Management of the injured hand – basic principles in rehabilitation

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Introduction

This article is aimed at introducing the basic principles during the post- operative period, and the continuation of the care till the patient resumes his/her personal and/or professional activities using the hand. This is the third of the series of articles on the management of hand injury in general. The reader is expected to refer to the previous articles on anatomy, assessment and management of the injured hand.

Rehabilitation of the injured hand is critical to ensure the best outcome after any form of trauma. Any hand injury management is incomplete without appropriate rehabilitation in the post repair/reconstruction period. The treating surgeon should have a sound understanding of the rehabilitation of the injured hand, and be patient enough to complete the appropriate therapy program without rushing for further surgery.

Rehabilitation of the injured hand is a broad subject that ranges from oedema control, scar management, various forms of splinting, tendon gliding and range of motion exercise programs. Many different therapy programs and protocols exist and these should be tailored to the individual case. However the goals are clear and the common principles applied are; control of pain, limiting soft tissue swelling, supporting the healing fractures, restoration of motion, and restoration of function. The ultimate aim is to provide the patient with a sensate, pain free, stable and supple hand, which enables them to return to daily activities and work. Hand therapy is best done by a dedicated therapist with the surgeon getting involved in the decision making and monitoring of the progress.

Early postoperative care

Dressing for the injured hand is the responsibility of the operating surgeon. At the end of the definitive reconstruction, the aim is to achieve primary soft tissue and skin cover, the preferred choice being non-adhesive dry gauze and cotton padding. The splints are incorporated in the dressing. The surgical dressing consists of multiple layers of gauze supporting the transverse arch and the web spaces. Conventional plaster of Paris (POP) splints are used in the form of a slab. In the case of flexor tendon injury a dorsal extension blocking splint is used whilst a volar flexion blocking slab is placed following extensor tendon repairs.

In general, in other types of hand injury, the position of the hand and the degree of joint flexion is determined according to the individual case. The commonly used position of safe immobilization which is also called intrinsic–plus posture, places wrist in about 30 degree extension, metacarpophalangeal joints in 70-90 degrees of flexion and interphalangeal joints in full extension. In this position the collateral ligaments of the wrist and finger joints in maximal stretch, thereby avoiding stiffness and contracture.

Hand injuries are mostly painful and require careful attention to pain control as pain limits movement and strength. Early mobilisation is encouraged in the majority of therapy programs and good analgesia is the key for successful patient motivation. Long acting local anaesthetics should be used in the form of local infiltration or as nerve blocks intraoperatively, providing analgesia in the immediate postoperative period. Combinations of different analgesics are used with the aim of keeping the patient pain free. Bulky dressing with protective splints and proper elevation helps to alleviate pain in the initial days.

Control of oedema and scar management

Complex and unique anatomy of the hand, especially the ability of the structures to glide relative to each other enables the hand to perform a variety of tasks ranging from simple to complex. Following injury and

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subsequent inflammation, oedema is inevitable, and scar formation is the final result causing stiffness, tendon adhesions and contractures. These pathological processes can prolong the recovery and significantly impair the hand function. The healing process, especially when adjacent soft tissue is damaged follows the principle of "one-wound" healing. That is, all structures damaged by the injury heal as one within the same scar. This prevents relative movement of individual structures. These gliding surfaces can be maintained or restored by early mobilization protocols.

