

The Use of Collagen-Based Filler for Trapeziometacarpal Osteoarthritis: Long-Term Follow-Up and Future Applications

CARTILAGE
2026, Vol. 17(3) 467–474
© The Author(s) 2025
DOI: 10.1177/19476035251354926
journals.sagepub.com/home/CAR


Massimo Corain¹, Niccolò Faccioli², and Umberto Lavagnolo^{1,3} 

Abstract

Background. Trapeziometacarpal osteoarthritis (TMO) is a prevalent degenerative condition. While conservative treatments such as physiotherapy, drugs, and corticosteroid or hyaluronic acid injections offer symptomatic relief, their long-term efficacy remains debated. A recent study has explored collagen-based fillers as an alternative, but long-term clinical outcomes are still under investigation. **Methods.** This study enrolled 64 patients diagnosed with TMO, stratified into 2 groups based on the Eaton-Littler classification (grade 1-2: group A; grade 3-4: group B). All patients received a percutaneous intra-articular injection of a cell-free collagenic hydrogel under ultrasound guidance. Outcomes were assessed more than 2 years using the Numeric Rating Scale (NRS) for pain, Jamar and Pinch tests for grip strength, and the Disability of the Arm, Shoulder, and Hand (DASH) questionnaire. **Results.** In both groups, all studied variables demonstrated a significant improvement ($P < 0.001$) that was sustained in the long term. Notably, greater improvement was observed in strength tests for Group A patients and in the DASH score for Group B patients. The most substantial improvement occurred between 2 and 6 months post-procedure. No adverse events were reported. **Conclusion.** Collagen-based filler injections provide long-term pain relief and functional improvement in TMO, representing a promising minimally invasive treatment option.

Trial registry name: NCT06881186

Keywords

thumb, infiltration, rhizarthrosis, ultrasound, orthobiologics

Introduction

Osteoarthritis of the trapeziometacarpal joint (TMO), also referred to as rhizarthrosis, is a degenerative condition that affects the joint between the first metacarpal bone and the trapezium.^{1,2} It is the second most frequent degenerative hand disease, following osteoarthritis of the distal interphalangeal joints.³ The occurrence of TMO increases significantly with age, with its prevalence reaching approximately 30% in postmenopausal women and as high as 91% in individuals above 80 years old.⁴ The higher incidence in women compared with men is not fully understood, though it may be influenced by anatomical differences, genetic factors, and hormones.⁵

Despite its prevalence, only a small proportion of patients develop symptomatic disease, which can lead to pain, swelling, and functional impairment, severely affecting the quality of life in advanced stages.^{2,5} According to the European League Against Rheumatism (EULAR), initial treatment should be conservative when symptoms first arise.

This may include physiotherapy, the use of nonsteroidal anti-inflammatory drugs (NSAIDs), ultrasound therapy, and the application of a brace during joint stressful activities.⁶ If pain persists and radiographic evidences show disease progression, infiltration therapy with hyaluronic acid (HA) or corticosteroids may be considered, although the effectiveness of these treatments remains a topic of debate.⁷⁻¹⁰ Some studies suggest that HA may offer better pain relief and

¹Hand Surgery Unit, University Hospital of Verona—Azienda Ospedaliera Universitaria Integrata di Verona, Verona, Italy

²Radiology Unit, University Hospital of Verona—Azienda Ospedaliera Universitaria Integrata di Verona, Verona, Italy

³Surgery, Dentistry, Maternity and Infant Department, University of Verona, Verona, Italy

Corresponding Author:

Umberto Lavagnolo, Surgery, Dentistry, Maternity and Infant Department, University of Verona, Piazzale Aristide Stefani 1, Verona 37126, Italy.

Email: umberto.lavagnolo@univr.it



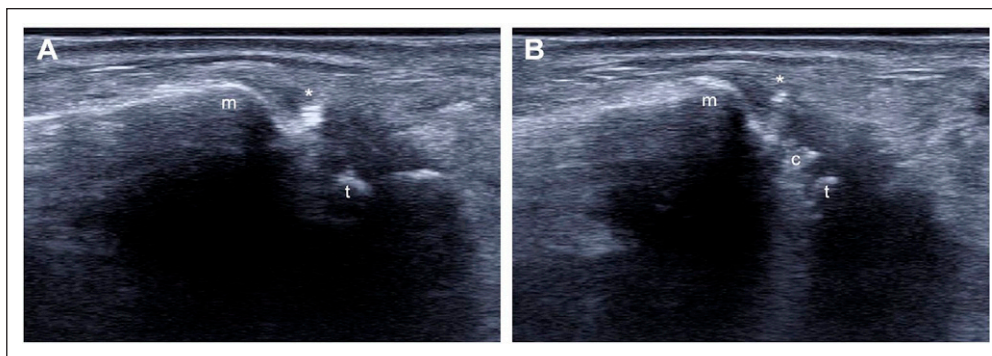


Figure 1. Ultrasound image of the trapeziometacarpal joint in a group A patient (stage I-II according to the Eaton-Littler classification) before **(A)** and after **(B)** the intra-articular injection. The collagen filler appears hyperechoic. * = needle; m = metacarpal; t = trapezium; c = collagen-based filler.

