

ANATOMICAL LIGAMENT RECONSTRUCTION FOR TRAPEZIOMETACARPAL OSTEROARTRITIS

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ABSTRACT

Osteoarthritis of the trapeziometacarpal (TMC) joint, the key joint in thumb opposition, is one of the most common diseases involving the hand, especially among middle-aged and elderly women, and can seriously impair overall hand function. Previous studies have indicated that joint instability from ligament insufficiency is the pathological mechanism underlying the disease. Therefore, various ligament reconstruction techniques have been developed to improve both the stability and kinematics of the joint. However, none of them involve anatomical ligament reconstruction and are almost always used in combination with trapeziectomy. In order to restore joint stability as well as to save the trapezium, we developed a new technique for reconstructing the anterior oblique ligament of the TMC joint anatomically using the distal part of the transverse carpal ligament. In this article, we describe the technique in detail and report the clinical outcome of 9 patients. 6 of whom were treated by ligament reconstruction alone while the other 3 underwent ligament reconstruction combined with surface joint replacement. All 9 patients maintained good stability and ROM of the joint at their final follow-up (3 years or longer). Although that follow-up period is admittedly short, we think anatomical ligament reconstruction with or without surface joint replacement is a rational alternative to ligament reconstruction tendon interposition (LITI) procedures.

Key words: Trapeziometacarpal joint, Osteoarthritis, Ligament reconstruction, Anterior oblique ligament, Dorsoradial ligament

INTRODUCTION

Osteoarthritis of the trapeziometacarpal joint is the 2nd most frequent degenerative process following distal interphalangeal joint arthritis and the most frequent pathology requiring surgery in the upper extremity.¹⁾ The incidence of idiopathic osteoarthritis of the TMC joint is high in women beyond the fifth decade of life and, as the disease progresses, deformity of the thumb and severely limited function develop. It has been reported that up to 33% of women over 55 years show radiographic evidence of TMC osteoarthritis.^{2,3)}

The thumb TMC joint is a shallow biconcave joint with a unique design that offers the joint a wide range of motion at the expense of stability. Chao demonstrated that 5 kg of tip pinch generates 50 kg of load transmission the TMC joint.⁴⁾ Therefore, the joint suffers huge mechanical stress even during daily use of the hand. To endure such stress, the joint has a complicated ligament system. Imaeda conducted a meticulous anatomical study of the stabilizing ligaments of the

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TMC joint and identified 5 separate ligaments.⁵⁾ Based on biomechanical analysis, they indicated that the anterior oblique ligament (AOL) is the primary stabilizer of the joint followed by the dorsoradial ligament. Because of accumulated mechanical stress over the years, these ligaments, especially the AOL, carry a risk of degenerative rupture. In fact, Pelligrini found a close correlation between detachment of the ligament and the existence of extensive articular degeneration.⁷⁾ Therefore, ligament instability, in particular ulno-volar ligament instability, has been postulated to be an important factor in the initiation and propagation of TMC joint osteoarthritis.^{7,8)}

Taking these facts into consideration, reconstruction of the AOL has been proposed for patients with symptomatic instability of the TMC joint without radiographic evidence of osteoarthritis. Freedman *et al.* analyzed the clinical and radiographic results in patients who had volar ligament reconstruction with a minimum follow-up period of 10 years and reported that it substantially alleviated pain and prevented or retarded degenerative diseases. Though various ligament reconstruction techniques have been developed, none of them replicate the anatomical structure or function of the key ligaments.

The purpose of the present study is to describe the treatment outcome of 9 patients with TMC osteoarthritis who were treated using anatomical reconstruction of the AOL and to demonstrate the feasibility and efficacy of the procedure.

PATIENTS AND METHODS

We treated 9 women with basal joint osteoarthritis limited to the TMC articulation using the novel anatomical AOL reconstruction.

The diagnosis of TMC osteoarthritis was based on both clinical and radiographic findings. All patients complained of chronic pain at the base of the thumb that was exacerbated by activities involving substantial gripping or pinching strength. Physical examination revealed tenderness at the TMC joint and pain with axial joint loading of the thumb. Other diagnoses such as carpal tunnel syndrome, stenosing tenosynovitis at the wrist, and carpal instability were excluded by physical examination. Each patient's history was taken to exclude degenerative disease of the TMC joint due to earlier trauma. Strength was quantified using a hand dynamometer and a pinch gauge to measure the grip and tip pinch forces. For radiographical examination, a *Bitte* view was taken to evaluate any degenerative changes in all the articulations around the trapezium and lateral view to evaluate degenerative changes of the TMC joint according to the criteria of Eaton.⁸⁾ Instability was evaluated with the method described by Glickel and a shift of the joint when it was passively stressed radialward was measured on the radial side of the joint.⁹⁾ The surgical indication was severe pain not responding to conservative treatment (rest, anti-inflammatory drugs, abduction splinting, steroid infiltration, and so forth).

