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What's New in Hand Surgery

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SPECIALTY UPDATE

What's New in Hand Surgery

By Peter C. Amadio, MD

This update reviews material presented at the 2006 annual meetings of the American Society for Surgery of the Hand (ASSH), American Association for Hand Surgery (AAHS), and the American Academy of Orthopaedic Surgeons (AAOS) as well as articles published in the field of hand surgery (other than those published in this journal) between August 2005 and July 2006. Over the years, as with other maturing organizations, the trend has been for fewer free papers and more symposia and hands-on workshops, including many non-CME-credit industry-sponsored workshops in facilities adjacent to the accredited scientific meeting. In addition, both hand surgery organizations feature presentations on shoulder and elbow surgery and general microsurgery that are beyond the scope of this review. Meeting abstracts for the ASSH and AAOS annual meetings are maintained online at www.assh.org and www.aaos.org, respectively.

Trauma

As noted in previous editions of this review, vascularized bone grafts appear to improve the results of treatment of scaphoid nonunions. A recent study, however, has brought attention to reasons why such surgery might fail¹. A retrospective review of fifty intracompartmental supraplantar artery-based vascularized bone grafts that were used to treat scaphoid nonunions revealed fourteen failures. While some procedures failed as a result of pin fixation (which, in comparison with screw fixation, was significantly associated with loss of fixation and graft extrusion), all of the other factors that were associated with failure were ones that could be identified preoperatively. Specifically, proximal pole osteonecrosis, preoperative humpback deformity or carpal collapse, male gender, and tobacco smoking all significantly increased the risk of failure.

Hand surgeons have sought a reliable reconstruction procedure for the treatment of scapholunate instability since the condition was first recognized more than thirty years ago. Now there is increasing evidence that a procedure that com-

bines features of several previously described reconstructions may provide such a solution. The authors of papers from the United States (delivered to the American Association for Hand Surgery), Spain², and the United Kingdom³ reported similar results for the modified Brunelli procedure, a tenodesis that employs a strip of the flexor carpi radialis tendon to stabilize the scaphotrapezial and scapholunate joints while controlling scaphoid rotation and ulnar translation. Together, the three series included >200 patients who had been managed over a period of ten years. After a minimum duration of follow-up of one year (mean, four years), there were no failures that necessitated reoperation in patients without a fixed deformity. Wrist motion and strength averaged 75% of normal values at the time of follow-up, and the correction of carpal instability was preserved. For those who are interested in learning more about the technique, the procedure is well illustrated in the report by Garcia-Elias et al.²

Despite a large body of literature, the ideal treatment for distal radial fractures is still unclear. A large meta-analysis of forty-six individual studies comprising >1500 patients failed to identify any advantage of internal fixation over external fixation in terms of final reduction, pain, motion, strength, or function⁴. External fixation was, however, more likely to be associated with complications such as infection or neuritis secondary to pin-mediated irritation. A prospective, multicenter study, presented to the AAOS, that compared the outcomes for thirty-five patients who had been managed with either bridging external fixation or volar plating, led to a similar conclusion.

Volar locking plates are popular for the treatment of distal radial fractures, but there have been few studies that have compared this method of treatment with others. In a recent study, fifty-three patients were randomized to fixation with either a volar locking plate or a volar nonlocking plate⁵. The radiographic parameters were not significantly different between the two groups, either initially or at the time of the most recent follow-up. One of the presumed benefits of locked volar plates is earlier mobilization, which is presumed to lead to better final motion. In a comparative study that was presented to the ASSH, thirty-one patients who had undergone

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volar plate fixation of a distal radial fracture were managed with either early mobilization (at the time of suture removal) or late mobilization (six weeks postoperatively). At three months after the fracture, there was no difference between the two groups in terms of pain, motion, strength, or function. Clearly, more clinical research is needed to determine the ideal role of volar locking plates in the treatment of fractures of the distal part of the radius as well as the actual benefits of such plates in comparison with other treatment modalities.

