"EVALUATION OF CARPEL TUNNEL MANAGEMENT ON EXPERIMENTAL PAIN MANAGEMENT STUDY"

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Abstract

This study aimed to compare the efficacy of ultrasound therapy and low-level laser therapy (LLLT) in the treatment of mild to moderate idiopathic carpal tunnel syndrome (CTS).

Procedure: Ninety hands in 50 consecutive patients with confirmed CTS by electromyography were randomly allocated into two experimental groups. One group received ultrasound therapy, while the other received LLLT. Both treatments were administered daily for 15 sessions over three weeks. Outcome measures included pain assessment, electroneurographic measurements, and pinch and grip strength before and after treatment, with follow-up assessments four weeks later.

Results: Improvement was significantly more pronounced in the ultrasound group compared to the LLLT group. Ultrasound therapy demonstrated superior outcomes in motor latency, motor action potential amplitude, finger pinch strength, and pain relief compared to LLLT. These effects were sustained during the follow-up period.

Conclusion: Ultrasound therapy was found to be more effective than LLLT in the treatment of mild to moderate idiopathic carpal tunnel syndrome. Further studies are warranted to explore the potential benefits of combining these treatments and to evaluate their long-term efficacy.

Keywords: *carpel tunnel syndrome, ultrasound therapy, laser therapy, pain relief, hand strength*

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1. Introduction

Carpal tunnel syndrome (CTS) stands as a prevalent and often debilitating condition that affects millions worldwide. Characterized by the compression of the median nerve at the wrist, it manifests through symptoms like tingling, numbness, and pain, primarily affecting the palm and fingers, especially the thumb, index, and middle fingers. While the condition's symptoms are well-documented, its historical journey and the intricate interplay of anatomy, physiology, and risk factors have contributed to its understanding and management over time. Throughout history, CTS has left its mark in surgical literature, with early observations dating back to the mid-19th century. It wasn't until the early 20th century that medical literature began to recognize and elucidate the condition, culminating in the first recorded use of the term "carpal tunnel syndrome" in 1939. Physician Dr. George S. Phalen's pioneering work in the 1950s and 1960s furthered our understanding of the pathology, laying the foundation for subsequent research and clinical interventions.

Epidemiological studies have revealed intriguing patterns regarding the prevalence and distribution of CTS. Age emerges as a significant factor, with an increasing number of cases observed up to the age of 50, followed by a gradual decline. Gender also plays a role, with women exhibiting a higher predisposition to CTS compared to men. Additionally, associations with obesity, pregnancy, and certain medical conditions like diabetes underscore the multifaceted nature of CTS etiology. Both occupational and non-occupational risk factors contribute to the development and exacerbation of CTS. Occupational hazards, such as repetitive wrist motions and the use of vibrating tools, have been implicated in CTS development, though the role of non-occupational factors like age, gender, and underlying medical conditions cannot be overlooked. Understanding these risk factors is crucial for early recognition, prevention, and targeted management strategies.

In this comprehensive exploration, we delve into the anatomy, epidemiology, and risk factors associated with carpal tunnel syndrome. By unraveling the complexities surrounding CTS, we aim to enhance awareness, foster interdisciplinary collaboration, and improve outcomes for individuals grappling with this debilitating condition.

2. PathoPhysiology

2.1 Nerve Degeneration: Secondary Degeneration: This occurs both distally and proximally to the site of injury and is termed secondary degeneration. Wallerian Degeneration: The axon cylinder swells and breaks into small pieces, appearing as debris within the nerve fiber. The myelin sheath disintegrates into fat droplets, while the neurilemmal sheath remains unaffected. Schwann cells multiply rapidly, and macrophages invade to remove debris, ultimately leaving the neurilemmal tube empty before being filled by Schwann cell cytoplasm.

Retrograde Degeneration: Occurs up to the first node of Ranvier from the site of injury. The cell body swells due to fluid accumulation, and the nucleus may be displaced towards the periphery. These changes collectively constitute retrograde degeneration.

Nerve Regeneration: Regeneration begins when the endoneurial tube filled with Schwann cells remains intact. Axonal sprouts extend across the site of injury, a process known as motor march. Successful nerve repair leads to regeneration of axons, which pass across the suture line. However, they rarely enter pre-existing Schwann tubes. The nerve architecture returns to normal following transaction and repair.

2.2 Classification of Nerve Injuries: Seddon's Classification: Based on the severity of nerve injury, including neuropraxia, axonotemesis, and neurotemesis. Sunderland Classification: Recommends five grades of increasing severity, considering factors like axon transport, continuity, perineurium, fascicles, and endoneurium. **Mechanisms of Nerve Injury**: Compression neuropathies, traction, laceration, cold injury, electrical shock, and injection are common mechanisms of nerve injury.

3. Investigation

Electrodiagnostic tests, including nerve conduction velocity studies, electromyography (EMG), and strength-duration (SD) curve analysis, are essential for evaluating median nerve injuries. Nerve conduction studies assess nerve conductivity and identify axonal or myelin involvement. EMG records muscle electrical activity, aiding in determining the extent and completeness of nerve injury. SD curve analysis provides objective evidence of nerve integrity based on the response to varying stimulus intensities and durations. These tests complement each other, offering valuable insights into the presence, severity, and prognosis of median nerve injuries, guiding treatment decisions and optimizing outcomes.