Oedema on the dorsum of the hand causes the skin to tighten forcing the metacarpophalangeal joints (MCPJ) in to hyperextension. The same fluid accumulates within tissue layers, sheaths, periarticular capsular structures and within the synovial spaces. Thus the oedema acutely impairs the function of the joint. With prolonged oedema, the articular capsular structures and collateral ligaments fibrose, effectively shortening them. The swollen hand assumes a characteristic posture with hyperextension of the MCPJ. Both types of edema fluid—transudate and exudate—can cause problems in the hand that can lead to joint stiffness. Exudate leads to fibrosis and joint contractures. Elevation and compression are the primary passive means of counteracting excessive tissue oedema. Muscular contractions are the active external means of aiding venous and lymphatic drainage. Full joint motion and tendon gliding, achieved with active exercise, should be the goal early in the treatment of edema. If edema persists despite the standard treatment of elevation and active exercise, the utilization of compressive dressings is necessary to prevent the stiffness. Management of oedema in the acute setting is with elevation, which starts in the emergency room and continues throughout. Subsequently compression bandages and garments, massaging and active movements are used to control oedema. Massaging and compression are important physical techniques to soften the scar in the healing zone.

The initial compressive dressing is the postoperative dressing placed by their surgeon. Several different types of custom made and commercial compressive dressings are available, depending on the area to be treated. It is important to note that tissue perfusion should not be compromised when using compression. This is very important in cases involving recent surgery, vascular damage, skin grafts, or replantation. The patient must be instructed by the therapist or surgeon about “not wrapping the extremity so tightly” that circulation is impeded. Compressive stockinet type dressings provide adequate pressure for reducing edema across the dorsum of the hand and up the arm. For individual digit compression, Coban® is a useful elastic wrap that adheres to itself. When wrapping individual fingers, the tip should be left open so that circulatory changes can be noted. The wrap should be applied in such a way that decreasing pressure is exerted distal to proximal in order to prevent compromising the circulation. The external compressive dressing should not restrict motion because exercises should be performed with the wrap. If splinting is necessary to prevent joint contractures or to maintain proper joint position, neither the splint straps nor the splinting material should be restrictive so as to cause pressure areas or block the fluid flow out of the hand and into the arm. Precautions should be taken so that the application of the splint does not exacerbate the existing problem.

In the healing process collagen synthesis, or scar formation, is the norm. But the scar tissue formed in between the structures binds them together in an attempt to heal as one wound. Because of the close proximity of structures in the hand, tendons, nerves, ligaments, and bone can heal within a continuous sheet of scar, therefore limiting motion between the structures. This extrinsic scar formation can be viewed as an enemy of motion that must be counteracted. One of the most common problems is adhesions of the flexor tendons to bone and surrounding structures after a fracture. Early active motion is the most effective treatment to avoid excessive scar adhesions between structures. However, prevention of excessive scar formation is not always possible. Treatment must then be directed toward influencing the scar maturation process. Intermittent mechanical pressure as in massaging and vibration and long-term sustained pressure as in pressure garments, on the scar can influence the process along with active and resistive exercises. Pressure on the scar provides the stimulus to slow scar formation and avoid excessive scar formation. In addition silicone in the form of gel sheets or in gel forms is used to manage scars.

Rehabilitation of tendon repairs

The goal of tendon repair and rehabilitation is to achieve a normally gliding and functioning tendon. This in turn

has two interrelated requirements: a repair strong enough not to break during movement, and a rehabilitation method that achieves tendon motion while respecting the mechanical limits of the chosen repair technique. Mobilized tendons have shown to heal quicker and are stronger with fewer adhesions than immobilized tendons.

Hence, tendon repair should be strong enough to allow function and gliding avoiding rupture of the tendon in the early phase. There are many programs and protocols available to rehabilitate the flexor tendon repairs. One of the first protocols was introduced by Kleinert. Later, many protocols were introduced. Yet, the ideal protocol, which gives the best functional outcome, is non-existent. Early active movement protocol, Klinert protocol and Durran protocol are some of the popular techniques. The authors preference is the early active movement protocol. All these methods involve a splint not to immobilize the hand but to allow a certain range of motion with protection against the extreme movements.