For distal radial fractures that are treated with external fixation, there has been a recent trend toward the use of fixation that does not cross the wrist joint. In a prospective, randomized study of thirty-eight patients over the age of fifty years who had an acute displaced distal radial fracture and were assessed at ten, twenty-six, and fifty-two weeks after the injury, no significant differences were noted between patients who had been randomized to bridging or nonbridging fixation with regard to pain, motion, strength, or satisfaction⁶. There was a small (1.4 mm) but significant difference in the restoration of radial length favoring the nonbridging group. Similar good results were noted in a larger study, presented to the AAHS, involving eighty patients who were managed with nonbridging fixation and in a prospective, randomized trial, presented to the ASSH, involving 102 patients who were managed with nonbridging external fixation and volar plate fixation. Thus, nonbridging external fixation appears to be a viable option for the treatment of most types of distal radial fractures.

Arthritis

Midcarpal arthrodesis is often indicated to treat the late consequences of scaphoid nonunion or scapholunate instability, yet the traditional methods of fixation, such as staples or Kirschner wires, have been associated with frequent complications. Several years ago, circular plates of various designs were introduced to solve the problem of achieving stable fixation at the site of a midcarpal arthrodesis, and the initial reports were promising. But now the bloom may be off the rose. The complications of this technique were emphasized in a recent report in which twenty-seven patients who were managed with circular plates were compared with thirty-one patients who were managed with Kirschner wires, staples, or screws⁷. The nonunion rate was 26% among patients managed with circular plates but only 3% among those managed with other methods of fixation. Nonunion, impingement, the DASH score, and satisfaction were all significantly worse in the circular plate group. Strength and motion were also worse, but not significantly so. Similar findings were noted in a study, presented to the AAOS, involving sixteen patients who were managed with a circular plate. Nine of the sixteen patients had major complications; there were four nonunions.

When midcarpal arthrodesis is successful, however, the results are durable. In a series that was presented to the AAOS, the results of 185 midcarpal arthrodeses that had been

performed between 1974 and 2002 were reviewed. In most cases, fixation had been performed with Kirschner wires or staples. After a mean duration of follow-up of nearly ten years, the nonunion rate was 5% and only seven patients required conversion to either total arthrodesis or wrist arthroplasty.

The results of proximal interphalangeal joint arthroplasty have much room for improvement. The benchmark silicone implant arthroplasty of this joint was described more than thirty years ago. Recently, a new implant fabricated of pyrolytic carbon has been designed. Preliminary results presented to the AAHS, however, suggest that little has changed. Over a two-year period, sixty-eight implants were inserted in forty-three patients with various forms of arthritis. At a maximum of two years of follow-up, the arc of motion had improved from 40° to 52°, while four implants were loose, nine had subsided, and 42% had shifted position, although they appeared stable. Eleven of the forty-three patients required additional surgery. A recently published report on sixteen arthroplasties in six patients who were followed for an average of one year demonstrated similar results⁸. These results are not different from those reported for silicone implant arthroplasty. In a series of twenty-seven silicone implant arthroplasties of the proximal interphalangeal joint that was presented to the AAOS, the range of motion was similar and, while subsidence was common, there were no reoperations after a mean six years of follow-up. Clearly, there is more work to be done to improve outcomes in this area.

Arthroplasty of the carpometacarpal joint of the thumb also remains in something of a time warp; the current standard is still some variation of trapezium excision, a procedure first described in the 1930s. One such variation is arthroscopic excision of the distal part of the trapezium. In a series of eighteen patients that was presented to the ASSH, the results were generally good at an average of seven years of follow-up, although a late rupture of the flexor pollicis longus did develop in one patient. As is typical, this case series included no comparison group, but the results are similar to those of other variations on trapeziectomy.

While there have been many reports on different ways to treat arthritis of the trapeziometacarpal joint, far less has been written on what to do when those operations fail. A retrospective review of 654 cases of trapeziometacarpal joint surgery at a single medical center sheds some light⁹. First, such operations were uncommon: in twelve years, only seventeen thumbs needed a second operation. Whether the initial operation was an implant arthroplasty or a complete or partial trapeziectomy, revision through completion of the trapeziectomy (if necessary), with soft-tissue interposition or ligament reconstruction as an adjunct, proved successful in thirteen of the seventeen patients reviewed.

Tendon

Tendon repair remains a popular subject for hand surgeons. In the past, research on tendon repair focused on suture meth-

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ods. Newer research, however, has focused on tissue-engineering applications that might speed healing. In one such study, presented to the ASSH, platelet-derived growth factor type BB (PDGF-BB) was embedded in fibrin matrices that were then implanted between the ends of lacerated tendons in a dog model. Dogs were killed at seven, ten, or twenty-one days. The treated tendons demonstrated significantly more cell proliferation and significantly better repair strength, with no difference in adhesions, when compared with tendons that had not been treated with PDGF-BB.

