality of life improvements.

Statistical analysis

A sample size of no less than 24 patients per group was estimated to provide a statistical power of 90% to identify a substantial effect size (Cohen's f: 0.40) with 1 degree of freedom and a significance level of p=0.05 on the Range of Motion assessment. T-student, χ^2, and Fisher's exact tests were used to evaluate initial discrepancies among the randomized groups. A two-factor Analysis of Variance (ANOVA) with repeated measures was employed to assess the interaction between time and techniques. Data were logarithmically transformed to ensure normality, and findings are expressed as mean±standard deviation (SD).

RESULTS

Out of the initial cohort of 160 patients, ten patients (nine patients with rheumatoid arthritis and one with post-traumatic osteoarthritis) were excluded for not having met the inclusion criteria, resulting in the final cohort of 150 patients. Sixty five patients had suspended arthroplasty using the abductor pollicis longus tendon interposition (Weilby modified Operation) (Group A), and 85 patients had arthroplasty using the new method (Parrone procedure) (Group B). Age, gender, and Basal Joint Arthritis (BJA) stage did not differ preoperatively between the two groups (Table 1).

Table 1. Characteristics of two patient groups

Characteristic	Group A (APL arthroplasty)	Group B (Novel technique)	p
Gender F/M	60/5	72/13	p=0.268
Age mean±SD (years)	62.5 ± 7.9	61 ± 8.5	p=0.376
Eaton-Littler third stage (N)	9	24	p=0.284
Eaton-Littler fourth stage (N)	56	61	p=0,0237
Surgical time mean ±SD (minutes)	43 ± 8.23	40.1 ± 6.97	p=0.029

APL, abductor pollicis longus; M, male; F, female; N, number of patients

Radiographic assessments revealed a proximal shift of the first metacarpal relative to the scaphoid in both groups. Surgical time (Tourniquet) was longer in Group A compared to Group B (43 ± 8.23 minutes vs. 40.1 ± 6.97 minutes; p=0.029) (Table 1).

The mean length of time between the last evaluation and surgery was 4.5 years, ranging from 32 to 72 months. All patients completed follow-up, with no reports of long-term postoperative complications except for one case of delayed wound healing, which resolved spontaneously about 45 days after surgery.

Both groups experienced significant reductions in pain postoperatively. At the final follow-up, the NPRS score decreased in Group A from 7.46 ± 1.34 to 1.85 ± 0.96 and in Group B from 6.72 ± 0.94 to 0.95 ± 1.15 (p=0.243) (Table 2). There was a significant postoperative improvement in the DASH score. Thumb metacarpophalangeal joint flexion-extension also improved, with significant increase in both groups (p=0.008). However, there was no significant difference in thumb opposition between the two groups postoperatively (p=0.789). Both groups showed improvements in pulp pinch strength and hand grip strength postoperatively, although the differences were not statistically significant (p=0.217 and p=0.198, respectively). Additionally, there was a decrease in the DASH score from 72.10 ± 3.98 to 10.20 ± 4.73 in Group B and from 68.13 ± 7.88 to 19.81 ± 10.81 in the Group B (p=0.012). Thumb metacarpophalangeal joint flexion-extension also improved (p=0.008), with Group A rising from 50.63 ± 12.48 to

58.42 ± 13.91 and Group B improving from 57.74 ± 7.83 to 69.32 ± 8.13. Before surgery, all patients in group A had thumb opposition with a Kapandji grade of 4.63 ± 1.1, while patients in group B had 4.52 ± 1.31. Afterwards, only 21 patients in Group A recovered complete abduction (grade 9), while 50% were able to touch the little finger pulp reaching grade 7. A thumb opposition of grade 8 ± 0.9 was noted in Group B, with five patients failing to reach grade 9 (p=0.789). All patients had a positive grinding test before surgery; subsequently, Group B showed a considerable improvement, with all patients having a negative grinding test after surgery, while 30% of patients in Group A continued to have a positive sign (p=0.700). The postoperative values of pulp pinch strength in Group A increased from 3.08 ± 0.79 kg to 4.07 ± 1.12 kg, while in Group B it grew from 2.87 ± 1.47 kg to 5.15 ± 2.83 kg (p=0.217). Additionally, both groups' hand grip strength increased after surgery: Group B rose from 27.1 ± 12.1 kg to 32.3 ± 13.6 kg (p=0.198) and Group A grew from preoperative values of 21.8 ± 5.9 kg to 24.1 ± 6.3 kg. In all groups, radiographic evaluation showed a proximal migration of the first metacarpal (MC) in relation to the scaphoid. At the last follow-up, the distance was 5.2 ± 1.2 mm in Group A, down from 6.9 ± 1.3 mm in the immediate post-operative period. The immediate post-operative gap in Group B was 7.5 ± 1.3 mm; however, it decreased to 4.9 ± 1.6 mm with an average step off of 2.6 mm (p=0.364). Group A experienced surgical time (Tourniquet) of 43 ± 8.23 minutes, while Group B experienced 40.1 ± 6.97 minutes (p = 0.03) (Table 2).

