

# Patient Outcomes of Thumb Arthroplasty Using a Hybrid Technique for Severe Osteoarthritis

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**Background:** Patient-based evaluations effectively quantify a patient's perception of the impact of a disorder and surgical results. With multiple surgical techniques for thumb carpometacarpal (CMC) arthritis, we propose a hybrid technique combining trapeziectomy with ligament reconstruction and tendon interposition and suture button suspensionplasty to evaluate its statistical significance and clinical relevance.

**Methods:** We conducted a retrospective study on patients receiving primary surgery of combining trapeziectomy with ligament reconstruction and tendon interposition and suture button suspensionplasty for advanced osteoarthritis from 2017 to 2023. Patient-reported outcome measurements (PROMs) including Quick Disabilities of the Arm, Shoulder and Hand, pain visual analog scale (VAS), and single assessment numeric evaluation (SANE) were analyzed at 2 years. Receiver operating characteristic curves derived clinically significant outcome (CSO) thresholds of minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient acceptable symptom state (PASS).

**Results:** PROMs from 32 hands (31 patients) exhibited significant difference at 2 years postoperatively. CSO thresholds of MCID were 18.2, 1, and 70 for Quick Disabilities of the Arm, Shoulder and Hand, VAS, and SANE, respectively. SCB values were 15.9, 1, and 75, and PASS were 18.2, 0, and 80. More than 80% of patients achieved CSO thresholds in all 3 scores, except for PASS in VAS and SANE scores, with 70% and 72% of patients reaching these cutoff values.

**Conclusions:** Significant improved difference were observed in 2-year PROMs, with most patients achieving MCID and SCB but not PASS for VAS and SANE scores. Continued observation of patients' perspectives on this surgery is warranted. (*Plast Reconstr Surg Glob Open* 2025;13:e6630; doi: [10.1097/GOX.00000000000006630](https://doi.org/10.1097/GOX.00000000000006630); Published online 10 April 2025.)

## INTRODUCTION

Thumb carpometacarpal (CMC) joint consists of a trapezium that resembles a saddle, and a metacarpal base, which has a reciprocating concavity to match the geometry.<sup>1</sup> This unique osseous morphology is integral for a wide range of motion including flexion-extension,

abduction-adduction, and opposition<sup>1</sup> but rendered with potential instability and protected by an elaborate arrangement of ligaments and muscles, particularly the anterior volar and dorsal ligaments.<sup>2,3</sup> Deformity of the CMC joint results in functional limitations manifesting as pain, weakness, and compromised execution of daily activities. Thumb CMC arthritis occurs in 5%–33% of adults, with most patients being female.

There are multiple surgical techniques for the treatment of thumb CMC arthritis involving trapezium-preserving or trapezium-sacrificing procedures depending on the condition of the trapezium<sup>1</sup> without a consensual gold standard. Currently, the 2 most commonly used techniques are trapeziectomy with ligament reconstruction and tendon interposition (LRTI), and Mini TightRope suture button suspensionplasty (SBS). The ideal goal of surgical treatment is removal of the arthritic joint while providing pain relief and restoration of thumb function.<sup>4,5</sup>

In recent years, patient-based evaluations have become well accepted as a means to quantify a patient's

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perception of the impact of a disorder and surgical results.<sup>6,7</sup> Statistically significant changes cannot provide information about the magnitude of a treatment effect and therefore may not be meaningful to either the patient or surgeon. To interpret whether a statistically significant treatment effect is also clinically relevant, parameters for clinically significant outcome (CSO) analysis have been developed. These parameters, used to evaluate the clinical relevancy of patient-reported outcome measures (PROMs), include the minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient acceptable symptom state (PASS).<sup>6,8,9</sup> Though the PROM information system was introduced in 2004 by the National Institutes of Health, there are still limited studies specific to the field of orthopedics and, particularly, of the hand and upper extremities.<sup>10,11</sup>

The purposes of this study were to (1) present a hybrid technique by using a combination of LRTI and SBS in treatment of advanced arthritis of thumb CMC joints and (2) report on the achievement rate of CSOs for PROMs at a minimum 2-year follow-up after surgical treatment. We hypothesized that meaningful MCID, SCB, and PASS values could be derived for PROM scores, and most patients would achieve CSO thresholds at 2-year follow-up.