Surgical Technique (Figs. 1, 2)

Under tourniquet control and axillary block with bupivacane, the basal joint is approached through a Wagner incision. The branches of the superficial radial nerve are identified and protected. The posterior capsule is incised and the lines are extended distally into the periosteum along either side of the proximal first metacarpal. Anteriorly, the thenar muscle is raised to expose the base of the first metacarpal, with care taken not to damage the radial artery. Then, the anterior capsule is incised along the joint line while the dorsoradial ligament, which presents beneath the distal insertion of the abductor pollicis longus (APL) tendon, is protected. The joint surface is inspected by applying longitudinal traction to the thumb to determine operative procedures. For joints with minimum to mild cartilage loss without osteophyte formation, anatomical ligament

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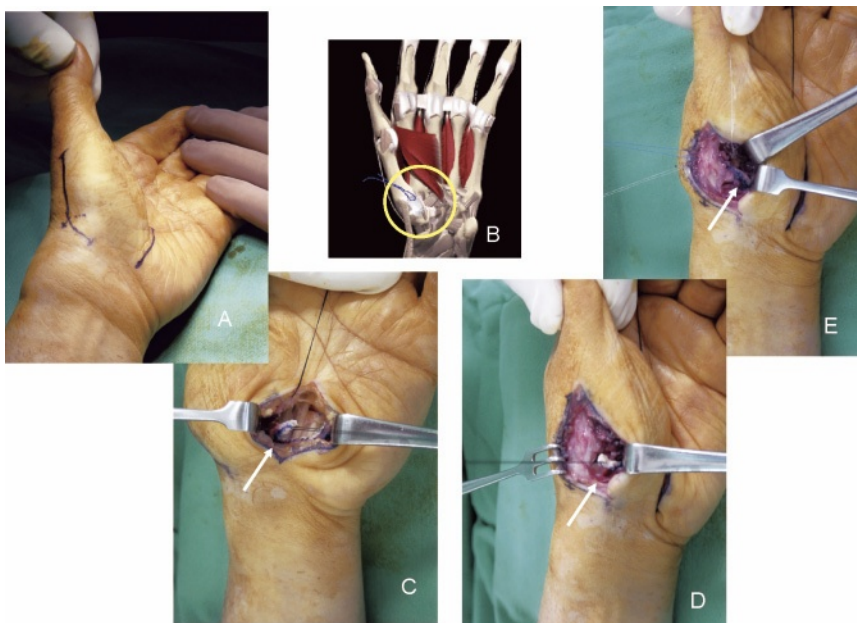


Fig. 1 (A) Both Wagner incision and mid palmar incision were made. (B)(C) Distal half of transverse carpal ligament was raised as a radially based ligament flap. (D) Ligament flap was tunneled under thenar flap (E) Ligament flap was sutured to the base of the first metacarpal.

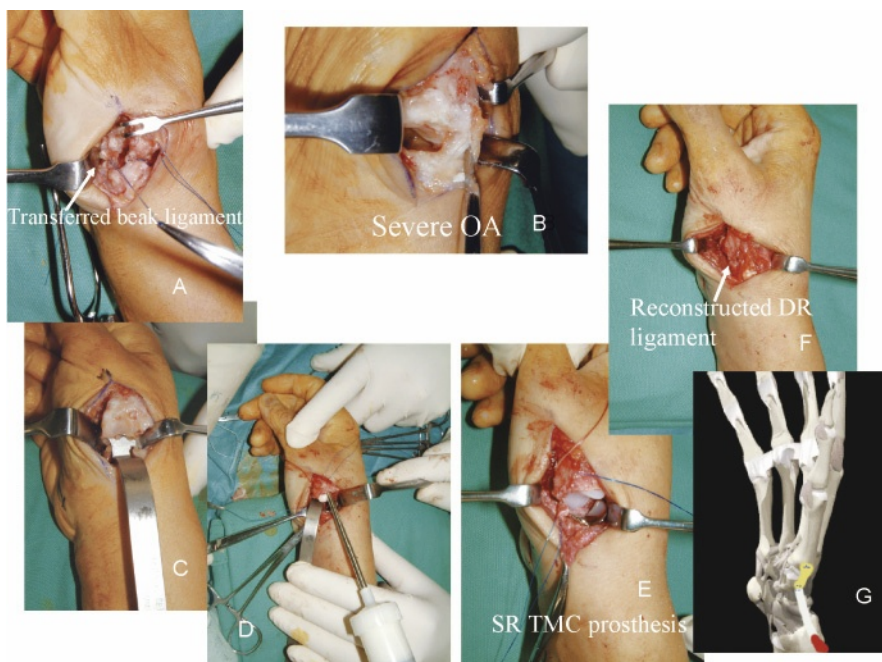


Fig. 2 (A) Transferred ligament flap. (B) Joint surface is observed by resecting joint capsule. Note that dorsoradial ligament is preserved. (C) Joint was book-opened by detaching dorsoradial ligament. (D) (E) Joint is replaced with SR TMC prosthesis. (G) Dorsoradial ligament is reattached and reinforced with the distal end of APL tendon.