The best results after flexor tendon repair usually are associated with carefully managed rehabilitation. Currently, both immediate active motion and early passive motion protocols are in use. Does the introduction of active motion early in the rehabilitation process improve the outcome of flexor tendon repair? A structured meta-analysis presented to the AAOS suggested that it may not. A Cochrane review produced no randomized trials, three clinical trials, and twenty-five case series. A meta-analysis of the three clinical trials showed little difference between active and passive-motion protocols with regard to final motion, but the active protocols were associated with an increased risk of tendon rupture.

Nerve

Recovery of sensibility after nerve injury is a perennial challenge for the hand surgeon and therapist. Often when only part of the innervation of a hand or digit is injured, it may be difficult to encourage the patient to consistently train the sensory distribution of the injured nerve and to avoid using uninjured nerve territories for daily activities. Recently, a group in Sweden developed a clever solution to this problem¹⁰. In a prospective, randomized, double-blind trial of thirteen patients, the use of a local anesthetic cream to anesthetize normally innervated skin, combined with sensory reeducation of a damaged median or ulnar nerve, was compared with sensory reeducation alone. The local anesthesia group showed significant improvement compared with the control group in terms of perception of touch, pressure, and tactile gnosis.

The role of nonoperative treatment of carpal tunnel syndrome continues to be refined. One recent study of twenty-five patients (forty-seven hands) who had been referred to a tertiary hand center for treatment evaluated the impact of initial symptom severity on the need for subsequent surgery¹¹. In all patients, the diagnosis was confirmed with electrodiagnostic testing. Symptom severity was assessed with use of questionnaires (including the Levine Symptom Severity Score [SSS] and the Disabilities of the Arm, Shoulder and Hand [DASH] index) at baseline, at six and twelve weeks, and at the time of dismissal from treatment. All patients were managed with nighttime splinting for twelve weeks before being considered for surgery. Ultimately, twenty-seven hands were treated surgically. The hands that went on to surgery had significantly higher initial symptom severity scores (3.4 compared with 2.9 on a 5-point scale, with 5 representing the

worst symptoms) and DASH scores (32 compared with 27 on a 100-point scale, with 100 representing the worst symptoms) and showed no improvement over twelve weeks of splint treatment. The authors concluded that patients with more severe initial symptoms are unlikely to improve with splint therapy but that those with less severe symptoms should be offered a trial of nighttime splinting before proceeding to surgery.

There is controversy among hand surgeons with regard to the usefulness of electrodiagnostic testing for making or confirming the diagnosis of carpal tunnel syndrome. In an interesting study that was presented to the ASSH, 143 patients were rated for the probability of having carpal tunnel syndrome on a weighted clinical scale¹² that included the presence or absence of thenar atrophy, the result of the Phalen test, loss of two-point discrimination, the Tinel sign, nocturnal numbness, and numbness in the median nerve distribution. This probability was then revised on the basis of the results of sensory nerve conduction testing. In most cases, the value of the electrodiagnostic test was to reduce the probability of carpal tunnel syndrome that had been predicted by the clinical algorithm alone, but this occurred primarily in patients in whom the clinical algorithm gave equivocal results. The authors concluded that electrodiagnostic tests are of the greatest value in uncertain cases and are not helpful for confirming a diagnosis when the clinical diagnosis is highly probable on the basis of their algorithm. The authors did not address the value or lack of value of electrodiagnosis for assessing severity or prognosis in patients in whom the clinical diagnosis is highly probable.