longer-lasting effects than corticosteroids, particularly in the early stages of the condition.¹¹⁻¹³ Conversely, corticosteroid injections may provide short-term relief by reducing inflammation.¹⁰ For patients who do not respond to conservative treatment and present with advanced symptomatic osteoarthritis, surgical options may be necessary.^{14,15} However, no single surgical method has been proven superior.¹⁶

The most widely used radiographic classification system for TMO is the Eaton-Littler classification, introduced by Richard Eaton and William Littler, which divides radiographic findings into 4 stages.^{17,18}

In recent years, the use of fillers (i.e., HA or Platelet-Rich Plasma [PRP]) for infiltration therapy has gained attention as a viable treatment option for TMO.¹⁹⁻²¹ A recent study has demonstrated positive clinical and radiographic outcomes with collagen-based filler, particularly in terms of pain relief and improved joint function.²² Importantly, these treatments do not interfere with the possibility of pursuing more invasive surgical options later on.

The objective of this study was to assess the long-term efficacy of treating TMO with a cell-free collagenic matrix hydrogel administered via percutaneous intra-articular infiltration under U/S guidance.

Methods

Sixty-four patients were enrolled during an initial outpatient clinical evaluation. All participants were adults with unilateral or bilateral TMO, diagnosed via radiographs obtained within the past year.

Patients were stratified into 2 groups (A and B) based on the Eaton-Littler classification: group A included patients with grade 1 or 2, whereas group B included those with grade 3 or 4. Exclusion criteria were defined as follows: prior cortisone and/or HA injections within the past 6 months, post-traumatic TMO, history of rheumatological diseases, age below 18 years old, current pregnancy, concomitant metabolic disorders such as diabetes.

The primary objective of the study was to evaluate the long-term effects of intra-articular injection of a cell-free

collagenic gel matrix into the TMO (ChondroFiller Liquid; Meidrix Biomedicals GmbH, Schelztorstraße 54-56, D-73728 Esslingen, Germany). Specifically, the following parameters were assessed: pain, using the Numeric Rating Scale (NRS);²³ grip strength, measured with the Jamar test;²⁴ pinch strength, evaluated with the Pinch tests (2-finger Pinch, 3-finger Pinch, and key Pinch);²⁵ and functional ability in daily activities, assessed using the Disability of the Arm, Shoulder, and Hand (DASH) questionnaire.²⁶

The secondary objectives were to evaluate the occurrence of any local or systemic adverse effects; to assess the efficacy of post-procedural immobilization, which was reduced compared with the previously established protocol;²² and to analyze potential statistical correlations between the assessed variables and age, sex, and the degree of TMO according to the Eaton-Littler classification.

Withdrawal of informed consent was established as the criterion for study discontinuation. The criteria for limb laterality or dominance were not deemed mandatory for enrollment.

Before the injection, the strength tests were administered, subjective pain levels were measured using the NRS, and the DASH questionnaire was completed (time 0—T0). The procedure was performed in a sterile outpatient operating room. Local anesthesia (1 ml of 2% lidocaine) was administered prior to the intra-articular injection. The injection was performed by a single operator with the patient in the supine position and under sterile field preparation. A portable ultrasound device (MyLabSigma; ESAOTE S.p.A., Genoa, Italy) equipped with a 4- to 15-MHz linear probe covered by a sterile sheath was used for guidance. The needle was introduced via a dorso-radial approach to the TMO, and proper intra-articular filling was confirmed in real time through ultrasound imaging²⁷ (**Fig. 1**). Following the injection, a fiberglass palm-to-thumb brace was applied, custom-molded to the patient's hand anatomy. This positioning brace was removed 2 weeks later during an outpatient visit, during which any observed adverse effects were also assessed.

A follow-up evaluation was conducted 60 days after the procedure (time 1—T1), assessing NRS and DASH scores

Table 1. Demographic Distribution of Treated Patients in the 2 Groups, Stratified According to the Eaton-Littler Classification (Group A: Stage I-II, Group B: Stage III-IV).

	GROUP A	GROUP B	
AGE	58.53 ± 8.30 years	67.97 ± 6.91 years	$P < 0.001^a$
GENDER	78.1% F 21.9% M	81.3% F 18.7% M	$P > 0.05^b$
SIDE	53.1% R 46.9% L	40.6% R 59.4% L	$P > 0.05^b$

A significant correlation was observed between group stratification and patient age ($P < 0.001$), marked in bold.