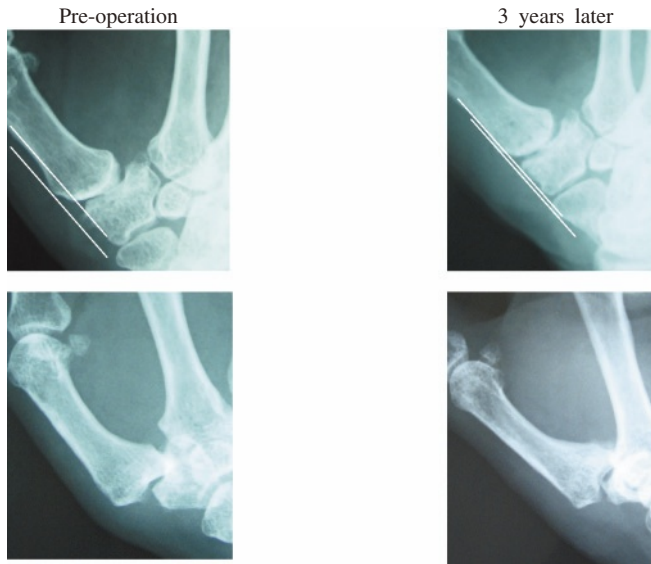


Fig. 3 Stress x-rays taken preoperatively (left panel) and at a 3-year follow-up (right panel).

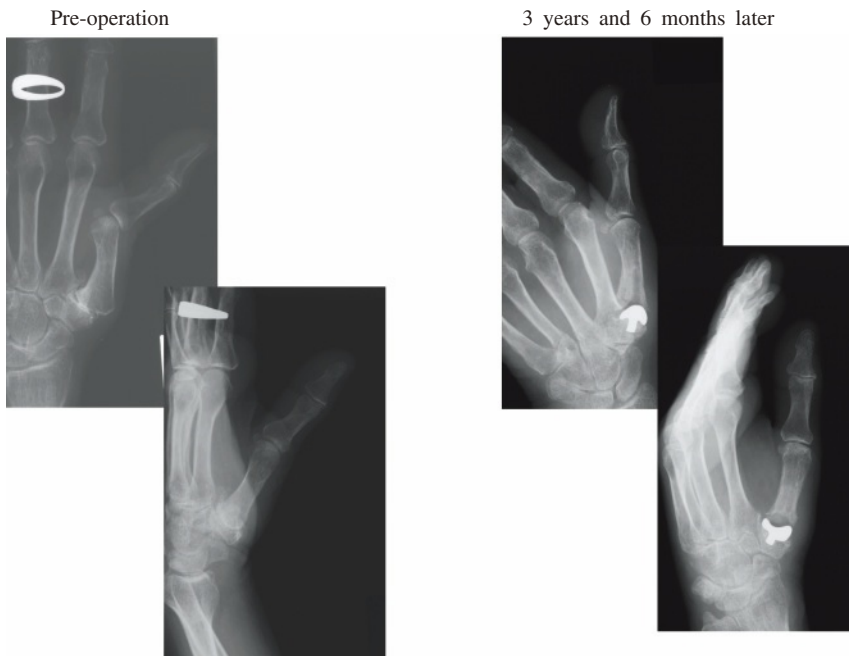


Fig. 4 X rays taken preoperatively (left panel. Note severely collapsed deformity of thumb) and at a 3 and a half year follow-up.

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reconstruction using the transverse carpal ligament is indicated. A radially-based ligament flap is raised through a standard midline volar carpal tunnel incision, and tunneled under the thenar muscles and fixed to the volar medial tubercle of the first metacarpal by the pull-out wire technique or with a Mitek mini anchor. If there is moderate to severe osteoarthritic change, the joint is book-opened by detaching both the APL tendon and the dorsoradial ligament at the base of the first metacarpal, it is then replaced with an Avanta SR TMC prosthesis, and AOL is reconstructed using the transverse carpal ligament. If there is apparent residual joint instability after reattachment of the dorsoradial ligament, the ligament is reinforced with the overlying distal end of the APL tendon.