## MATERIALS AND METHODS

We performed a retrospective study from 2017 to 2023 at our tertiary center. We included patients with symptomatic Eaton stage 3 or 4 thumb CMC osteoarthritis who received surgery with our technique. Exclusion criteria included patients who had a follow-up period less than 2 years or those who received revision surgery. Ethical committee clearance was obtained from the institute before study commencement.

### Surgical Technique

Surgery was performed under general anesthesia with tourniquet application. Volar incision was made on the radial border of the thenar eminence with the thenar muscle peeled from the base of the first metacarpal and trapezium. The trapezium was excised. The flexor carpi radialis (FCR) splitting tendon graft was harvested from the proximal part, and the distal insertion remained attached (Fig. 1A). We split the FCR tendon longitudinally, so that the harvested radial half was fit to pass antegradely through the predrilled bone tunnel of the first metacarpal base, and then sutured back to the FCR insertion to stabilize the intermetacarpal joint. The remaining free end of the split graft served as an interposition spacer to fill the defect created from the trapeziectomy. Then, we passed a provisional Kirschner guide wire through the base of the first and second metacarpals (Fig. 1B). The position was confirmed using a portable fluoroscope. A CMC Mini TightRope (Arthrex, Naples, FL) was channeled through this Kirschner guide wire and was fixed under appropriate tension for suspensionplasty. Postoperatively, plain radiographs of the hand were taken in both posteroanterior and oblique views (Fig. 2). Patients were rigidly immobilized in a thumb spica splint

## Takeaways

**Question:** What are the clinically significant outcome achievement rates for patient-reported outcome measures using a hybrid technique of ligament reconstruction and tendon interposition and suture button suspensionplasty for thumb carpometacarpal osteoarthritis?

**Findings:** Of 32 hands surveyed, more than 80% of patients achieved clinically significant outcome thresholds. Patient acceptable symptom state in visual analog scale and single assessment numeric evaluation were achieved by 70% and 72%, respectively.

**Meaning:** The hybrid technique for thumb carpometacarpal osteoarthritis achieves clinically significant patient-reported outcome measures.

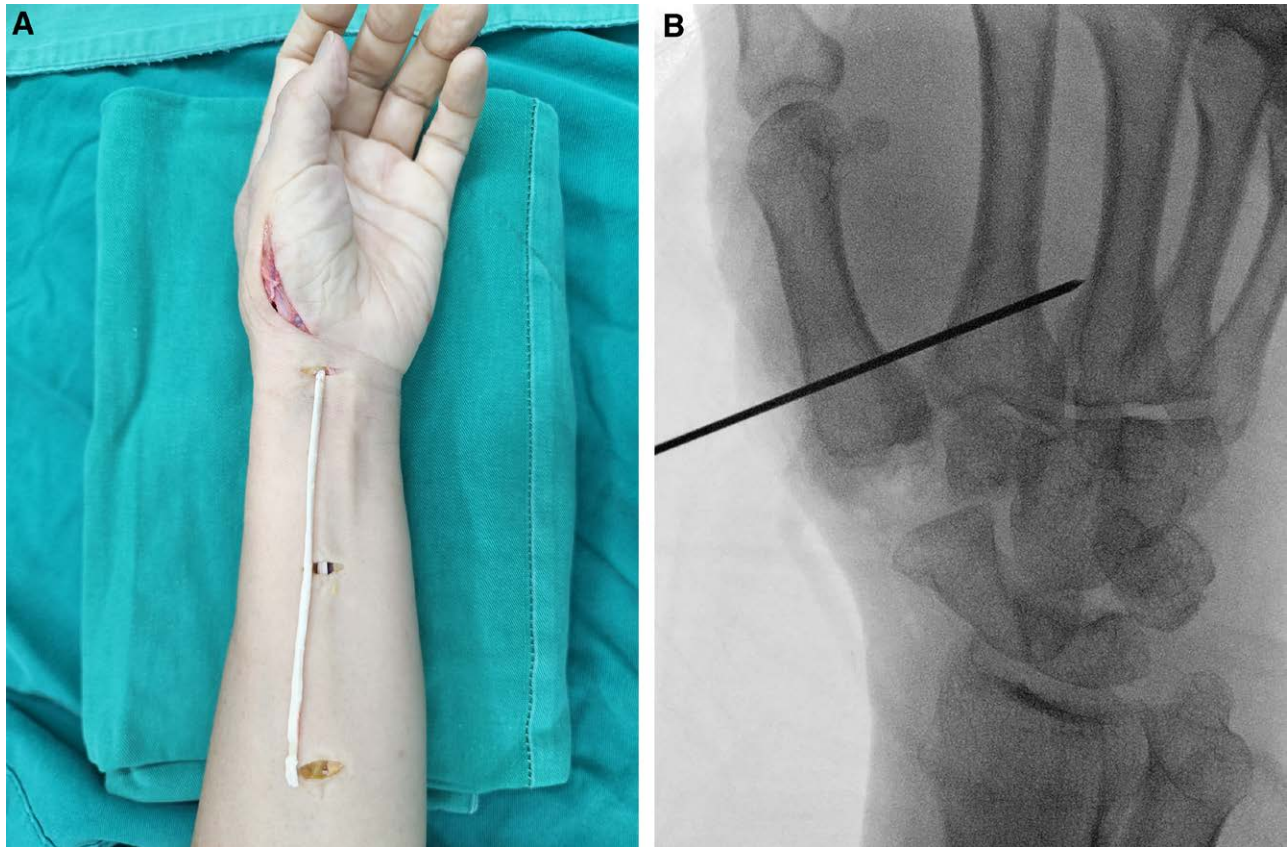
for 6 weeks and then transitioned to a removable hand-based orthosis. Hand therapy with gentle thumb and wrist motion was started at this time with gradual strengthening initiated at 8–12 weeks after surgery. The orthosis was weaned at 3 months, permitting the patient to increase activities gradually as tolerated. Remarkably, our patients did not have impressive postoperative edema, and recovery was rather straightforward.

