Case Reports

Incorporating Nerve-Gliding Techniques In The Conservative Treatment Of Cubital Tunnel Syndrome

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Abstract

Objective: To discuss the diagnosis and treatment of a patient with cubital tunnel syndrome and to illustrate novel treatment modalities for the ulnar nerve and its surrounding structures and target tissues. The rationale for the addition of nerve-gliding techniques will be highlighted.

Clinical Features: Two months after onset, a 17-year-old female nursing student who had a traumatic onset of cubital tunnel syndrome still experienced pain around the elbow and paresthesia in the ulnar nerve distribution. Electrodiagnostic tests were negative. Segmental cervicothoracic motion dysfunctions were present which were regarded as contributing factors hindering natural recovery.

Intervention and Outcomes: After 6 sessions consisting of nerve-gliding techniques and segmental joint manipulation and a home exercise program consisting of nerve gliding and light free-weight exercises, a substantial improvement was recorded on both the impairment and functional level (pain scales, clinical tests, and Northwick Park Questionnaire). Symptoms did not recur within a 10-month follow-up period, and pain and disability had completely resolved.

Conclusions: Movement-based management may be beneficial in the conservative management of cubital tunnel syndrome. As this intervention is in contrast with the traditional recommendation of immobilization, comparing the effects of both interventions in a systematic way is an essential next step to determine the optimal treatment of patients with cubital tunnel syndrome. (J Manipulative Physiol Ther 2004;27:560-568)

Key Indexing Terms: *Manipulation; Neurodynamic Test; Ulnar Nerve; Cubital Tunnel Syndrome; Rehabilitation*

There is currently considerable debate regarding the diagnostic validity of neural provocation tests, as described by Elvey[1] and Butler,[2] especially when the clinical diagnosis of neural involvement is not supported by the presence of irregularities in electrodiagnostic tests. Likewise, the use of nerve-gliding treatment techniques remains controversial. This is reflected by the heated debates in different journals.[3-7] In our opinion, this is at least partially caused by the fact that the reasoning behind the use of nerve provocation tests and nerve-gliding techniques is rather poorly understood by many practitioners. In this case report, we illustrate the clinical diagnosis and the use of nerve-gliding techniques in a patient with cubital tunnel syndrome.

Entrapment of the ulnar nerve at the elbow, commonly referred to as cubital tunnel syndrome, is the most common ulnar nerve neuropathy and the second most common nerve entrapment after carpal tunnel syndrome.[8] Because a reliable distinction is difficult,[9] most authors do not strictly reserve the diagnosis to an entrapment situated at the cubital

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Table 1. *McGowan's grading system for cubital tunnel syndrome*

Grade 1: mild symptoms	Grade 2: moderate and persistent symptoms	Grade 3: severe symptoms
Intermittent paresthesia	Paresthesia	Paresthesia
Minor hypoesthesia	Hypoesthesia	Obvious loss of sensation
No motor changes	Mild weakness of ulnar innervated muscles	Significant functional and motor impairment
	Early signs of muscular atrophy	Muscle atrophy of the hand intrinsics
		Possible digital clawing of fourth and fifth digits

tunnel but also include more proximal neuropathies, such as along the epicondylar groove.[8,10] McGowan[11] differentiated 3 grades of ulnar nerve compression (Table 1), and conservative medical care is advocated in patients with the following findings: (1) early symptoms and intermittent episodes; (2) mild paresthesia, without significant pain; and (3) minimal physical findings with normal motor examination.[12] Only approximately half of the patients with mild cubital tunnel syndrome can be expected to recover with conservative treatment.[13] If symptoms persist after at least 3 to 6 months of conservative treatment, surgery is considered.[12,14]

Although cubital tunnel syndrome is a common entrapment neuropathy and a well-defined clinical entity,[15] the conservative treatment is not well documented. Standard nonoperative management consists of ergonomic modifications, avoidance of aggravating movements or postures, night splinting, nonsteroidal anti-inflammatory medication, and physical and/or occupational therapy with appropriate modalities.[12,16] However, it is not specified what is meant with "appropriate modalities." Standard textbooks also report in a rather limited way on therapeutic possibilities.