Another controversial topic among hand surgeons is the value of simultaneous carpal tunnel release in patients with severe bilateral symptoms. Some surgeons prefer simultaneous surgery in order to reduce total disability time, whereas others recommend staged procedures in order to minimize difficulties when the patient attempts to perform self-care activities with two bandaged hands in the immediate post-operative period. A recent study addressed this question by prospectively evaluating the return to activities among thirty-eight patients who had had unilateral carpal tunnel release and thirty-seven patients who had had simultaneous bilateral release¹³. For the entire group of staged and simultaneous procedures, the mean time to return to driving was nine days, the mean time to return to activities of daily living was thirteen days, and the mean time to return to work was seventeen days. There was no difference in the time to return to activities or in symptom relief based on whether one or both hands had been operated upon. A related study, presented to the ASSH, reviewed the cost effectiveness of surgery in sixty-one patients with staged bilateral carpal tunnel release and fifty-two patients with simultaneous bilateral carpal tunnel release. All patients were followed for at least one year. The simultaneous group had similar final satisfaction with the outcome, with roughly 60% of the cost, time off work, and necessary follow-up office visits of the staged group. Those studies provide more evidence to support the growing tendency toward si-

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multaneous bilateral release in patients who have symptomatic bilateral carpal tunnel syndrome.

Vascular Problems

Botulinum toxin A is a neuromuscular blocking agent that has proved to be useful in cosmetic and neurological surgery, including the treatment of hyperhidrosis. Now it has been shown to be helpful for treating Raynaud disease and other vasospastic disorders. In two different papers that were presented to the AAHS, a total of sixteen patients (including patients with digital ulcers) were followed for as long as two years after the injection of as much as 100 units of Botulinum toxin A in the hand to treat vasospasm. In all cases, pain decreased within twenty-four to forty-eight hours after the injection. In many cases, ulcerations also healed. Repeat injections were needed at three to twelve-month intervals. These data suggest that Botulinum toxin A may be a useful alternative to digital sympathectomy in patients with vasospastic disorders of the hand.

Tumors

The treatment of giant-cell tumor of the distal part of the radius is controversial. When the tumor is confined within the bone, many surgeons prefer aggressive curettage and adjuvant treatment, in the form of cryotherapy and cementation or phenolization and cementation, with preservation of the local bone and adjacent joint; others prefer wide excision and reconstruction. For tumors that extend outside the bone, most surgeons favor wide excision and reconstruction. In an interesting paper that was presented to the AAHS, a middle ground was staked out. In that study, fifteen patients had been managed with use of an algorithm in which soft-tissue extension that was confined within the pronator quadratus was treated with curettage, cryosurgery, and cementation, whereas more extensive soft-tissue extension, including any intra-articular extension, was treated with wide excision, reconstruction with a fibular graft, and wrist arthrodesis. In all, nine patients were managed with curettage and six were managed with arthrodesis. After a mean duration of follow-up of four years, there was only one local recurrence, in the curettage group. Functional results were significantly better in the curettage group. On the basis of these results, it appears reasonable to consider curettage, cryosurgery, and cementation when faced with a patient who has a giant-cell tumor of the distal part of the radius with no cortical penetration or limited penetration without violation of the pronator quadratus.

Do sarcomas in the hand behave differently than similar tumors elsewhere? Maybe. A recent study compared the survival outcomes associated with 123 primary sarcomas of the hand with those associated with >6500 similar tumors in other parts of the body¹⁴. After a mean duration of follow-up of four years, the mortality rate was 6% for the patients with hand tumors and 13% for the others. This difference was true for the hand tumors as a group, but not for any specific tumor type, perhaps because the numbers of the individual tumor types

in the hand were rather small. Unfortunately, the investigators did not attempt to correlate survival with tumor size or delay in diagnosis, both of which have been postulated to favor successful treatment in the hand, where tumors are often detected early because they are easily noticed and are often excised while still small.

Sometimes sarcomas in the hand are diagnosed retrospectively when a lesion that is presumed to be benign is excised and is subsequently found to be malignant. In such cases, can magnetic resonance imaging accurately assess the completeness of the initial excision? The answer appears to be "sometimes." In a study that was presented to the AAHS, thirty-three patients were managed with reexcision of soft-tissue sarcomas that had been marginally excised. Preoperative magnetic resonance imaging demonstrated suspected residual tumor in seventeen cases and no tumor in sixteen. The postoperative pathologic examination demonstrated that magnetic resonance imaging was correct roughly 80% of the time, with nearly equal numbers of false-positive results (three) and false-negative results (four). On the basis of these data, it appears that magnetic resonance imaging cannot reliably determine the presence or absence of residual tumor after unplanned marginal excision of a sarcoma in the hand.