Each rehabilitation methods vary in their protocol but there are common basic principles. There are variations of these methods in clinical practice today. The once popular rubber band technique made known by Kleinert et al., has now been favoured against by passive and active motion protocols. Programs involve a step-wise progression of passive movements in order to reduce adhesion but preventing excessive loading and the active motion to overcome stiffness and swelling of digits. Patient compliance is vitally important for the success of flexor tendon repairs. Patients who ignore the rehabilitation protocols can certainly have a bad impact on the outcome. The trend to incorporate more active mobilization seems to be favoured but further study in this area is needed.

The extensor mechanisms of the hand are a complex function determined by its intricate anatomy. Thin and flat extensor tendons, especially over the fingers are technically difficult to repair surgically. The rehabilitation methods differ in various zones. Following repair of the extensor tendons, use of a specific rehabilitation regimen involves consideration of the zone of injury, severity of injury, quality of the repair and also patient factors. The delicate balance of finger motion can be compromised in injuries to the extensor tendons. Traditionally injuries to zones I, II, and III are immobilized in a splint following repairs. These splints are finger based and the duration of full time splinting varies between 4 and 6 weeks. Intermittent or night time splinting is used subsequently with guided mobilization by the hand therapist. Zone IV and V repairs can be protected with wrist extension (400) and slight flexion at the metacarpophalangeal joint and extension of interphalangeal joints for about 4 weeks. More proximal repairs are managed with similar splints but allowing interphalangeal joint movements.

After extensor tendon repair, immobilization would lead to the formation of a strong fibrous union at the repair site, which has less chance of breakage. The potential disadvantage of immobilization is adhesion formation around the repair site, which can result in limitation of flexion. Early mobilization theoretically result in less adhesions and better range of flexion, but the risk of weakening the tendon repair is considerable. Poor quality repairs can lead to repair site rupture or scar stretch resulting in extension loss or lag. Improved understanding of tendon biology, better surgical technique and evidence for early motion following flexor tendon repair, have generated increasing interest in using the principle of early motion when treating extensor tendon injuries.

Rehabilitation of injured nerves

Rehabilitation following nerve injuries involve many aspects such as, preventing muscle atrophy, maintaining range of motion of the joints, control of pain of neural origin, sensory re-education and splinting for prevention of deformities. It is very important to educate patients with impairment of protective sensation, following nerve injuries as they are prone to get more injuries. In order to prevent joint stiffness, passive range of movement exercise and splinting in selected cases are employed.

Chronic intractable pain or complex regional pain is a potential complication of peripheral nerve injuries. Early recognition of this intractable problem, and prompt intervention by a multidisciplinary team approach to the pain is essential. Both pharmacological and non-pharmacological measures are being used. But the response is often unpredictable. Aggressive physical therapy, electrical stimulation, nerve blocks and psychological care are essential components in the management of this complex problem.

Significant functional deficits and muscle atrophy are consequences of major upper limb nerve injuries. Motor end plates at neuromuscular junction undergo significant changes which are irreversible. Even with proper nerve regeneration, if there are irreversible changes at neuromuscular junction, the desired function is not going to be recoverable. Physical therapy is being used to care for the muscles till the nerve recovery is complete. They take the form of electrical stimulation, passive range of movement, massaging, ultrasound, laser and splints. Maintenance of physiological length, prevention of vascular and lymphatic stasis, prevention of contractures and joint stiffness are the key aims during the recovery period.

Conclusion

Functional loss is the concern in many complex hand injuries. Strengthening, coordination, fine movements and functional adaptations are special aspects in the rehabilitation to achieve improved outcome. Psycho-social support is an integral component in rehabilitation especially in mutilated and complex injuries. Undoubtedly immobilization of the injured hand would help to protect the surgical repairs but promote more stiffness. In essence there should be a balance between immobilization and early mobilization and the key for this is stronger repairs and rigid fixations. Rehabilitation is not complete until the patient is back to independent hand usage in daily living and in occupation. In mutilated hands, certain splints and devices are required to help overcome the functional deficits. Appropriate post-operative care and hand therapy can make a significant difference in the functional outcome.

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