Analogous conservative guidelines exist for the treatment of patients with carpal tunnel syndrome.[17] Recent studies, however, have included soft tissue and joint manipulation of the upper extremity and spine.[18] To date, it is not clear yet what the prime components of the conservative medical or chiropractic care are. Rozmaryn et al[19] showed the benefits of adding nerve-gliding and tendon-gliding exercises to the standard conservative management of carpal tunnel syndrome. Of those patients who performed a home program of mobilization exercises for the median nerve and its surrounding structures in the carpal tunnel, only 43% underwent surgery, compared with 71% of those who did not perform the nerve-gliding and tendon-gliding exercises. After a 2-year follow-up, the majority of patients of the experimental group who did not undergo surgery still reported good to excellent results.

The aim of this case report is to illustrate how nerve-gliding techniques throughout the different stages of tissue healing can be incorporated in the standard conservative management of cubital tunnel syndrome, in some degree analogous to the management of carpal tunnel syndrome.

Case Report

History

The patient was a 17-year-old right-handed nursing student. She forcefully hit the dorsomedial aspect of her right elbow on the edge of a radiator and immediately experienced sharp elbow pain and a tingling sensation into the ulnar side of her hand. As symptoms persisted, she consulted a physician after 1 week. Three weeks after the trauma, her arm was immobilized in a cast for 2 weeks, and vitamin B supplements were prescribed. During the immobilization, symptoms were aggravated when she leaned onto her elbow. As elbow pain and abnormal sensations persisted, she was referred for manipulative therapy 2 months after the trauma. Radiographs and diagnostic ultrasound of the elbow and electrodiagnostic tests of the ulnar nerve revealed no abnormalities.

The patient described her dorsomedial elbow pain as a nagging annoying pain, which was intermittent and varied between 1.4 and 7.1 on a visual analog scale (VAS). A tingling sensation and numbness were still occasionally present over the hypothenar eminence and little finger. She did not describe weakness or dropping of objects. Symptoms were aggravated by leaning onto the elbow, by unilateral or bilateral overhead throwing activities, and by carrying a bag over the ipsilateral shoulder with the elbow in a position of combined flexion and pronation and with the wrist extended. Once the elbow pain was provoked, it radiated half way into her upper and lower arms and disappeared after approximately 2 hours. On average, she experienced 2 episodes of pain daily. Her sleep was occasionally disturbed by pain, and she occasionally experienced paresthesia or numbness at night.

In addition, a locking of her right elbow sporadically occurred when she reached out her arm, which resolved by moving the elbow. Regarding her medical history, she reported no shoulder or wrist problems and no previous elbow trauma, but mentioned recurrent self-limiting neck stiffness. The last episode occurred approximately 10 days before the first therapy session, after doing a few series of