### Patient-reported Outcome Questionnaires

PROMs were conducted with preoperative and postoperative questionnaires. The pain visual analog scale (VAS) is a self-reported pain rating scale recorded with a single handwritten mark placed at 1 point along a 10-cm line that represents a continuum between the 2 ends of the scale—“no pain” on the left end (score 0) and “worst pain” on the right end (score 10).<sup>12</sup> The Quick Disabilities of the Arm, Shoulder and Hand (qDASH) is an 11-item questionnaire that addresses symptoms and physical function of the upper extremity.<sup>7</sup> It provides a summative score on a 100-point scale, with 100 indicating the most disability. Scores are obtained by summing circled responses, dividing the total by the number of items completed, subtracting 1, and then multiplying that figure by 25. The single assessment numeric evaluation (SANE) comprises a single question asking the patient to write down a number between 0 and 100 that reflects what percentage of normal they would assign their current status to.<sup>13</sup> This score would be influenced by the patient’s expectations, previous health state, symptoms, limitations, and recovery experience.<sup>13</sup>

### Anchor Questions

CSO thresholds for qDASH, VAS, and SANE scores were derived through anchor-based methods with anchor questions addressing changes in symptoms to determine CSO thresholds. To derive the MCID and SCB, patients were asked to evaluate their current postoperative state compared with before surgery. The question includes 4 response items: A, none; B, poor; C, good; and D, excellent.<sup>6</sup> The description for each of the responses is provided in Table 1. If the patient answered A or B, they were placed in the unchanged group. The unchanged group was used as the control group for this study. If they answered C or D,



**Fig. 1.** A split FCR tendon graft is harvested from the right forearm using 3 separation incisions. A, Harvest of the FCR graft. B, Intraoperative plain radiograph after trapeziectomy is completed, and K-wire is passed through the first and second metacarpal base.

they were placed in the changed and improved group, respectively. The anchor question “Are you satisfied with the surgery given your current pain level, function, and daily life” used to determine the PASS consisted of a yes or no question regarding surgical satisfaction.<sup>6</sup> Those who answered yes were classified as satisfied, and those who answered no were classified as unsatisfied.

#### Statistical Analyses

The preoperative and postoperative comparisons of SANE, VAS, and qDASH scores were evaluated by the *t* test. A *P* value of less than 0.05 was considered statistically significant. Receiver operating characteristic (ROC) curves were drawn from each score, and the area under the curve (AUC) was calculated. An AUC greater than or equal to 0.7 was considered acceptable, and an AUC greater than or equal to 0.8 was considered excellent. The MCID and SCB were derived using the between-patients change and the sensitivity- and specificity-based approach.<sup>8</sup> The PASS was derived using the sensitivity- and specificity-based approach alone. The optimum cutoff value between the unchanged and changed groups was determined to be the MCID value; the optimal cutoff value between the unchanged and improved groups was the SCB value; and the optimal cutoff value between the unsatisfied and satisfied groups was the PASS value.<sup>6</sup> An ROC curve analysis was performed using the reference

software MedCalc (v19.0.7; MedCalc Software bvba), and other statistical analyses were conducted with SPSS for Windows (v 24.0.0.0; IBM Corp).