^aStudent's *t*-test.

^bChi-square test.

and performing strength tests. At 6 months (time 2—T2), 1 year (time 3—T3), and 2 year (time 4—T4) post-injection, all patients underwent other outpatient evaluations, including repeat Jamar and Pinch tests as well as reassessment of NRS and DASH scores. All the clinical evaluations were conducted by the same operator.

All statistical analyses were performed considering a significance threshold set at $P < 0.05$. Data were presented as mean ± standard deviation for normally distributed variables, and as median (interquartile range) for non-normally distributed variables.

A comprehensive statistical analysis was conducted to assess differences in demographic and clinical parameters between groups, as well as changes over time. All statistical tests were chosen based on the distribution of the data, which was assessed using the Shapiro-Wilk test for normality. For continuous variables, descriptive statistics were computed, including mean and standard deviation for normally distributed data, and median with interquartile range for non-normally distributed data. Differences in baseline characteristics between groups were evaluated using an independent Student's *t*-test for normally distributed variables and the Mann-Whitney *U* test for non-normally distributed variables. Categorical variables, such as gender and laterality, were analyzed using chi-square or Fisher's exact tests as appropriate.

To evaluate changes in clinical parameters over time within each group, a repeated-measures approach was employed. If a variable followed a normal distribution at all time points, a 1-way repeated-measures analysis of variance (ANOVA) was used to assess differences across time. For non-normally distributed variables, the Friedman test was applied.

Pairwise comparisons between consecutive time points (T0-T1, T1-T2, T2-T3, T3-T4) were performed separately for each group. If data were normally distributed, a paired *t*-test was used. In cases where normality was not met, the Wilcoxon signed-rank test was applied.

A multivariate linear regression model was constructed to investigate the influence of demographic factors, including age, gender, and group classification, on clinical outcomes. Regression coefficients and *P*-values were computed to determine the strength and significance of associations.

All values related to strength tests are expressed in kilogram-force (kgf).

Results

All enrolled patients completed the protocol, and no adverse events were recorded following the intra-articular injection. The 2 groups (i.e., A and B) were numerically homogeneous, each consisting of 32 patients. Age, sex, and laterality evidences are summarized in **Table 1**.

The Shapiro-Wilk test assessed the normality of the age distribution ($P = 0.11$). The independent Student's *t*-test showed a significant difference between the groups ($P < 0.001$).

Therefore, the chi-square test was applied to evaluate statistical differences, demonstrating a non-significant relationship between laterality or gender and disease severity ($P > 0.05$).

The results of the analyzed variables at different measurement points are summarized in **Figure 2** for group A and in **Figure 3** for group B. All collected data are summarized in **Table 2**; none of the analyzed variables showed a normal distribution. In group A, the Jamar test showed a marked increase up to T2, followed by stabilization at a plateau. In contrast, in group B, the test exhibited a continued, albeit minimal, progressive improvement. All pinch tests in group A followed a qualitative trend similar to that of the Jamar test, whereas in group B, improvement was observed only up to T1, followed by a plateau. Regarding pain assessment, the NRS showed a more pronounced reduction between T1 and T3 in both groups, with subsequent stabilization at T4. Functional disability, assessed using the DASH score, revealed a marked improvement in group A between T1 and T3, with a tendency toward slight worsening at T4. Conversely, in group B, the DASH score showed progressive improvement throughout all follow-up assessments.

JAMAR = Jamar test; PINCH 1 = 2-finger pinch test; PINCH 2 = 3-finger pinch test; PINCH 3 = key pinch test; NRS = Numeric Rating Scale; DASH = Disability of the Arm, Shoulder, and Hand questionnaire; T0 = intra-articular injection; T1 = 2 months; T2 = 6 months; T3 = 12 months; T4 = 24 months. To evaluate changes in clinical