New Directions in Hand Surgery

Hand surgery is being redefined, both by its practitioners and by the societies that guide the specialty. A paper that was presented to the ASSH described the results of a survey of ASSH members regarding their microsurgery skills and microsurgery case load. More than 700 replies were received, representing 46% of ASSH active members. Replantations were performed by only 59% of the respondents. Surgeons not performing replantations most frequently cited busy elective schedules (48%) and lack of confidence in their microsurgical skills (37%). In contrast to an apparently reduced interest in microsurgery, hand surgeons are expressing increasing interest in surgery of the elbow and shoulder, as evidenced by more papers and CME courses in these areas sponsored by hand surgical societies. Indeed, in September 2006, the ASSH changed its mission statement from "the mission of the ASSH is to advance the science and practice of hand surgery through education, research and advocacy on behalf of patients and practitioners" to "the mission of the ASSH is to advance the science and practice of hand and upper extremity surgery through education, research and advocacy on behalf of patients and practitioners." How these changes in emphasis will affect the evolution of the specialty of hand surgery remains to be seen.

Upcoming Meetings

The Sixty-second Annual Meeting of the American Society for Surgery of the Hand will be held in Seattle, Washington, on September 27 through 29, 2007. The ASSH will also sponsor a number of CME activities in 2007. A program on Advances in Elbow Surgery will be held at the Orthopaedic Learning Cen-

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ter in Rosemont, Illinois, on April 13 and 14, 2007. A Comprehensive Review in Hand and Upper Extremity Surgery will be held in Chicago, Illinois, on July 13 through 15, 2007. A program on Shoulder Arthroscopy Fundamentals for the Hand Surgeon will be held at the Orthopaedic Learning Center in Rosemont, Illinois, on August 13 and 14, 2007.

The Thirty-eighth Annual Meeting of the American Association for Hand Surgery will be held in Beverly Hills, California, on January 9 through 12, 2008. The annual meetings of the AAHS are always held in combination with the annual meetings of the American Society for Reconstructive Microsurgery and the American Society for Peripheral Nerve. These three organizations also share certain management functions, permitting closer integration of their meetings, even offering a combined registration option. They will meet together again in 2009. The AAHS will also sponsor a CME program on Hand and Upper Limb Trauma in Queenstown, New Zealand, on March 7 through 9, 2007.

In addition to the meetings of the ASSH and AAHS, the International Federation of Societies of Surgery of the Hand will hold its Tenth Triennial Congress in Sydney, Australia, on March 11 through 15, 2007.

All of these meetings are open to all interested parties. Further details will be available on the society web sites, listed below. The annual meetings of both the American Society for Surgery of the Hand and the American Association for Hand Surgery accept free papers and also feature a wide variety of instructional courses and symposia, many with hands-on sessions.

Hand Surgery Societies

Membership in the two hand surgery societies is restricted to those who have had specific hand surgery training and, in the case of the American Society for Surgery of the Hand, those who have received the Certificate of Added Qualifications in Hand Surgery offered by the American Boards of Orthopaedic Surgery, Plastic Surgery, and Surgery. Further information on

membership as well as any of the above meetings can be obtained by contacting the organizations directly. Finally, both organizations maintain active web sites, with educational and informational content directed to the public and interested medical professionals as well as members.

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Evidence-Based Orthopaedics

The editorial staff of *The Journal* reviewed a large number of recently published research studies related to the musculoskeletal system that received a Level of Evidence grade of I. Over 100 medical journals were reviewed to identify these articles, which all have high-quality study design. In addition to articles published previously in this journal or cited already in this Update, seven level-I articles were identified that were relevant to hand surgery. A list of those titles is appended to this review after the standard bibliography. We have provided a brief commentary about each of the articles to help to guide your further reading, in an evidence-based fashion, in this subspecialty area.

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Evidence-Based Articles Related to Hand Surgery

Atroshi I, Larsson GU, Ornstein E, Hofer M, Johnsson R, Ranstam J. Outcomes of endoscopic surgery compared with open surgery for carpal tunnel syndrome among employed patients: randomised controlled trial. *BMJ*. 2006;332:1473.

One hundred twenty-eight patients with clinically diagnosed and electrophysiologically confirmed carpal tunnel syndrome were randomly assigned to endoscopic or open carpal tunnel release and were assessed at three, six, twelve, and fifty-two weeks. The primary outcome was palmar pain as assessed on a 0 to 100 scale. Secondary outcomes included return to work, carpal tunnel symptoms, quality of life, hand sensation, and grip strength. The only significant differences in outcome were in the rate (52% compared with 82%) and severity (13 points on the 100-point scale) of palmar pain at twelve weeks. The authors concluded that the small benefit and the similarity of other outcomes called the cost effectiveness of endoscopic carpal tunnel release into question.