Complications such as complex regional pain syndrome and scar hypersensitivity were minimal and resolved spontaneously in the majority of cases. Notably, the prevalence of Flexor Carpi Radialis (FCR) tendinitis was significantly lower in the group managed with the novel technique compared to the conventional technique.

DISCUSSION

A variety of management strategies exist for basal thumb arthritis, each potentially effective in pain relief. However, no single procedure has shown to be superior, despite theoretical benefits such as preserving trapezial height (19). Long-term data on improvement and cartilage repair with regenerative therapies are limited (20). While arthrodesis of the trapeziometacarpal joint can yield good functional outcome with low to moderate patient-reported disability and pain, it is associated with a high complication rate (21,22). Given that trapezectomy and arthrodesis are now considered outdated by some authors (5,21–27), tenoplasty and prosthesis are considered as the primary surgical options (28–42).

The complications observed with the conventional technique (5,13,25–30) highlight its limitations and justify the adoption of the novel surgical approach. Complications such as radial nerve lesions, de Quervain's syndrome, and APL tendon rupture were prevalent in the cohort managed with the conventional technique (25–30,33,35,36). Additionally, joint instability and first ray detachment were observed, likely due to compromised radial joint capsule integrity (25–27,30). These complications underscore the challenges associated with the conventional approach, including aesthetic concerns, compromised tendon integrity, and prolonged recovery periods (25–36). Given these challenges, prostheses have increasingly been preferred over interposition tendon arthroplasty (31–40).

A recent prospective randomized study comparing trapeziectomy with tendon interposition arthroplasty to total joint replacement using the Touch TMC prosthesis (KeriMedical, Geneva, Switzerland) suggested that joint replacement should be preferred, reserving interposition arthroplasty for cases involving prosthetic complications or scaphoid-trapezium-trapezoid osteoarthritis (33). Other comparative studies found no significant differences in outcomes between 6 months and 1 year postoperatively, though total joint arthroplasty showed a significant advantage in strength and range of motion (34–39).

The most common complications of interposition arthroplasty are subsidence and tendinitis, whereas the greatest advantage of prosthesis use is the near-total absence of these complications. The Suture Button Suspensionplasty technique for thumb carpometacarpal joint osteoarthritis was developed to improve upon trapeziectomy while avoiding these complications (41,42). However, both prosthesis and suture button suspensionplasty are costly. In response to these limitations, a novel and cost-effective suspensionplasty technique has been introduced (Figure 2) (41,42). This technique eliminates the need for APL tendon mobilization and minimizes incision size, reducing the risk of joint instability and first ray detachment by avoiding the radial joint capsule. Moreover, biological integration of the tendon within the first metacarpal base and joint capsule reduces the need for prolonged immobilization and decreases the likelihood of postoperative stiffness.