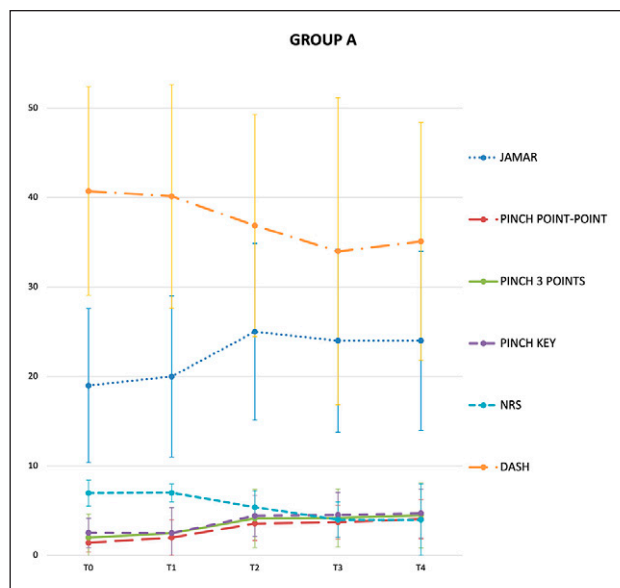


Figure 2. Graphical trend of the analyzed variables in group A (stage I-II according to the Eaton-Littler classification). JAMAR = Jamar test (kgf); PINCH POINT-POINT = 2-finger pinch test (kgf); PINCH 3 POINTS = 3-finger pinch test (kgf); PINCH KEY = key pinch test (kgf); NRS = Numeric Rating Scale (points); DASH = Disability of the Arm, Shoulder, and Hand questionnaire (points); T0 = intra-articular injection; T1 = 2 months; T2 = 6 months; T3 = 12 months; T4 = 24 months.

parameters over time, separate analyses were conducted for the 2 groups. In group A, the Friedman test demonstrated statistically significant changes in the Jamar test ($P < 0.001$), the 2-finger Pinch test ($P < 0.001$), the 3-finger Pinch test ($P < 0.001$), the key Pinch test ($P < 0.001$), the NRS ($P < 0.001$), and the DASH score ($P < 0.001$) across the time points. In group B, similar findings were observed,

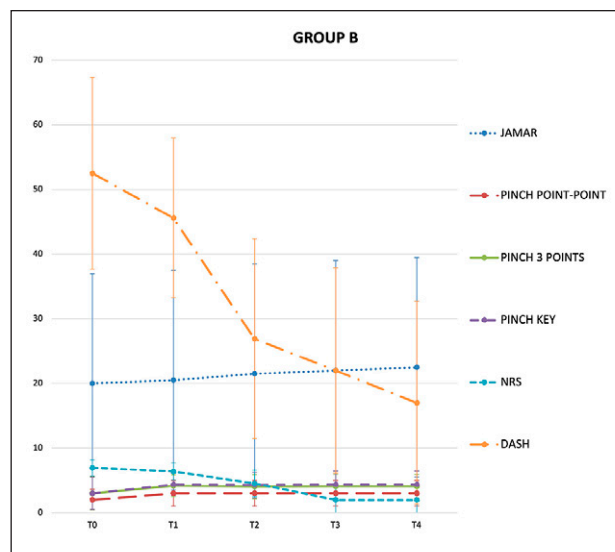


Figure 3. Graphical trend of the analyzed variables in group B (stage III-IV according to the Eaton-Littler classification). JAMAR = Jamar test (kgf); PINCH POINT-POINT = 2-finger pinch test (kgf); PINCH 3 POINTS = 3-finger pinch test (kgf); PINCH KEY = key pinch test (kgf); NRS = Numeric Rating Scale (points); DASH = Disability of the Arm, Shoulder, and Hand questionnaire (points); T0 = intra-articular injection; T1 = 2 months; T2 = 6 months; T3 = 12 months; T4 = 24 months.

with all primary variables exhibiting statistically significant within-group differences over time ($P < 0.001$).

To investigate specific differences between consecutive time points, the Wilcoxon signed-rank test was applied. The results are summarized in **Table 3**.

A multivariate regression model was applied to assess the influence of age, gender, and group classification on primary clinical outcomes. In reference to the gender, males exhibited higher Jamar scores across all time points,

Table 2. Collected Data for all Variables Analyzed at the Different Time Points of the Study in the 2 Groups Stratified According to the Eaton-Littler classification (Group A: Stage I-II, Group B: Stage III-IV). As all variables were non-normally distributed, data are presented as median (interquartile range).

	JAMAR	PINCH I	PINCH 2	PINCH 3	NRS	DASH
GROUP A						
T0	19 (16.6-25.3)	1.5 (0.5-2)	2 (0.9-3.5)	2.8 (1-3.6)	7 (6-8)	40.7 (30.8-46.3)
T1	20 (16.8-25.8)	2 (1-3)	2.5 (1.8-4.6)	2.5 (1.4-4.3)	7 (6-7)	39.6 (31.9-48)
T2	25 (20.4-30.3)	3.1 (2.4-5)	4.2 (3-6.3)	4.3 (2.4-7)	5.5 (4-6.3)	36.2 (27.7-44)
T3	24 (20.8-31)	3.8 (2.8-5)	4.2 (3-6.3)	4.3 (2.8-7)	4 (4-6)	34 (25.7-42.8)
T4	24 (21-31)	4.1 (2.8-5.5)	4.5 (3.4-7)	4.8 (2.8-7)	4 (2-6)	35.1 (25.8-39)
GROUP B						
T0	20 (16.5-33)	2 (1-2.8)	3 (2-4.8)	3 (2-4.5)	7 (6-8)	52.5 (43-67.2)
T1	21 (18.5-35)	3 (2-4)	4 (3-5)	5 (3-5.5)	7 (5-7.5)	46.7 (36.2-56.8)
T2	22 (18.5-35)	3 (2-4)	4 (3-5)	5 (3-5.5)	4 (3-6)	26.9 (15.5-30.3)
T3	22 (18.5-35)	3 (2-4)	4 (3-5)	5 (3-5.5)	2 (1.5-4)	22 (16.3-33.5)
T4	23 (18.5-35)	3 (2-4)	4 (3-5)	5 (3-5.5)	2 (1.5-4)	18 (12.2-28)