Fusetti C, Poletti PA, Pradel PH, Garavaglia G, Platon A, Della Santa DR, Bianchi S. Diagnosis of occult scaphoid fracture with high-spatial-resolution sonography: a prospective blind study. *J Trauma*. 2005;59:677-81.

Twenty-four patients with clinically suspected scaphoid fractures and normal radiographic findings were evaluated with high-spatial-resolution sonography on the basis of three criteria: cortical infraction, effusion in the radiocarpal joint, and effusion in the scaphotrapezoid joint. The gold standard was computed tomography. Five patients were found to have fractures on computed tomography. The high-spatial-resolution sonography had a sensitivity of 100% and a specificity of 79%. The authors concluded that high-spatial-resolution sonography can reduce the need for computed tomography in patients with a suspected scaphoid fracture.

Hui AC, Wong S, Leung CH, Tong P, Mok V, Poon D, Li-Tsang CW, Wong LK, Boet R. A randomized control trial of surgery vs steroid injection for carpal tunnel syndrome. *Neurology*. 2005;64:2074-8.

Fifty patients with clinically diagnosed, electrophysiologically confirmed idiopathic carpal tunnel syndrome were randomly assigned to either open release or a single injection of 15 mg of methylprednisolone acetate. Patients whose symptoms had persisted for more than one year or who had evidence of thenar atrophy were excluded. Patients were followed for twenty weeks. Patients in the surgical group had significantly greater improvement in terms of symptoms and electrophysiological parameters. Grip strength was slightly less in the surgical group than in the injection group at twenty weeks, but not significantly so. The authors concluded that surgery results in better symptomatic and electrophysiological outcomes than does injection in patients with recent-onset carpal tunnel syndrome.

Parkkila T, Belt EA, Hakala M, Kautiainen H, Leppilahti J. Comparison of Swanson and Sutter metacarpophalangeal arthroplasties in patients with rheumatoid arthritis: a prospective and randomized trial. *J Hand Surg [Am]*. 2005;30:1276-81.

Fifty-three patients with rheumatoid arthritis were referred for surgical treatment of the metacarpophalangeal joints. A total of fifty-eight hands were randomized to treatment with either Swanson or Sutter implants. A total of seventy-five Swanson and ninety-nine Sutter implants were followed for a minimum of three years after surgery. Nine hands with forty-one implants were lost to follow-up. No significant differences in outcome were noted between the groups.

van Rijssen AL, Gerbrandy FS, Ter Linden H, Klip H, Werker PM. A comparison of the direct outcomes of percutaneous needle fasciotomy and limited fasciotomy for Dupuytren's disease: a 6-week follow-up study. *J Hand Surg [Am]*. 2006;31:717-25.

A total of 166 fingers with a total extension deficit of <90° were randomized to either percutaneous needle fasciotomy or limited fasciotomy and were followed for six weeks. In this short-term follow-up study, no significant differences were noted in terms of motion, satisfaction, or the rate of complications.

Wajon A, Ada L, Edmunds I. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. *Cochrane Database Syst Rev*. 2005;4:CD004631.

The Cochrane Library databases were searched for randomized, quasi-randomized, and controlled studies involving surgery of the trapeziometacarpal joint. A total of seven studies involving 384 patients were included in the analysis. Five different procedures (trapeziectomy alone, trapeziectomy with soft-tissue interposition, trapeziectomy with ligament reconstruction, trapeziectomy with interposition and reconstruction, and joint replacement) were included. No procedure demonstrated superiority over the others in terms of pain, function, satisfaction, motion, or strength, but trapeziectomy was associated with the fewest adverse events, whereas trapeziectomy with interposition and reconstruction was associated with the most.

Watts AC, McEachan J. The use of a fine-gauge needle to reduce pain in open carpal tunnel decompression: a randomized controlled trial. *J Hand Surg [Br]*. 2005;30:615-7.

Eighty-six patients were randomized to receive local anesthesia with either a 23 or 27-gauge needle. Those who were injected with the 27-gauge needle reported significantly less pain during the injection and significantly less anxiety regarding future injections.