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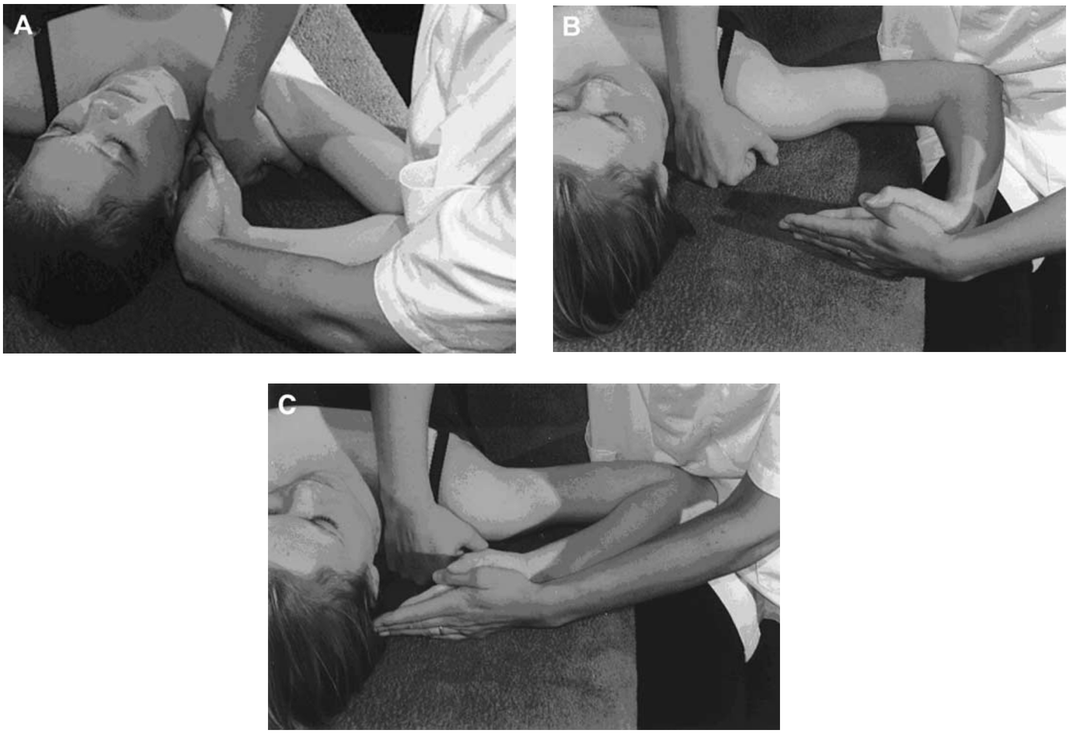

Fig 1. *Panel A shows the final stage of the $NPT_{ULNAR\ NERVE}$. Panels B and C show the end positions of an example of a treatment technique to enhance ulnar nerve gliding with minimal loading of the ulnar nerve (sliding technique). Wrist extension (loading), combined with an elbow movement toward extension (unloading) (B), is alternated with elbow flexion (loading), combined with a wrist movement toward flexion (unloading) (C). In contrast, panels A and B represent the end positions of a neural mobilization technique which alternatively loads (A) and unloads the ulnar nerve and brachial plexus (B) (tensioning technique).*

sit-ups. According to the guidelines for the assessment of psychosocial risk factors for long-term disability and work loss (yellow flags), her presentation did not reveal major risks. She was not too concerned about the locking feeling but wanted to be able to function without pain.

Physical Examination

Inspection revealed no deformities or swelling around the elbow, and a normal carrying angle was present. No relevant abnormalities could be detected with quick screening tests for the cervical spine, right shoulder, and wrist. Inspection revealed that cervical left side bending was slightly limited, but no symptoms were provoked. Passive elbow extension was 10° limited with an abnormal hard capsular end feel. Passive elbow flexion was 5° greater than on the uninvolved side but caused no pain. A standard goniometer was used for the measurements. Elbow pain could be reproduced when flexion was repeatedly performed and when flexion was combined with valgus stress. Passive supination was approximately 5° increased and pronation 5° limited. Both movements partially reproduced the elbow pain when the end range was reached. Varus and valgus stress tests were negative.

Testing of the shoulder girdle, elbow, and wrist muscles revealed pain-free, full strength, and normal length, although repeated isometric resisted elbow extension reproduced pain around the elbow. Isometric resisted testing of combined wrist flexion and ulnar deviation also provoked the elbow pain. Testing for intra-articular movement (joint play) revealed a decreased radial glide of the ulna in relation to the humerus. Radial head movements were judged normal.