Table 3. Significance of Variables Considering Temporal Differences Between Consecutive Assessments in the 2 Groups Stratified According to the Eaton-Littler Classification (Group A: Stage I-II, Group B: Stage III-IV).

	GROUP A						GROUP B					
	JAMAR	PINCH I	PINCH 2	PINCH 3	NRS	DASH	JAMAR	PINCH I	PINCH 2	PINCH 3	NRS	DASH
T0-T1	0.003	0.002	<0.001	0.117	0.127	0.607	<0.001	<0.001	0.001	<0.001	0.053	0.002
T1-T2	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	1.000	0.281	0.147	0.444	<0.001	<0.001
T2-T3	0.400	0.027	0.940	0.210	0.008	0.005	0.083	0.325	0.325	0.169	<0.001	0.730
T3-T4	0.136	0.010	0.019	0.130	0.006	0.583	0.423	1.000	1.000	1.000	0.169	0.256

The Wilcoxon signed-rank test was applied for all evaluations.

Statistically significant differences are marked in bold.

JAMAR = Jamar test; PINCH I = two-finger pinch test; PINCH 2 = three-finger pinch test; PINCH 3 = key pinch test; NRS = Numeric Rating Scale; DASH = Disability of the Arm, Shoulder, and Hand questionnaire; T0 = intra-articular injection; T1 = 2 months; T2 = 6 months; T3 = 12 months; T4 = 24 months.

influencing grip strength measurements ($P < 0.001$). Moreover, a young age-related reduction in pinch strength ($P = 0.016$) has been detected. Finally, the degree of disease severity (i.e., A or B) had a significant impact on DASH scores ($P < 0.01$), confirming the increased functional impairment in Group B.

Participation in the study required signing an informed consent form. The study was approved by the local Ethical Committee and registered on the Protocol Registration & Results System (trial registry name: NCT06881186).

Discussion

This study demonstrated that intra-articular collagen injection in patients with TMO is effective in relieving pain, restoring strength, and reducing disability in daily activities. This surgical device, previously validated for TMO treatment,²² is further supported by this study, which includes a larger patient population and an extended follow-up period.

In reference to the conservative treatment of TMO, intra-articular injections of various substances have long been a common therapeutic approach.²¹ However, the long-term effects of such procedures remain unclear. Three of the most commonly used infiltrative treatments include corticosteroids, HA, and PRP.²⁸ Despite extensive investigation in multiple studies, their mid-term efficacy appears to be comparable, and studies reporting follow-up periods longer than 12 months are rare.⁸ For example, Bahadir *et al.*²⁹ reported that pain levels decreased significantly over 12 months in patients treated with steroid injections and over 6 months in those treated with sodium hyaluronate, while pinch strength did not improve in either group, but grip strength showed significant improvement in both. Wang *et al.*³⁰ reported significant improvements in pain, function, and patient satisfaction in individuals treated with two different HA-based viscosupplementation solutions, with effects lasting up to 2 years. However, Cormier *et al.*⁷ observed a significant reduction in activity-related pain 3 months after intra-articular injection with both HA and corticosteroids, whereas no

significant improvement was noted at 12 months or with regard to resting pain.

The acellular collagen-based filler is capable of providing a viscosupplementation effect along with an improvement in the intra-articular microenvironment in patients affected by osteoarthritis.^{31,32}

All enrolled patients completed the proposed protocol, demonstrating a high level of compliance, which could be interpreted as a strong interest in improving an otherwise debilitating clinical condition, particularly concerning daily activities.

This study demonstrated the feasibility of performing intra-articular injections in an outpatient setting under ultrasound guidance. This represents a significant methodological advancement, allowing for the application of the procedure in an office-based surgery context. Indeed, increasing attention is being paid to reducing the costs of surgical procedures,^{33,34} especially for high-incidence conditions such as TMO.

