Volume of the Thumb Carpometacarpal Joint

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Abstract

Background The volume of the carpometacarpal joint of the thumb (TCMC) and its capacity to accommodate fluid injection is unknown.

Questions/Purpose The purpose of the present study is to assess the volume of the TCMC.

Methods Forty-two thumbs undergoing surgical treatment for symptomatic TCMC osteoarthritis (OA) were evaluated. Prior to the start of the surgical procedure saline was injected into the TCMC until resistance was felt and no further saline could be injected. The maximum volume (MaxVol) of injectate was measured and recorded.

Results Mean MaxVol among all patients was 0.9 cc (range: 0.2–3.0 cc). There were 15 patients with 1 cc or more injected, the rest were less than 1 cc. The mean MaxVol for Eaton 2 thumbs was 1.5 cc, for Eaton 3 thumbs 0.9 cc, and for Eaton 4 thumbs 0.7 cc, with negative correlation between Eaton stage and MaxVol.

Conclusion TCMC has limited capacity for injected fluid.

Level of Evidence This is a Level II, diagnostic study.

Keywords

- carpometacarpal joint
- thumb
- volume
- fluid injection

The thumb carpometacarpal joint (TCMC) is a common location for development of degenerative osteoarthritis, with a prevalence suggested to be as high as 40%.¹ Symptoms of TCMC osteoarthritis (TCMC OA) include pain at the base of the thumb, weakness with grip or grasp, or a feeling of crepitus with thumb motion, though the stage of arthritis radiographically does not correlate to patient symptoms.² Conservative management is indicated as an initial step for most patients with TCMC OA. Commonly utilized non-surgical management modalities include splinting, analgesics, therapy, and injections.³

Injection into the TCMC joint has been shown to be an effective means of decreasing pain, and studies have demonstrated efficacy with both corticosteroids and hyaluronic acid,³ though corticosteroid injections are utilized most commonly.¹ There is little data available to guide surgeons regarding the volume of injectate that can be accommodated within the TCMC joint. Corticosteroids are thought to relieve pain by reducing intra-articular inflammation and though there is little data to support this notion, injection into the joint itself

should be more effective in achieving this. In our anecdotal experience injecting patients in clinic, the TCMC joint is able to accommodate a small volume of injectate comfortably, and once that volume is exceeded pain increases.

The purpose of the present study is to quantify the volume of the TCMC joint in patients with symptomatic TCMC OA. We hypothesized that the volume available for the injectate would be limited, and that joints with advanced disease stages may have a lower volume available due to poor joint compliance.

Methods

Institutional Review Board approval was obtained. Forty-three patients undergoing surgical treatment for symptomatic TCMC OA were evaluated prospectively over a 6-month period by three orthopaedic hand-fellowship trained hand surgeons. Demographic information including age, gender, side affected, and Eaton stage was recorded. Prior to the start

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of the surgical procedure and after induction of anesthesia (regional block and intravenous sedation), saline was injected into the TCMC joint. A 22-gauge needle attached to a graduated 3-cc syringe filled with saline was used. Intra-articular placement was ensured using fluoroscopy. Saline was then injected until resistance was felt and no further saline could be injected. Appropriate placement was further confirmed by witnessing dynamic distal translation of the thumb metacarpal under live fluoroscopy during the injection, and by backflow of the saline back into the syringe. The needle and syringe were removed and a standard surgical approach to the CMC joint was performed, and intra-articular placement of the saline again verified by back-flow of saline upon capsulotomy of the joint. The maximum volume (MaxVol) of injectate was measured and recorded. One patient was excluded from analysis owing to no resistance being encountered. The remaining 42 thumbs formed the study group.

Statistical analysis was performed by using the Student's *t*-test for comparison of continuous variables. The Mann-Whitney *U* test for unmatched non-parametrically distributed samples was used to test for differences in joint volume according to gender. Correlations were established using the Pearson correlation coefficient. Statistical significance was set at $p < 0.05$.

Results

There were 26 women and 16 men. The mean age was 63.8 years (range: 50–81). There were 3 patients with Eaton stage 2, 31 with Eaton stage 3, and 8 with Eaton stage 4 arthritis. There were no patients with stage 1 disease.

The mean MaxVol among all patients was 0.9 cc (range: 0.2–3.0 cc) and the standard deviation was 0.5 cc. There were 15 patients with 1 cc or more injected, the rest were less than 1 cc. There was a weak correlation between age and MaxVol ($r = 0.11$, $p = 0.48$). We did not identify a difference in joint volume between women (mean 0.9 cc, S.D 0.6) and men (mean 0.9 cc, S.D. 0.5, $p = 0.97$). The mean MaxVol for Eaton 2 thumbs was 1.5 cc (S.D - 0.1), for Eaton 3 thumbs 0.9 cc (S.D - 0.3), and for Eaton 4 thumbs 0.7 cc (S.D - 0.1), with negative correlation between Eaton stage and MaxVol ($r = -0.28$, $p = 0.05$). (→ Fig. 1)

Discussion

Injections into the TCMC joint are commonly performed for symptomatic basal joint arthritis.^{1,3–9} The findings of our study demonstrate that the available volume in the arthritic TCMC joint is approximately 1 cc. For the overwhelming majority of patients, there was a point at which the joint was at capacity and beyond which injection of additional saline was not possible. Although we were not able to assess this in our anesthetized patients, we suspect that in an awake patient attempts to exceed this volume would be uncomfortable and would further limit the volume available for the injectate.

The volume of the joint trended downward with increasing stage of arthritis. Though we were not adequately powered among subgroups to determine whether this was a statistically significant finding, it may be that as the joint becomes more arthritic the capsule becomes stiffer and less compliant. This may have implications for post-operative stability of the thumb metacarpal base after arthroplasty.

We are aware of only one other study in the orthopaedic literature assessing joint volume. Matziolis et al¹⁰ assessed the volume of the knee joint prior to total joint arthroplasty. They found that knee joint volume was correlated to patient height. It is not clear clinically whether intra-articular injection is needed to achieve maximum effect. In trigger digits, intra-sheath injection has been shown to be unnecessary¹¹ but to our knowledge this has not been discretely assessed in the thumb—it is possible that intra-articular injection is not necessary to achieve therapeutic results. Also, we do not know what the therapeutic dose of steroid is. Most clinicians use a combination of steroid and local anesthetic in their injections, often with a combined volume of 1–2 cc. Based upon our results, the majority of patients have CMC joints that are unable to accommodate 1 cc or more. Physicians should consider this when planning what volume to inject. It is possible that limiting the volume of injectate in this manner would result in subtherapeutic dose of steroid.

There are limitations to this study. Although we had radiographic confirmation of the needle within the joint, visualization of the joint insufflating under live fluoroscopy during injection, and tactile resistance once the joint reached capacity, it is possible that the injection was not accurately

Fig. 1 Average MaxVol injected stratified by Eaton stage.

within the TCMC joint. Given the above factors, however, we are confident that injection was performed into the joint.

Our study demonstrates that the volume of the arthritic TCMC joint is limited. Physicians injecting into this area should bear this in mind. Clinically, we are careful not to continue to apply forceful pressure once the capacity of the joint has been reached. Further study would be necessary to quantify the volume, dosage and type and if intra-articular steroid injection is the most effective for symptomatic relief of the TCMC joint.

Ethical Committee Review

This study was reviewed and approved by an Institutional Review Board. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). Informed consent was waived per institutional protocol. Informed consent was waived per institutional protocol.

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Conflict of Interest

None declared.

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