Examination of sensation in the distribution of the ulnar nerve, including light touch, vibration sense, and superficial pain, did not reveal differences in comparison with the uninvolved side. Specific signs for ulnar neuropathy, such as Wartenberg sign (an abducted little finger because of the weakness of the muscle interosseus palmaris III) and Froment sign (flexion of the interphalangeal joint of the thumb against the index finger in attempting to hold a piece of paper because of weakness of the muscle adductor pollicis) were absent. Although these signs are in common use, it should be noted that, to our knowledge, the validity of these tests has not been analyzed yet. Tinel test at the elbow caused paresthesia in the ulnar nerve distribution, only on the involved side. However, inferences should be made with caution as percussion on the ulnar nerve has been found positive in up to 24% of a sample of asymptomatic subjects.[20]

The elbow flexion test, which consists of a 1-minute sustained elbow flexion with the wrist in a neutral position,[21] produced pain around the right elbow and a tingling

sensation in the ulnar nerve distribution of the hand. The test has a high positive predictive value (0.97), indicating a high probability of cubital tunnel syndrome if the test is positive.[21] This test is also described with the addition of wrist extension[15] or flexion.[22]

The patient's symptoms were best reproduced by the neural provocation test for the ulnar nerve ($NPT_{ULNAR\ NERVE}$). This test consists of a sequence of passive maneuvers: wrist extension, forearm pronation, elbow flexion, shoulder lateral rotation, shoulder girdle depression, and shoulder abduction (Fig 1A).[2] Numerous anatomic studies have shown a longitudinal excursion, elongation, and a tension increase of the ulnar nerve, together with a pressure increase in and around the nerve, when elbow, wrist, and shoulder movements are performed.[23-26] The test is considered positive if symptoms can be reproduced, if structural differentiation supports neurogenic involvement, and if differences with the uninvolved side can be shown with reduced range of motion (ROM).

Although few studies analyzed the diagnostic validity of neural provocation tests yet, Shacklock[27] made a valuable contribution by showing different test responses for the $NPT_{ULNAR\ NERVE}$ before and after surgery in a single case report of a patient with a surgically proven ulnar nerve entrapment. In our patient, symptoms were initiated when elbow flexion was introduced. Symptoms decreased by adding cervical ipsilateral side bending and aggravated by the addition of shoulder abduction or cervical contralateral side bending. Altering symptoms by changing the provocation of part of the nervous system by changing remote joint positions with no direct musculoskeletal link with the symptomatic region helps in structural differentiation and supports the hypothesis of neural involvement. Normal physiological responses were elicited on the uninvolved side. The neural provocation tests for the median and radial nerve were negative.

In comparison with the uninvolved side, palpation of the ulnar nerve along the epicondylar groove toward the aponeurotic arch of the flexor carpi ulnaris was painful. No anterior subluxation of the nerve could be observed.

As sessions progressed, we also noticed passive intervertebral motion restrictions at the levels T1-T2, T2-T3, and T8-T9 and a limited excursion of ribs 7 and 8 on the involved side.

Treatment Plan

Our first aim was to increase the patient's insight into the disorder by explaining the pathomechanism of the lesion and to prevent provocative positions and movements. The goals of the intervention were to normalize the sensitivity of the nervous system, restore normal nerve biomechanics, and regulate the elbow and spinal dysfunctions.

Neurodynamic mobilizations were performed aimed at reducing intraneural and extraneural edema, increasing blood circulation, and restoring neural tissue mobility. Neurodynamic mobilizations to enhance ulnar nerve gliding included sliding techniques and, to a lesser extent, tensioning techniques. A sliding technique is an alternation of combined movements of (at least) 2 joints in which 1 movement loads the peripheral nervous system while the other movement simultaneously unloads the nervous system (Fig 1, alternation between B and C). It is thought that these techniques facilitate nerve gliding without intensely challenging the nervous system.[2] In contrast, a tensioning technique alternatively loads and unloads part of the peripheral nervous system (Fig 1, alternation between A and B). Clinical support for the concept of sliding and tensioning techniques has recently been established by showing a cumulative and neutralizing impact on the nervous system when the number of simultaneously applied test components was varied.[28]

The articular dysfunctions of the elbow and thorax were treated with passive manual joint mobilization and manipulation. Although motion restrictions in the thorax are also common in asymptomatic subjects, the dysfunctions were addressed as they were considered relevant for the disorder and were hindering the patient. Light free-weight exercises were performed to facilitate optimal tissue healing of the injured tissues, to restore the tissue health of the target tissues of the ulnar nerve, and to reintegrate neuromotor control. A detailed overview of the treatment modalities is presented in Table 2.