4. Diagnosis

The subjective assessment begins with identifying the patient's demographics, chief complaints, and history of presenting complaints, detailing the onset, nature, aggravating and relieving factors of pain, sensory loss, and difficulty in wrist movement. Past medical history, associated problems like leprosy or Guillain-Barre syndrome, and family history of genetic issues are noted, along with personal and socioeconomic details. On objective assessment, observation reveals signs such as wrist drop, swelling, and muscle atrophy. Palpation assesses for tenderness, swelling, and muscle tone. Examination includes sensory and motor assessments, checking for deficits in superficial and deep sensation, muscle strength, tone, and range of motion. Special tests like Tinel's sign, Phalen's test, and carpal compression test help confirm median nerve involvement. Functional evaluation assesses hand grip and daily activities performance. Investigations include nerve conduction velocity studies, electromyography, and strength-duration curve analysis to confirm the diagnosis of carpal tunnel syndrome, differentiating it from other conditions like flexor carpi radialis tenosynovitis or median nerve compression at the elbow. The subjective and objective assessments provide comprehensive information to diagnose carpal tunnel syndrome accurately. Treatment planning and prognosis are based on these findings, ensuring appropriate management for the patient's condition.

5. Management

5.1 Non operative method- Initial treatment: NSAIDs; if ineffective, Prednisolone for 8 days (40mg for 2 days) , and carpal tunnel splint. Injection for intermittent symptoms <1yr.

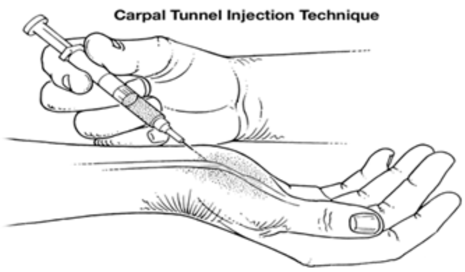

Fig.1- Carpal tunnel injection technique

5.2 Physiotherapy management

Conservative management for mild to moderate carpal tunnel syndrome involves wrist splinting, activity modification, and patient education. Joint mobilization, tendon gliding exercises, and median nerve mobilization help improve mobility. Muscle-setting exercises progress to strengthening and endurance exercises. Focus on speed, coordination, and fine finger dexterity. Educate patients on monitoring symptoms and modifying activities to prevent recurrence. Avoid aggravating motions like sustained wrist flexion and repetitive wrist movements combined with gripping and pinching.

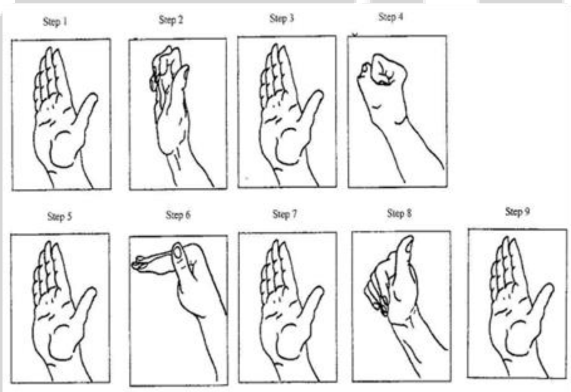

Fig.2- Glide exercises of carpal tunnel syndrome

Surgical intervention for carpal tunnel syndrome involves open or endoscopic release of the transverse carpal ligament. Open carpal tunnel release offers direct visualization of anatomy and allows exploration for other contributing factors. Endoscopic release involves smaller incisions and quicker recovery but has technical challenges and limited visual field. Both methods aim to alleviate compression of the median nerve, with open release being the gold standard, while endoscopic release may offer advantages in terms of scarring and faster return to activities.

Post-operative management of carpal tunnel release surgery involves gradual mobilization, wound management, and scar tissue mobilization. Initially, maximum protection is provided with splinting and precautions to prevent flexor tendon bowstringing. Active exercises are gradually introduced, focusing on finger and wrist mobility, strength, and dexterity. Scar tissue mobilization and sensory reeducation help alleviate hypersensitivity. Secondary prevention includes avoiding crutches, maintaining proper sleep positions, and vigilance for tight casts or splints to prevent further nerve injury.

6. Prognosis

With a good prognosis in more than 90% of cases, neuropraxia—which is defined by transient nerve malfunction without axonal damage—often results in a quick and complete recovery, especially in regions like the forearm and wrist. When there is damage to the nerve fibers but not the connective tissue framework (axonotmesis), there is a possibility of recovery. If, however, there is no improvement over time, there is little hope. On the other hand, neurotmesis, in which nerve continuity is completely destroyed, usually prevents full recovery, highlighting the crucial role that nerve integrity plays in prognostic evaluation.

7. Conclusion

Our study provides evidence supporting the effectiveness of ultrasound therapy over low-level laser therapy (LLLT) in the management of mild to moderate idiopathic carpal tunnel syndrome (CTS). Ultrasound therapy demonstrated superior outcomes in terms of pain relief, motor latency, motor action potential amplitude, and finger pinch strength compared to LLLT. These findings suggest that ultrasound therapy may be a more beneficial treatment modality for individuals with CTS. However, further research is needed to explore the long-term efficacy and potential synergistic effects of combining ultrasound and LLLT therapies in the management of CTS. Nonetheless, our results contribute to the growing body of literature supporting the use of ultrasound therapy as a valuable intervention for CTS patients.

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