Regarding the analyzed variables, despite overall statistical significance being achieved for both patient populations, it is of interest to evaluate each group separately to distinguish trends based on the time of assessment.

For group A, grip and opposition strength tests showed the greatest improvement between months 2 and 6 post-procedure, followed by stabilization and maintenance of the acquired functionality (**Table 3**). Regarding pain and disability, the most significant improvements were observed between 2-6 and 6-12 months post-procedure. Pain continued to improve significantly across all analyzed time points, whereas improvement in disability was limited to the first year. Notably, a slight—though not statistically significant—worsening of disability was observed at the 2-year follow-up.

For patients in group B, although a slight graphical trend of improvement was observed, statistical significance in strength tests was detected only within the first 2 months post-injection (**Table 3**). Conversely, pain reduction was significant up to 6 months and then up to 12 months, followed by stabilization. Finally, disability showed consistent

graphical improvement, with statistically significant changes observed at 2 and 6 months post-procedure.

Thus, patients in group A appeared to exhibit a greater improvement in strength recovery than in disability reduction, whereas patients in group B demonstrated a more substantial reduction in reported disability compared with strength recovery. Furthermore, this observation is consistent with findings from the previous study.²² Hypothetically, younger patients with early-stage TMO may possess greater functional resources, allowing for a more effective restoration of joint mobility and mechanics, which are only mildly compromised by the disease. Conversely, their higher functional demands might lead to a subjectively perceived disability that is only partially resolved, despite improved overall functionality. In contrast, older patients with advanced disease likely have more structurally damaged joints, which cannot be substantially improved through intra-articular injections, thus limiting functional recovery. However, due to their lower functional demands, their subjective disability relief might be greater, ultimately leading to a more pronounced sense of overall well-being compared to group A patients. Multivariate regression analysis identified a notable correlation between male sex and significant grip strength improvement, as well as between younger age and improved opposition strength. In addition, group B patients exhibited a greater reduction in disability compared with group A patients; further studies with larger populations are required to clarify these considerations.

Comparison of the results of this study with similar reports in the literature is challenging due to the lack of other studies on intra-articular collagen injection, the limited standardization of study populations (particularly regarding disease stage), and the typically short follow-up periods investigated.

The main limitations of this study are the absence of a control group using other injectable treatments and the lack of a blinded protocol. Future studies should aim to compare the effects of collagen-based filler with other commonly used injectable therapies (e.g., corticosteroids, HA, PRP). Finally, it would be of interest to evaluate the actual economic impact of this procedure, particularly in comparison with other treatment options.

Given the widespread prevalence of TMO, implementing accessible treatments that minimize waiting times for traditional surgical interventions is crucial. This approach may help delay or even avoid surgical procedures, reserving them for advanced disease stages or as a second-line therapy.

Conclusions

This study demonstrates the long-term efficacy and safety of intra-articular injections of a cell-free collagen-based filler in patients with TMO. The treatment resulted in significant pain

reduction, improved grip and pinch strength, and enhanced functional ability, with greater strength recovery in early-stage patients and more pronounced disability reduction in advanced cases. Notably, the procedure was well tolerated, with no reported adverse events, and was successfully performed in an outpatient setting under ultrasound guidance. These findings support the use of collagen-based fillers as a viable conservative option for managing this condition, potentially delaying or reducing the need for surgical intervention. Further studies with larger cohorts and imaging-based assessments are warranted to confirm these results.

Acknowledgments

The authors acknowledge no external assistance except for the contributions of the study authors.

ORCID iD

Umberto Lavagnolo  <https://orcid.org/0000-0002-7614-812X>

Ethical Considerations

The study was reviewed and approved by the local Ethics Committee (approval number: 3185CESC). In addition, the trial was registered on the Protocol Registration & Results System (PRS) portal (NCT Number: 06881186).

Consent to Participate

All patients provided written informed consent for study enrollment, as approved by the local Ethics Committee. Withdrawal of informed consent was considered an indication of the patient's decision to discontinue participation in the study. All informed consents were collected and archived.

Consent for Publication

All patients provided written informed consent for the publication of the data collected during the study, as part of the informed consent approved by the local Ethics Committee. Withdrawal of informed consent was considered an indication of the patient's decision to withhold the publication of their collected data.

Author Contributions

MC conceived, planned, performed the treatments and conducted the study as the principal investigator, contributing to manuscript drafting. UL conducted the study, collected data, performed statistical analyses, and wrote the manuscript. NF contributed to the diagnostic imaging investigations performed.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

All data were recorded and archived at the institution where the study was conducted. These data are available for consultation upon formal request to the relevant administrative offices.