To objectify treatment effects, a VAS was used to measure the changes in pain intensity. The patient was asked to quantify the pain she experienced in the 24 hours preceding the intervention. The boundaries of the scale were defined as "no pain" and "intolerable pain." Improvements in VAS scores of at least 2 cm are required to represent a meaningful improvement.[29] The available ROM during the $NPT_{ULNAR\ NERVE}$ and the elbow mobility were measured with a standard goniometer to monitor the evolution of the neurogenic and articular dysfunction. Although the smallest meaningful improvement in ROM has not been analyzed yet for the $NPT_{ULNAR\ NERVE}$, the smallest detectable difference in the equivalent test for the median nerve equals 7.2°.[30] Given the similar nature of the tests, we assume that the $NPT_{ULNAR\ NERVE}$ is also sensitive to small changes. The Northwick Park Questionnaire[31] was used to document the patient's functional status and was used at the first, last, and follow-up visits. Scores on this questionnaire range from 0 to 100, and a decrease of 10 points or more corresponds with a substantial improvement.

After 6 treatment sessions in a time span of 1 month, the patient described her situation as much better and was satisfied with the treatment outcome. The pain intensity and level of disability had progressively decreased, and the $NPT_{ULNAR\ NERVE}$ could no longer reveal abnormalities when compared with the uninvolved side. Whereas the elbow flexion test was initially positive, the test response

Table 2. *Summary of the interventions and outcome*

Session	Assessment	Treatment
Session 1, day 1	S/E: see Case Report in text Mean (24 h) VAS: 4.4/10 Northwick Park Questionnaire: 25/100 P/E: see case report in text	Explanation and education Elbow: passive extension mobilization, grade III NPT$_{\text{ULNAR NERVE}}$: In: head neutral, shoulder 90° abduction and lateral rotation, elbow 90°; Did: pronation and supination (3 × 10)
Session 2, day 7	S/E: increased symptoms for 2 days after session 1 mean (24 h) VAS: 4.3/10 P/E: elbow: extension restriction (−10°), pain Pronation restriction (−5°), pain NPT$_{\text{ULNAR NERVE}}$: symptoms on elbow flexion	Elbow: passive extension mobilization, grades II and III Passive pronation mobilization, grades II and III Distraction, grade III, in −10° extension NPT$_{\text{ULNAR NERVE}}$: In: see session 1 + pronation forearm; Did: elbow flexion 90°-140° (3 × 10, alternated with elbow oscillations, grade I)
Session 3, day 10	S/E: no arm symptoms for 2 days after session 2 Elbow locking in extension 2 days of neck stiffness after sit-ups Mean (24 h) VAS: 3.0/10 P/E: elbow: extension: normal Pronation: end range pain Radial glide of ulna: restricted, no pain T1-T2 and T2-T3: restriction + pain toward extension and right rotation	Elbow: passive pronation mobilization, grades III-IV Radial glide of ulna in ulnar nerve preloaded position, grades III-IV NPT$_{\text{ULNAR NERVE}}$: In: see session 2 + elbow flexion; Did: shoulder abduction 80°-120° (3 × 10) T1-T2 and T2-T3: high-velocity distraction thrust Home exercises: active ulnar nerve sliding techniques (Fig 1) (1 × 10 daily)
Session 4, day 14	S/E: no symptoms, except preceding day after leaning on elbow for 4 h (+ pins and needles at night) Mean (24 h) VAS: 5.2/10 P/E: elbow: normal Elbow flexion test: normal NPT$_{\text{ULNAR NERVE}}$: symptoms on 115° shoulder abduction T2-T3: restricted toward right rotation, no pain	Elbow: as session 3, but combined with active movement NPT$_{\text{ULNAR NERVE}}$: In: as session 3; Did: shoulder abduction 100°-130° (3 × 10) T2-T3: high-velocity rotation thrust Home exercises: active ulnar nerve-sliding techniques (Fig 1) (3 × 10 daily) Series of light free-weight exercises, such as supine dumbbell Elbow extension and pronation (each exercise: 1 × 10 daily)
Session 5, day 21	S/E: no symptoms, except once after cleaning Mean (24 h) VAS: 2.0/10 P/E: elbow: normal Cubital tunnel syndrome tests (elbow flexion test, Tinel sign): normal T8-T9 and ribs 7 and 8: motion restriction, pain	NPT$_{\text{ULNAR NERVE}}$: In: as session 4 + depression shoulder girdle; Did: shoulder abduction 100°-145° (3 × 10). Note: after 3 series, patient mentioned thoracic pain. Subsequent P/E revealed motion restrictions (see P/E of this session) T8-T9: high-velocity distraction thrust Ribs 7 and 8: high-velocity thrust Home exercises: active ulnar nerve tensioning techniques (like Fig 1) (3 × 10 daily) Series of light free-weight exercises (each exercise: 3 × 20 daily)
Session 6, day 28	S/E: no symptoms Mean (24 h) VAS: 0/10 Northwick Park Questionnaire: 6/100 P/E: elbow: normal NPT$_{\text{ULNAR NERVE}}$: normal Thoracic spine + ribs: normal	Checking home exercise program and advice to continue exercises for 1 mo
Follow-up 6 wk and 10 mo	S/E: no symptoms, no locking No hinder during activities of daily living Mean (24 h) VAS: 0/10 Northwick Park Questionnaire: 0/100 P/E: elbow: normal Elbow flexion test + compression: normal NPT$_{\text{ULNAR NERVE}}$: normal	