## RESULTS

In total, our study had a total of 31 patients and 32 hands. The baseline demographic data are presented in Table 2. Another 2 patients (2 hands) were excluded and had only 1-year PROMs, which were above the mean scores of the included patients and may interfere with the general outcomes. There were 4 men and 27 women with the mean age of 57.6 years (range, 29–75 y) on receiving surgery. Surgery was performed on 13 right hands, and 19 left hands. Preoperative Eaton and Littler Classification was stage 3 in 15 hands and stage 4 in 17 hands.

The mean preoperative scores in qDASH, VAS, and SANE were 38.4 (range, 31.8–52.4), 4 (range, 2–6), and 21.9 (range, 10–35), respectively; mean 2-year scores, 14.1 (range, 6.8–25), 0.4 (range, 0–2), and 76.6 (range, 65–90), respectively (Table 3). All 3 PROM scores exhibited significant difference between preoperative status and 2-year follow-up. CSO analysis using ROC was performed to count AUC and determine the optimal cutoff values of the MCID, SCB, and PASS for each PROM score (Table 4). The MCID values for qDASH, VAS, and SANE scores at 2 years were 18.2, 1, and 70, respectively. The SCB values for qDASH, VAS, SANE were 15.9, 1, and 75 respectively.





**Fig. 2.** Postoperative plain radiographs of the hand in posteroanterior (A) and oblique (B) views.

**Table 1. Anchor Questions Modified and Derived From Kim et al**

Answer	Description	Group
MCID and SCB		
Compared with before surgery, how is your current postoperative state?		
A: none	No improvement of pain and discomfort	Unchanged
B: poor	Slight improvement but pain and discomfort remains	Unchanged
C: good	Improvement of pain and discomfort compared with before surgery preoperative status; experiences occasional discomfort	Changed
D: excellent	Satisfactory improvement of pain and discomfort, no discomfort experienced	Improved
PASS		
Are you satisfied with the surgery given your current pain level, function, and daily life?		
Unsatisfied	Patients not satisfied with present symptoms and functional state	Unsatisfied
Satisfied	Patients satisfied with present symptoms and functional state	Satisfied

**Table 2. Baseline Demographic Data**

	Mean ± SD or No. (%)
Age, y	57.6 (range 29–75)
Sex	
Male	4 (13)
Female	27 (87)
Hand	
Right	13 (41)
Left	19 (59)
Eaton-Littler classification	
Stage 3	15 (47)
Stage 4	17 (53)

Surgery was performed in 32 hands.

Moreover, the PASS values for qDASH, VAS, and SANE were 18.2, 0, and 80, respectively. At 2-year follow-up, more than 80% of patients achieved cutoff values of CSO thresholds in all 3 scores except the PASS values in VAS

and SANE scores. PASS cutoff values for VAS and SANE scores were achieved by 70% and 72% of the study population, respectively.

## DISCUSSION

### Surgical Techniques for Thumb CMC Arthritis

Since simple trapeziectomy was first introduced by Gervis<sup>14</sup> in 1949, various modifications with recent technical and innovative advances have sought to improve long-term outcomes. Operative treatment for thumb CMC arthritis can be divided into trapezium sparing and sacrificing procedures. The overall choice regarding trapezium sparing and sacrificing procedures seems dependent on patient-related factors and surgeon preference. Currently, favored choices in published literature include a total trapeziectomy with either an LRTI or SBS.<sup>15</sup> LRTI involves using part or all of a distally based FCR tendon

**Table 3. Patient-reported Outcome Measures**

N = 32	Preoperative	2 Y	Delta	P
qDASH	38.4 ± 5.1	14.1 ± 4.6	24.4 ± 0.8	<0.01
VAS	4.0 ± 1.0	0.4 ± 0.8	3.6 ± 0.9	<0.01
SANE	21.9 ± 6.9	76.6 ± 7.6	54.7 ± 11.5	<0.01

**Table 4. MCID, SCB, and PASS Values for Each Score at 2 Years**

	Cutoff*	Hands†	Sensitivity	Specificity	AUC
qDASH					
MCID	18.2	30 (94%)	0.916	0.776	0.767
SCB	15.9	26 (81%)	0.867	0.758	0.713
PASS	18.2	30 (94%)	0.95	0.91	0.857
VAS					
MCID	1	28 (88%)	0.833	0.656	0.704
SCB	1	28 (88%)	0.933	0.65	0.7
PASS	0	25 (70%)	0.9	0.611	0.757
SANE					
MCID	70	30 (94%)	0.958	0.667	0.951
SCB	75	27 (84%)	0.901	0.733	0.742
PASS	80	23 (72%)	0.95	0.857	0.714

\*Cutoff thresholds of MCID, SCB, and PASS for improvement of each score.