References

- Pellegrini VD Jr. Pathomechanics of the thumb trapeziometacarpal joint. *Hand Clin.* 2001;17(2):175-84.
- Katarincic JA. Thumb kinematics and their relevance to function. *Hand Clin.* 2001;17(2):169-74.
- Sodha S, Ring D, Zurakowski D, Jupiter JB. Prevalence of osteoarthritis of the trapeziometacarpal joint. *J Bone Joint Surg Am.* 2005;87(12):2614-8. doi:10.2106/JBJS.E.00104.
- Jonsson H. Age related prevalence of hand osteoarthritis diagnosed by photography (HOAScore). *BMC Musculoskelet Disord.* 2017;18(1):508. doi:10.1186/s12891-017-1870-0.
- Slatkowsky-Christensen B, Mowinckel P, Loge JH, Kvien TK. Health-related quality of life in women with symptomatic hand osteoarthritis: a comparison with rheumatoid arthritis patients, healthy controls, and normative data. *Arthritis Rheum.* 2007;57(8):1404-9. doi:10.1002/art.23079.
- Zhang W, Doherty M, Leeb BF, Alekseeva L, Arden NK, Bijlsma JW, *et al.* EULAR evidence based recommendations for the management of hand osteoarthritis: report of a Task Force of the EULAR Standing Committee for International Clinical Studies Including Therapeutics (ESCISt). *Ann Rheum Dis.* 2007;66(3):377-88. doi:10.1136/ard.2006.062091.
- Cormier G, Denis A, Leske C, Varin S, Dimet J, Planche L, *et al.* Improvement of rhizarthrosis pain management with the infiltration of hyaluronic acid and corticosteroids versus corticosteroids alone. *Jt Bone Spine.* 2025;92:105849. doi:10.1016/j.jbspin.2025.105849.
- Donovan RL, Edwards TA, Judge A, Blom AW, Kunutsor SK, Whitehouse MR. Effects of recurrent intra-articular corticosteroid injections for osteoarthritis at 3 months and beyond: a systematic review and meta-analysis in comparison to other injectables. *Osteoarthritis Cartilage.* 2022;30(12):1658-69. doi:10.1016/j.joca.2022.07.011.
- Krez AN, Wu KA, Klifto KM, Pidgeon TS, Klifto CS, Ruch DS. Efficacy of intra-articular corticosteroid injection for nonsurgical management of trapeziometacarpal osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. *J Hand Surg Am.* 2024;49(6):511-25. doi:10.1016/j.jhsa.2024.02.001.
- Fowler A, Swindells MG, Burke FD. Intra-articular corticosteroid injections to manage trapeziometacarpal osteoarthritis-a systematic review. *Hand (N Y).* 2015;10(4):583-92. doi:10.1007/s11552-015-9778-3.
- Papalia R, Diaz LA, Torre G, Albo E, Tecame A, Sterzi S, *et al.* Intrarticular injections of hyaluronic acid for trapeziometacarpal osteoarthritis: a systematic review. *J Biol Regul Homeost Agents.* 2017;31(4 Suppl 2):45-53.
- Tenti S, Pascarelli NA, Giannotti S, Galeazzi M, Giordano N, Fioravanti A. Can hybrid hyaluronic acid represent a valid approach to treat rizoarthrosis? a retrospective comparative study. *BMC Musculoskelet Disord.* 2017;18(1):444. doi:10.1186/s12891-017-1809-5.
- Henrotin Y, Raman R, Richette P, Bard H, Jerosch J, Conrozier T, *et al.* Consensus statement on viscosupplementation with hyaluronic acid for the management of osteoarthritis. *Semin Arthritis Rheum.* 2015;45(2):140-9. doi:10.1016/j.semarthrit.2015.04.011.
- Li YK, White C, Ignacy TA, Thoma A. Comparison of trapeziectomy and trapeziectomy with ligament reconstruction and tendon interposition: a systematic literature review. *Plast Reconstr Surg.* 2011;128(1):199-207. doi:10.1097/PRS.0b013e318217435a.
- Hippensteel KJ, Calfee R, Dardas AZ, Gelberman R, Osei D, Wall L. Functional outcomes of thumb trapeziometacarpal arthrodesis with a locked plate versus ligament reconstruction and tendon interposition. *J Hand Surg Am.* 2017;42(9):685-92. doi:10.1016/j.jhsa.2017.05.018.
- Saheb RLC, Vaz BAS, Soeira TP, Shimaoka FJ, Herrero CFPDS, Mazzer N. Surgical treatment for rhizarthrosis: a systematic review of the last 10 years. *Acta Orthop Bras.* 2022;30(1):e246704. doi:10.1590/1413-785220223001e246704.
- Eaton RG, Littler JW. Ligament reconstruction for the painful thumb carpometacarpal joint. *J Bone Joint Surg Am.* 1973;55(8):1655-66.
- Eaton RG, Glickel SZ. Trapeziometacarpal osteoarthritis. Staging as a rationale for treatment. *Hand Clin.* 1987;3(4):455-71.
- Spaans AJ, van Minnen LP, Kon M, Schuurman AH, Schreuders AR, Vermeulen GM. Conservative treatment of thumb base osteoarthritis: a systematic review. *J Hand Surg Am.* 2015;40(1):16. doi:10.1016/j.jhsa.2014.08.047.
- Becker SJE, Bruinsma WE, Guitton TG, van der Horst CMAM, Strackee SD, Ring D. Variation in Treatment for Trapeziometacarpal Arthritis. *Arch Bone Jt Surg.* 2021;9(2):158-66. doi:10.22038/abjs.2020.42060.2144.
- Golovachev N, Ghayyad K, Sarli N, Meade J, Hirsch D, Kachooei AR. Nonoperative management of trapeziometacarpal joint arthritis: a systematic review of the clinical trials. *Cureus.* 2024;16(8):e66801. doi:10.7759/cureus.66801.
- Corain M, Zanotti F, Giardini M, Gasperotti L, Invernizzi E, Biasi V, *et al.* The use of an acellular collagen matrix ChondroFiller® liquid for trapeziometacarpal osteoarthritis. *J Arthritis.* 2023;12(2):001-6. <https://www.iomeworld.org/open-access/the-use-of-an-acellular-collagen-matrix-chondrofiller-liquid-for-trapeziometacarpal-osteoarthritis.pdf>.
- Karcioglu O, Topacoglu H, Dikme O, Dikme O. A systematic review of the pain scales in adults: which to use? *Am J Emerg Med.* 2018;36(4):707-14. doi:10.1016/j.ajem.2018.01.008.
- Roberts HC, Denison HJ, Martin HJ, Patel HP, Syddall H, Cooper C, *et al.* A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age Ageing.* 2011;40(4):423-9. doi:10.1093/ageing/afr051.
- Mahbub MH, Kurozawa Y, Ishitake T, Kume Y, Miyashita K, Sakakibara H, *et al.* A systematic review of diagnostic performance of quantitative tests to assess musculoskeletal disorders in hand-arm vibration syndrome. *Ind Health.* 2015;53(5):391-7. doi:10.2486/indhealth.2014-0221.
- De Smet L. The DASH questionnaire and score in the evaluation of hand and wrist disorders. *Acta Orthop Belg.* 2008;74(5):575-81.