S/E, Subjective examination; *P/E*, physical examination.

Table 3. *Interpretation of the principal findings regarding ulnar nerve involvement*

Findings	Supporting (basic) research
Positive isometric resisted wrist flexion and ulnar deviation (combined)	Cubital tunnel pressure raises from 9 to 92 mm Hg with contraction of the flexor carpi ulnaris muscle.[33]
Positive repeated isometric resisted elbow extension	May be caused by an anomalous musculotendinous slip of the triceps which sometimes runs through the groove behind the medial epicondyle of the humerus and can cause inflammation because of mechanical irritation.[34]
Positive elbow flexion test	The ulnar nerve is stretched in elbow flexion,[21] with maximal strains around the medial epicondyle.[24] In 25% of cadavers, strains greater than 10% occurred in the ulnar nerve when the elbow was flexed.[24] Nerve elongation of that extent has demonstrated to compromise intraneural blood flow.[35] The diameter of the cubital tunnel decreases with elbow flexion, resulting in an increased intraneural and extraneural pressure.[21,25] The test has a high positive predictive value, indicating a high probability of cubital tunnel syndrome if the test is positive.[21]
Positive neural provocation test for the ulnar nerve	Besides the abovementioned biomechanical support, the diagnostic validity of the test was illustrated in surgically proven ulnar nerve neuropathy.[27]
Negative Froment sign and Wartenberg sign	Tests of function of muscles innervated by the ulnar nerve were expected to be negative, because light touch and vibration sense were negative, and these are the first that are affected in early stages of nerve entrapment.[14]
Positive ulnar nerve palpation	Injured or inflamed peripheral nerves are characterized by an increased sensitivity to mechanical stimuli.[36]
No electrodiagnostic abnormalities	Negative electrodiagnostic tests in the presence of clinical symptoms may occur when noncompressed fibers are being sampled, whereas compressed fibers and connective tissue sheaths may cause clinical symptoms.[10]

had normalized after 1 month, even when combined with pressure on the ulnar nerve at the cubital tunnel. Compared with the elbow flexion tests, the additional value of the combined pressure and flexion test is its high negative predictive value (0.99), indicating with a high probability that cubital tunnel syndrome is absent or no longer present if the test is negative.[21] Although no specific treatment was initiated for the locking feeling, it did not recur once the other symptoms were resolved. However, in case of a loose fibrocartilage segment, recurrence cannot be excluded. The improvement was maintained after a 6-week and 10-month follow-up. A detailed description of the evolution is presented in Table 2.