†The number of hands achieving the cutoff thresholds.

AUC, area under the curve.

to suspend the thumb metacarpal while creating an interposition arthroplasty within the trapezial space created by the trapeziectomy, to prevent the first metacarpal from migrating and contacting the scaphoid.<sup>1,2,15</sup> Disadvantages of this technique include the morbidity associated with tendon harvesting, such as scar and adhesion formation, hematoma, neuroma, and complex regional pain syndrome.<sup>1</sup> SBS involves a braided, nonabsorbable suture placed at the insertion of the abductor pollicis longus (APL) and FCR tendons, creating a suture sling to support the thumb metacarpal base.<sup>16</sup> SBS has been used to prevent subsidence and potentially improve functional outcomes with the use of a minimally invasive approach.<sup>1</sup> Superiority of this technique also comprises not requiring the need for tendon harvest and earlier rehabilitation and return to function.<sup>17</sup> Biomechanically, it is associated with superior maintenance of trapezial space height compared with LRTI, advocating for earlier rehabilitation.<sup>18</sup> Drawbacks include the risk of implant failure and pull-out of the suture button, risk of scaphoid abutment with excessive force, and that it is a self-paid item.<sup>19</sup>

#### Single Versus Combined Surgical Technique?

Our surgical technique includes a total trapeziectomy with split FCR suspension-interposition arthroplasty and augmentation with the Mini TightRope. Although most studies in the literature describe a single LRTI or SBS method,<sup>15</sup> the reason we decided to use a combination of the 2 methods is to maximally enhance the stability of the CMC joint. This way, volar stability can be achieved and augmented by the LRTI method and dorsal stability by the SBS method. Stability of the thumb CMC joint is given great attention, as thumb metacarpal subsidence causes a biomechanical disadvantage, potentially resulting in weakness of thumb pinch strength and pain at the articulating joint.<sup>17,18</sup> With sufficient stability provided

by the combination of LRTI and Mini TightRope, SBS could reduce the postoperative immobilization period and allow earlier range of motion, speeding up the recovery process.<sup>18</sup> In a cadaveric study, SBS demonstrated greater resistance to metacarpal subsidence with incremental loading up to 20 lbs compared with LRTI (8.0 versus 5.5 mm) ( $P = 0.04$ ).<sup>15</sup> This result is supported by the study by Hooke et al,<sup>18</sup> which also showed greater maintenance of trapezial gap size with single Mini TightRope versus LRTI ( $P < 0.01$ ). SBS has also been shown to be an effective treatment option for revision of previous thumb CMC osteoarthritis surgery, with outcomes comparable to revision using LRTI, and the added benefit of shorter operative times and earlier mobilization.<sup>17</sup> Cost may be an issue, as SBS is a self-paid item in Taiwan. However, SBS is overall cost-effective, considering the reduced length of stay, hospital costs, and opioid use with this combined technique, compared with the costs associated with revision surgery if instability or subsidence results from a single surgical technique. Further studies on cost analysis and evaluation of the amount of time on average saved with our technique are warranted to determine actual cost-effectiveness. In the index surgery, we used only a half-split FCR tendon for LRTI and preserved another half, considering that the bone tunnel size and the role of FCR tendon as a carpal stabilizer<sup>20</sup> reduced this potential risk.

#### Patient-reported Outcomes and Clinical Findings

Statistical significance of outcome scores do not always equate with clinical significance, and consequently, establishment of MCID, SCB, and PASS is critical for the meaningful and objective interpretation of outcome measures in published studies and clinical practice.<sup>21</sup> Complementary to MCID, which sets a lower bound for clinically meaningful improvement, SCB represents the threshold for

improvement that patients would consider optimal.<sup>22</sup> Together, these values can be used to define a range of outcomes—from the smallest clinically meaningful change to the ideal treatment response.<sup>22</sup> Although MCID and SCB aid in the interpretation of PROM score changes, PASS represents the absolute PROM score at which patients would be satisfied with the symptoms.<sup>6,8,22</sup> It can be used by clinicians to set treatment goals and manage patient expectations. MCID, SCB, and PASS are context-dependent values that vary based on conditions, treatments, and patient population in which they are calculated.<sup>21,22</sup> It is therefore necessary to calculate MCID, SCB, and PASS values in a variety of patient populations to provide clinicians with appropriate benchmarks for use in research and clinical practice.