27. Mezian K, Ricci V, Jačisko J, Sobotová K, Angerová Y, Naňka O, *et al.* Ultrasound imaging and guidance in common wrist/hand pathologies. *Am J Phys Med Rehabil.* 2021;100(6):599-609. doi:10.1097/PHM.0000000000001683.
28. Hasiba-Pappas S, Kamolz LP, Luze H, Nischwitz SP, Lumenta DB, Winter R. Regenerative therapies for basal thumb arthritis-a systematic review. *Int J Mol Sci.* 2023;24(19):14909. doi:10.3390/ijms241914909.
29. Bahadır C, Onal B, Dayan VY, Güler N. Comparison of therapeutic effects of sodium hyaluronate and corticosteroid injections on trapeziometacarpal joint osteoarthritis. *Clin Rheumatol.* 2009;28(5):529-33. doi:10.1007/s10067-008-1079-6.
30. Wang PH, Wu CH, Ma CH, Chiu YC, Wu PT, Jou IM. Comparison of intra-articular injection of ArtiAid®-Mini with Ostenil®-Mini for trapeziometacarpal osteoarthritis: a double-blind, prospective, randomized, non-inferiority trial. *Jt Dis Relat Surg.* 2023;34(1):50-7. doi:10.52312/jdrs.2023.876.
31. Volpi P, Zini R, Erschbaumer F, Beggio M, Busilacchi A, Carimati G. Effectiveness of a novel hydrolyzed collagen formulation in treating patients with symptomatic knee osteoarthritis: a multicentric retrospective clinical study. *Int Orthop.* 2021;45(2):375-80. doi:10.1007/s00264-020-04616-8.
32. In Y, Alshammari SM, Kim MS. Effect of repeated intra-articular administration of collagen as a treatment for knee osteoarthritis: a case report. *J Int Med Res.* 2024;52(11):3000605241291735. doi:10.1177/03000605241291735.
33. Rago R, Franceschini F, Tomassini CR. Short Hospitalization system: a new way of interpreting day surgery care. *Minerva Anesthesiol.* 2016;82(1):103-11.
34. Thompson NB, Calandruccio JH. Hand surgery in the ambulatory surgery center. *Orthop Clin North Am.* 2018;49(1):69-72. doi:10.1016/j.ocl.2017.08.009.