CASE REPORTS AND RESULTS

Case 1 (Fig. 3)

A 47-year-old house wife visited our hospital with a complaint of pain at the base of the right thumb. Both a physical examination and x-ray revealed moderate instability and painful crepitation at the trapeziometacarpal joint. Because the pain did not respond to intensive conservative treatments for a couple of months, anatomical anterior oblique ligament reconstruction was carried out. The pain disappeared and the joint alignment was restored after surgery and appeared well at a 3 years follow-up.

Case 2 (Fig. 4)

A 72-year-old house wife complained of pain and deformity at the base of the thumb. X ray revealed stage III osteoarthritis of the TMC joint with collapsed deformity of the first ray. Since intensive conservative treatment failed, the joint was replaced with an Avanta SR total TMC prosthesis and the anterior oblique ligament was reconstructed with the transverse carpal ligament. As evidenced by Fig. 4, the collapsed deformity was corrected and the joint alignment was well maintained at a 3 year-6 months follow-up.

Between 2002 and 2004, we treated 9 joints of 9 females. 6 with anatomical AOL reconstruction alone, and the other three were by anatomical AOL reconstruction combined with total joint replacement. At the final follow up, tip pinch was 3.7 kg, radial abduction 60 degrees, and opposition as determined by Kapanji's opposition test was 9 on the average. Regarding pain, only one patient complained of mild pain after strenuous use of the thumb.

DISCUSSION

As mentioned by Grevis, although trapeziectomy alone can provides substantial pain relief no matter how much degenerative change has occurred around the trapezium, it almost always leads to significant shortening and weakness of the thumb. In order to maintain the trapezial gap as near to normal as possible, various LRTI procedures have been used.

There are number of surgical options regarding the selection and the use of tendons for support ligaments including tendon slips from the flexor carpi radialis, APL, or extensor carpi radialis longus.¹¹⁾ However, it is still not clear whether these additional procedures can really alleviate the problem of trapeziectomy.^{12, 13)} There are a couple of reasons for this. Since none of the procedures are anatomical reconstructions, it is difficult to determine the optimal tension of the reconstructed ligament. In addition, as mentioned by Trumble, the tendon graft does not

provide a substantial replacement of volume for the gap after trapeziectomy.¹⁴⁾

In order to solve these problems, partial or total joint arthroplasties have been developed to establish a pain-free, stable, and mobile joint with normal thumb length while preserving the trapezium. Though there are different TMC arthroplasty designs, most of them are variations on the constrained ball and socket concept which can not restore normal kinematics and transmit huge stress to the stem-bone interface owing to the small contact area.¹⁵⁾ Therefore, total joint replacement is associated with a relatively high failure rate (between 10% in the series of cemented prosthesis of Nicholas and Calderwood¹⁶⁾ and 46% in the noncemented prosthesis series of Wachtl and Sennwald).¹⁷⁾ The Avanta SR TMC prosthesis developed by Linscheid has a resurfacing design with biconcave reciprocating articular surfaces that closely duplicate the anatomy of the saddle joint of the TMC joint while preserving a wider cortical and trabecular contact surface area for distribution of the joint's compressive loads.¹⁸⁾ The problem with this carefully designed prosthesis is that it can not offer stability by itself due to its unconstrained design. In addition, since the prosthesis occupies the medullary canal of the first metacarpal base, any reported reconstruction procedures of the anterior oblique ligament can not be applied. Considering that ligament instability, in particular AOL instability, is an important factor in the initiation and propagation of TMC joint osteoarthritis, unconstrained total joint replacement without ligament reconstruction does not appear to be a rational option in spite of its theoretical advantages. In fact, Ubeda-Perez reported failure rates as high as 70% at a 3 year follow-up in his series of Avanta SR TMC prosthesis, and concluded that the anatomical SR TMC prosthesis is not an adequate surgical option for the treatment of TMC osteoarthritis.¹⁹⁾

We hypothesized that the combined use of ligament reconstruction with surface replacement arthroplasty should yield the best results in terms of the kinematics, stability, and longevity of reconstructed joints. The anatomical reconstruction of AOL employed in the present study was first described by Elmaraphy who conducted a cadaveric study to clarify the anatomic relationship between AOL and the transverse carpal ligament. Tanaka used the procedure on 7 cases with primary TMC instability without arthritic change and reported its feasibility and efficacy.²⁰⁾ In the present study, we treated 6 cases with Eaton stage II basal joint arthritis and found that it substantially alleviated pain and prevented or retarded degenerative diseases at a follow-up of three years or longer. In addition, neither loosening nor spontaneous ankylosis through periprosthetic calcification took place in any of the three cases treated with Avanta SR prosthesis and anatomical ligament reconstruction. Although the follow-up period is still short, the anatomical reconstruction of AOL appears to confirm the indication of a trapezium-saving procedure for TMC joint osteoarthritis.

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