Discussion

In the analysis of a patient's complaints, there is support for a biopsychosocial approach, in which symptoms and signs are appreciated both in a biologic and psychosocial context.[32] However, in this case, no dominant psychosocial risk factors were identified, and the principal pain mechanisms seemed to be related to nociceptive and peripheral neurogenic input. Therefore, the analysis was limited to a biologic or tissue-based approach. In this section, the potentially involved structures after the traumatic impact are analyzed and related to the different stages of tissue healing.

Based on innervation patterns and symptom behavior, different structures which could contribute to the symptoms could be identified. The principal findings supporting cubital tunnel syndrome are listed in Table 3. An additional fracture of the medial elbow was improbable because of normal radiographs. Fragments of cartilage, infolding of synovial tissues into the joint space, or partial capsular involvement could not be excluded because of the locking feeling, the changed ROM and pathological end feel of physiological joint movements, and the altered accessory movements. There seemed no involvement of the medial collateral ligament as the valgus stress test was normal. Although several isometric resisted muscle tests were painful, there was little anamnestic support for a primary musculotendinous lesion, and positive tests could be explained because of the presence of the cubital tunnel syndrome (Table 3). Medial arm pain may also be referred from the C8 or T1 nerve roots. Although the patient reported recurrent self-limiting cervical symptoms, cervical examination could not reproduce symptoms. The upper thoracic segmental dysfunctions were regarded as a possible contributing factor in the genesis and/or maintenance of the neurogenic disorder.

The patient's complaints resulted from of a direct trauma. The connective tissues of nerves get easily injured, and the superficial location leaves the ulnar nerve susceptible to injury from a traumatic impact.[10] After tissue damage, the time-dependent process of healing passes through 3 overlapping stages: the inflammatory (4-7 days), the fibroblastic or proliferative (3 weeks), and the remodeling and maturation (3-12 months) phase.[33,34]After the inflammation, the tensile strength of the wound gradually increases, and the continuous deposition and removal of matrix components result in remodeling of the wound along the lines of the presented

load.[33] The definitive tissue structure is established in the remodeling and maturation phase. Dense collagen bundles begin to appear, and the definitive scar is formed.[33] Cross-linking occurs, and the tensile strength increases under the influence of activity-induced load, as the collagen fibers are reoriented along the functional lines of stress.

These general principles also apply to the connective tissue of peripheral nerves, although several specific points should be considered. The intrinsic afferent innervation of the nerve (nervi nervorum) and the well-developed blood supply make the connective tissues of peripheral nerves particularly reactive.[35] Furthermore, inflammation and edema inhibit normal nerve gliding,[14,23] and the intraneural edema results in increased intraneural pressure, which rapidly compromises intraneural blood circulation.[36] The resultant neuroischemia may cause pain and other symptoms, such as paresthesia.[15,37] If hypoxia continues, damage to the capillary endothelium may follow, increasing the edematous situation. In the absence of lymphatic vessels,[38] endoneurial edema cannot be easily evacuated and becomes an ideal environment for excessive fibroblasts proliferation and the beginning of intraneural fibrosis.[35,39] The segment that develops fibrosis loses its extensibility and elasticity.[39] In addition, the mesoneurium, the loose sheath around the nerve permitting the nerve to glide alongside adjacent tissues, may become fibrotic and may retract subsequent to trauma, compromising the nerve's mobility.[40]