The CSO threshold of a given score can be calculated either through anchor-based or distribution-based methods.<sup>8,22,23</sup> Anchor-based methods are limited by the choice of an anchor question, which is a subjective assessment, and could be susceptible to recall bias and be influenced by the statistical distribution of scores within each category of the anchor question.<sup>8,22,24</sup> Distribution-based methods are purely statistical approaches, do not use clinical questionnaires, and are strictly related to baseline characteristics and results of the cohort of patients evaluated.<sup>8,24</sup> Furthermore, distribution-based methods do not address the question of the patient's perspective of clinically important change, which is a completely different perspective from a statistical significance.<sup>8,25</sup> This is the main reason we chose to calculate the CSO thresholds using anchor-based methods in our study.

Although SBS has gained popularity over the past decade as a dependable option for revision thumb CMC arthritis surgery,<sup>19,26</sup> there is a paucity of studies documenting the MCID, SCB, or PASS specifically among individuals diagnosed with thumb CMC osteoarthritis who underwent SBS alone or in combination. A retrospective review by Guerrero et al<sup>17</sup> demonstrated that SBS had outcomes comparable to those of LRTI, with the added benefit of shorter operative times and earlier mobilization. There was significant improvement in the VAS score for SBS, but not for LRTI, and the difference of qDASH scores was not significant between both groups. This suggested that SBS would be a better solution in many situations. The study by Wolf et al<sup>5</sup> reported on 130 patients who underwent trapeziectomy and APL suspension-interposition arthroplasty for thumb CMC arthritis and revealed similar outcomes to ours regarding pain VAS score and qDASH score. The main difference was the use of APL graft as opposed to FCR in our study and a single surgical technique versus a combined LRTI and SBS in ours. Another study by Randall et al<sup>27</sup> in 2022 reported the MCID and SCB for VAS-pain scores in postoperative hand surgery patients at up to 4 months follow-up. MCID and SCB were established with an anchor-based approach using the ROC analysis with an AUC of 0.72, consistent with acceptable discrimination. A systematic review performed by Wininger et al<sup>28</sup> compared the outcomes and complication rates of LRTI and SBS. They found similar

improved DASH/qDASH scores between the 2 methods. The MCID for qDASH was a 15-point difference, which was achieved by 87.5% of the LRTI group and 100% in the SBS group. Our study established CSO thresholds from PROMs using anchor-based methods. All except the PASS for VAS and SANE were achieved by more than 80% of the study population. Additional research with an extended period of observation within a larger cohort is warranted to elucidate patients' satisfaction concerning the index surgical intervention.

### Limitations

There are several limitations to this study, including small sample size and relatively short-term follow-up. Given that there are yet few publications regarding single SBS or combined surgery, PROMs resulting from our combined technique may not exhibit a meaningful dissemination on more complex surgery. In addition, there is no clear consensus on the best methodology to calculate and establish CSO thresholds. A study with a shorter or longer mean follow-up period may yield different results, due to the longitudinal changes in patient's physical function after surgery as well as the increase in recall bias inherent to longer follow-up periods in anchor-based MCID calculations.<sup>21</sup> Another limitation of this study is absent analysis of possible factors influencing the MCID, SCB, and PASS, such as cultural background, occupation (sedentary versus manual laborer), smoking status, and body mass index. It is crucial to underscore that when applying these values in clinical settings that they are not meant to be universal thresholds. Moreover, further studies comparing our hybrid with a single procedure technique, as well as reports on cost analysis and evaluation on saved time, are warranted.

## CONCLUSIONS

This is the first known study to date reporting the MCID, SCB, and PASS values for PROMs in patients receiving trapeziectomy with LRTI and SBS. This provides meaningful and objective clinical interpretation of improvements in outcomes scores after thumb CMC osteoarthritis surgery. In our study, we found significant improvement in qDASH, VAS, and SANE scores at 2 years postoperatively. CSO analyses showed that most patients were able to achieve the threshold value for MCID and SCB values but not for PASS regarding VAS and SANE scores. Therefore, sustained observation regarding patients' perspectives on the index surgery is warranted.

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### DISCLOSURE

*The authors have no financial interest to declare in relation to the content of this article.*

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