Our radiographic assessments revealed no subsidence or suspension loss in either group, indicating the stability of the joint following surgery. Given that FCR tendinitis can hinder postoperative recovery and diminish quality of life, the reduced prevalence observed with the novel technique suggests its supe-

Table 2. Outcome assessment of subjective and objective parameters of two patient groups

Clinical parameters	Group A (APL arthroplasty)		Group B (Novel technique)		p
	First evaluation	Last follow up	First evaluation	Last follow up	
			Mean ±SD		
NPRS	7.46 ± 1.34	1.85 ± 0.96	6.72 ± 0.94	0.95 ± 1.15	0.243
DASH	68.13 ± 7.88	19.81 ± 10.81	72.10 ± 3.98	10.20 ± 4.73	0.012
ROM (°)	50.63 ± 12.48	58.42 ± 13.91	57.74 ± 7.83	69.32 ± 8.13	0.008
Kapandji test*	4.63 ± 1.1	7.36 ± 0.75	4.52 ± 1.31	8.4 ± 0.98	0.789
Pulp pinch strength (kg)	3.08 ± 0.79	4.07 ± 1.12	2.87 ± 1.47	5.15 ± 2.83	0.217
Hand grip strength (kg)	21.8 ± 5.9	24.1 ± 6.3	27.1 ± 12.1	32.3 ± 13.6	0.198
Metacarpal shift (mm)	6.9 ± 1.3	5.2 ± 1.2	7.5 ± 1.3	4.9 ± 1.6	0.364
Grinding (%)	100	27	100	5	0.700

*dynamometer-assessed grip strength;
NPRS, Numeric Pain Rating Scale; DASH, Disability of the Arm, Shoulder and Hand; ROM, Range of movement;

riority in preserving tendon integrity and minimizing postoperative complications. These findings are consistent with previous studies reporting favourable outcome with the novel technique (41,42). However, further comparative studies, particularly those with larger sample sizes and long-term follow-up, are needed to fully elucidate the benefits of this approach compared to traditional techniques.

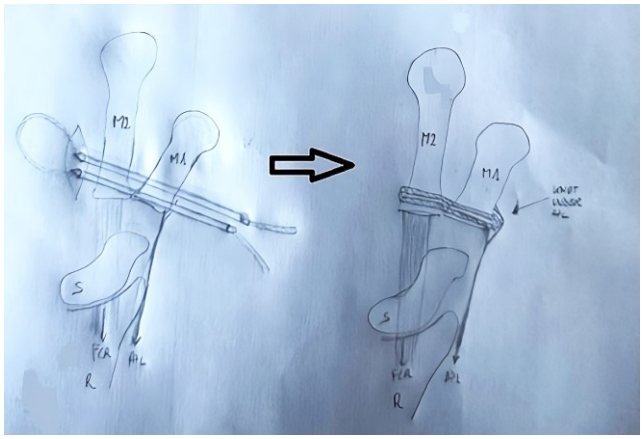

Figure 2. ***Parrone's technique*** (Parrone G., 2024). M1, first metacarpal; M2, second metacarpal; S, scaphoid; R, radius; APL, abductor pollicis longus

We can conclusively affirm that, following the refinement of the conventional technique, our past experience indicated a favourable outcome in 90% of patients, irrespective of patient age. However, after numerous years and the successful management of countless rizhoarthrosis cases, our preference now unequivocally favours the novel technique. This preference is underscored by several key advantages: the technique's minimally invasive approach, absence of tendon sacrifice, elimination of the necessity for a robust joint capsule for reconstruction, and the omission of plaster immobilization with its associated tissue integration challenges. Moreover, the elimination of postoperative rigidity necessitates a more extended course of physiotherapy for recovery. Crucially, patient satisfaction corroborates our preference for the novel technique. Patients with bilateral disease, initially managed with the conventional technique and subsequently treated with the novel technique, consistently reported reduced pain levels and experienced simpler and faster rehabilitation.

In conclusion, the novel surgical technique offers several advantages over conventional methods, including enhanced pain management, improved aesthetic outcomes, and better preservation of tendon integrity. Although complications were minimal with both techniques, the lower prevalence of FCR (Flexor Carpi Radialis) tendinitis with the novel technique highlights its potential to improve postoperative recovery and patient satisfaction.

AUTHOR CONTRIBUTIONS

Conceptualization, G.P. and R.DV.; Methodology, G.P., A.C. and R.DV.; Writing – original draft, G.P. and A.C.; Data curation, A.C., G.FC and L.C.; Software, A.C.; Investigation, G.FC., A.M. and A.DM; Formal Analysis, M.CG.; Validation, M.CG. and R.DV.; Supervision, A.M. and R.DV.; Writing – review & editing, R.DV. All authors have read and agreed to the published version of the manuscript.

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TRANSPARENCY DECLARATION

Conflict of interests: None to declare.

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