Throughout the different stages of repair, gradual nondamaging movement aimed at evacuation of edema and dispersal of irritating chemicals, increase of blood circulation, and prevention of unorganized collagen formation and adherence to adjacent structures is required. However, the patient's elbow was immobilized in the early remodeling phase, hindering optimal loading of the joint and its surrounding tissues, including the ulnar nerve. As a result, articular and neural dysfunctions were maintained. Moreover, an unpadded cast frequently forms a new site of compression, and the development of cubital tunnel syndrome may also have been facilitated by this sustained elbow flexion, resulting in prolonged nerve elongation and compression.[23,25,37]

Finally, it is important to realize that neural and nonneural dysfunctions may mutually hinder each other's recovery. If the nervous system has lost some of its normal abilities to glide, forces which normally may have been absorbed along the course of the nerve can no longer be transmitted.[2,39] Therefore, activities of daily living may cause reinjury. Increased stress on the nerve caused by an articular dysfunction may also contribute to a perpetuation of the lesions. Furthermore, inflammatory mediators may be released into the target tissues upon antidromic activation of the neuron, impairing the physical health of the innervated structures.[41] This implicates that not only the articular dysfunction of the elbow may hold back the restoration of the nerve dysfunction, but that also the neurogenic disorder may impede recovery of the articular dysfunction, as the medial elbow joint is innervated by the ulnar nerve.

Therefore, an integrated treatment plan addressing neural, articular, and muscular structures was designed.

Although case reports cannot show cause-and-effect relationships, there is evidence from basic science and clinical studies to support the potential benefits of the proposed treatment. The discussion will be limited to studies pertaining to the peripheral nervous system.

Moving the elbow results in nerve gliding[26,42] and alters the pressure around the ulnar nerve.[25] Movement and the subsequent pressure changes may facilitate the evacuation of accumulated intraneural and extraneural fluids which may regulate the increased pressure. Within certain limits, blood circulation and axonal transport will recover after the removal of pressure.[43] Furthermore, axoplasm has thixotropic characteristics, which means that it becomes more liquid with movement. It seems acceptable to assume that adequate levels of pressure changes in and around the nerve during movement enhance axoplasm movement. Both the circulation and axonal transport are vital for the functional and structural integrity of a neuron.[44]

Regarding the endoneurial circulation, the microvascular bed has a considerable reserve capacity, and only parts of the bed are being functional under normal conditions. If the nerve is rubbed slightly, numerous vessels, not previously observed, begin to function.[44] Anatomic and clinical studies have shown that the ulnar nerve glides up to 1 cm when the elbow is moved through a full ROM.[26,42] We assume that the sliding of the nerve against its surrounding structures and intraneural sliding of the different fascicles have a similar physiological effect as gentle experimental rubbing, and that endoneurial circulation is enhanced during neurodynamic mobilizations. In this regard, sliding techniques seem preferential to tensioning techniques because the latter induce more tension and elongation of the nerve segment, which is known to compromise intraneural circulation.[44]

To our knowledge, only 1 study previously analyzed the effect of mobilization in patients with cubital tunnel syndrome. Weirich et al[45] compared the effect of immediate versus delayed postoperative mobilization after subcutaneous transposition of the ulnar nerve. Although both groups showed significant improvements, the patients of the immediate mobilization group returned to work and resumed activities of daily living substantially earlier than patients in the delayed mobilization group.

Conclusion

In a review, Dellon[13] concluded that approximately half of the patients with mild cubital tunnel syndrome can be expected to recover with conservative treatment and that

for the patients with moderate and severe symptoms, a conservative treatment is completely unsuccessful. Unfortunately, none of the reviewed studies documented conservative treatment in detail. We believe that recent neurophysiological advances allow us to better appreciate the role that conservative treatment can play in a large number of patients with cubital tunnel syndrome and other entrapment neuropathies. In agreement with the renewed approach of patients with carpal tunnel syndrome,[19] the potential benefits of incorporating an integrated dynamic treatment approach in the conservative management of cubital tunnel syndrome have to be analyzed in a systematic way and weighed against the current preference of partial immobilization.

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