

Minimally Invasive Hand Surgery and Treatment

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Minimal Incisions in Surgery

Modern surgery has seen a dramatic change in access to anatomic areas of the body. Much smaller incisions utilizing advanced endoscopic techniques and instrumentation has helped lessen patient morbidity and the need for prolonged hospitalization. As experience is gained in the various techniques, operative times for these operations continue to improve as well. The use of these techniques has quickly become mainstays for surgical procedures in the United States, UK, Canada, Europe, Asia and other counties around the world.

Laparoscopic surgery has existed since the development of diagnostic laparoscopy in the 1960s. The pioneers of laparoscopic surgery Semm K and Muehe E changed it from a diagnostic to a surgical procedure at the beginning of the 1980s, and it has since become a frequently applied technique for a wide field of indications. The procedure has become the gold standard for many organ systems, with some of the most common being reproductive (particularly gynecological) and digestive (as for cholecystectomy). A significant improvement in surgical training, as well as developments of instruments, imaging, and surgical techniques, has made laparoscopic surgery safe and feasible across different medical fields [1].

Hand and upper extremity surgery, like other areas of surgery, has seen rapid expansion of minimally invasive endoscopic operations and procedures. Surgery involving the shoulder, elbow and wrist all utilize techniques for access and repair of various conditions using small incisions. Use of smaller incisions and access points has, in most cases, decreased morbidity and shortened operating times for well-trained and experienced Hand and Upper Extremity surgeons. Three common techniques for minimally invasive Hand and Upper Extremity surgery and treatment include: 1) Endoscopic Carpal Tunnel Surgery, 2) Treatment of Dupuytren's Contracture and 3) Management of Vasospastic Disorders such as Raynaud's phenomenon.

Carpal tunnel syndrome

Carpal tunnel syndrome (CTS) is a one of the most common conditions treated by hand surgeons. As the median nerve passes through the wrist with the flexor tendons, under the transverse carpal ligament, compression of the nerve can cause a multitude of symptoms. Patients usually present with complaints of numbness, pain, and tingling of the thumb through ring fingers. Persistent CTS can lead to denervation of intrinsic muscles of the hand and paraesthesias. By incising the transverse carpal ligament, the carpal tunnel has its volume increased and thereby the median nerve is decompressed. Traditionally, the operation has been performed through a longitudinal incision through the proximal palm, with direct open dissection through the subcutaneous fat to the transverse

carpal ligament. This technique remained the standard of care for several decades.

With the trend towards minimally invasive surgery across medicine, new techniques led to the introduction of the endoscopic carpal tunnel release (ECTR) in 1987 by Okutsu et al. Initial reaction to the procedure questioned the utility of performing an endoscopic surgery through an incision only slightly larger than that used in the tried-and-true open technique. Incision placement is very different however, especially in the one incision technique, with the scar healing in the proximal wrist crease as opposed to within the glabrous skin of the palm. This leads to quicker incision healing time and decreased recovery time for the patient [2,3].

ECTR, much like many other minimally invasive techniques, has been thoroughly scrutinized in comparison to the traditional open method for outcomes in efficacy, complications, patient satisfaction, etc. The technique has evolved over the years with refinements to improve patient safety and decrease complications. Complications rates now remain fairly low for both OCTR and ECTR, with some studies showing one or the other with greater complications, however both being essentially equivocal over time [2-4]. Long-term results from both techniques also show equivocal relief of symptoms, recurrence rates, grip strengths, and DASH scores. Two factors, which repeatedly differentiate the two techniques, are patient satisfaction and return to work time.

Patient satisfaction between the two techniques trends towards ECTR [4]. Due to the fact that CTS is usually a bilateral disease, some patients have undergone an OCTR on one side and ECTR on the contralateral side. Invariably those patients prefer the less invasive approach, usually attributing this preference to quicker recovery time and decreased scar pain. Persistent pillar pain is reduced in ECTR secondary to lack of dissection through the soft tissues overlying the carpal tunnel. Return to work time is lower in ECTR, as quicker recovery times translate to earlier return to function and employment [2-4]. While incentives for patients to return to work vary according to several factors, those patients with the firm goal of returning to work find benefit in ECTR.

As ECTR has become a more accepted technique for surgical intervention for carpal tunnel, increasing numbers of surgeons are learning to perform ECTR [5,6]. This uptick in the number of ECTRs performed is seen highest in surgeons trained in accredited hand fellowship training programs. The complication rate has also been shown to be less for ECTR compared to OCTR in fellowship-trained surgeons [6]. The ECTR technique has also begun to be investigated for use in cubital tunnel release through a smaller incision. Early studies have also shown decreased return to work times, but as of now there is no long term data comparing the two methods, secondary to the relatively new procedure.

Dupuytren's disease

Dupuytren's disease is a fibroproliferative disorder of palmar and digital fascia that may result in contractures of the metacarpophalangeal and interphalangeal joints of the hands. Since the early descriptions of this disease process many surgical options have been described. Some of these include radical fasciectomy, dermatofasciectomy, limited fasciectomy, percutaneous fasciotomy and collagenase injection [7]. Since there is currently no cure for Dupuytren's none of these treatment options can eradicate the disease. The bane of this pathological process is recurrence or progression of disease. In recent years medicine has seen a shifted towards less invasive treatment options, fewer hospital stays, and decreased recovery time. This has led surgeons and patients to desire surgeries or treatment options with less healing time and faster recovery.

Surgery still remains the gold standard for treatment of Dupuytren's disease; however the most common surgical procedure being performed currently is a limited fasciectomy. This minimizes the large incisions and expedites healing and recovery time [8]. Several other minimally invasive options exist to treat Dupuytren's contracture. This includes percutaneous needle fasciotomy and collagenase injection. The percutaneous needle fasciotomy involves using a 25-gauge needle to perforate the cord along several points to weaken it and ultimately straightening the finger [9].

The use of collagenase involves injecting an enzyme into a palpable cord used, which will selectively degrade type 3 collagen and weaken the cord. This is followed by manipulation of the finger usually within 24-48 hours, ultimately straightening the contracted finger. Both of these options can be performed in the office setting and also decrease down time when compared to traditional surgery. With the introduction of collagenase onto the market in 2010 we have seen a down turn in surgical intervention for single cord and less severe contractures. While both of these less invasive procedures have gained popularity with surgeons and patients, they do carry a higher recurrence rate compared to open surgery [9,10].

Vasospastic disorders

Maurice Raynaud was the first to describe in 1862 the phenomenon of acral vasospasm clinically manifested as pallor, cyanosis, suffusion, a sense of fullness or tautness, sometimes accompanied by pain. Work by other investigators in the next decades has defined that this condition, termed as Raynaud's disease, can be the sole manifestation in a patient-called in that case primary Raynaud's phenomenon (RP)-or accompany other diseases, mainly connective tissue autoimmune disorders, such as systemic sclerosis (SSc), systemic lupus erythematosus, and Sjogren's syndrome. In the latter case, the term secondary RP is used [11].

Vasospastic disorders of the hands, particularly Raynaud's phenomenon, can lead to significant morbidity. Pain, ulcerations and tissue loss resulting from digital ischemia have historically been treated with oral medications, topical agents, nerve blocks and, in severe cases, digital sympathectomy.

Calcium channel blockers are the most commonly prescribed drugs for people with primary Raynaud's phenomenon. Seven randomized trials with 296 participants showed that the use of Nifedipine or Nicardipine were minimally effective in relieving the severity of vasospastic symptoms [12].

Nerve blocks provide only temporary relief are expensive and often require multiple injections. Percutaneous sympathetic blockade with a variety of agents, including mepivacaine and bupivacaine³⁵ has also been shown to be an effective treatment for refractory RS. A 2-week infusion of mepivacaine through a thoracic sympathetic catheter placed in the T2 vertebral segment was shown to facilitate ulcer healing in refractory secondary RS [13].

Botulinum toxin type A (Onabotulinum toxin A injection) has been used, recently, for the treatment of patients with ischemic ulceration and digital pain as a result of Raynaud's disease or syndrome. Although the mechanism of action through which botulinum toxin alleviates pain and enhances perfusion of the fingers in symptomatic Raynaud's patients is not yet elucidated, the dramatic improvement warrants further trials and investigation.

Botulinum toxin type A inhibits the release of acetylcholine from the presynaptic membrane. This chemical sympathectomy inhibits smooth muscle contraction. Its role in cutaneous circulation is presumed to be inhibition of vascular smooth muscle cell contraction, causing vasodilation. Another mechanism of action may involve increased perfusion within the muscle units and myocytes [14,15].

Botulinum toxin type A injections into the hand offer an important nonsurgical approach to patients with Raynaud's phenomenon. Vascular function is abnormal in patients with Raynaud's phenomenon. Onabotulinum toxin A injection has a distinct improvement in the vascularity and pain in patients who have failed conservative management aimed at promoting vasodilation [14-16]. However, the effects of Onabotulinum toxin A are likely not related to direct action on the vessels, but rather to modulation of the innervation of the vessels or blockade of the chronic neuropathic pain pathways. The pathways of the imbalance of vascular tone and chronic neuropathic pain are complex and multimodal. Continued research in this area may lead to more specific treatment for Raynaud's patients [14,16]

Discussion

The use of smaller access incisions and non-surgical techniques has helped to minimize patient morbidity for a variety of medical and surgical problems. Hand and upper extremity surgery, like several other surgical specialties, has adopted innovative techniques for managing common hand problems. Three of the most common clinical problems faced by hand surgeons are carpal tunnel syndrome, Dupuytren's disease with contracture and vasospastic disorders. As shown above, these problems are able to be treated with a combination of small incisions for access and injection therapies that, in some cases, eliminates the need for invasive surgery. The trend towards common use of these modalities should lessen patient morbidity; time off from work and/or school and medical costs in the future.

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