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Brachial plexus injury following blunt trauma; an anatomical variation in electrodiagnostic findings

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Abstract: Damage to the brachial plexus branches is one of the most important events during traumatic events, which may cause various disabilities. Electrodiagnostic testing is the preferred method to evaluate the extent of damage to the brachial plexus following trauma. The case presented in this paper, is a 26-year-old man who had near normal function of pronator teres and flexor carpi radialis muscles on electrodiagnostic testing following a right upper limb severe blunt injury at the level of his arm. After surgical investigation, we found a rare variation in the proximal part of the median nerve. In this case, branches to the pronator teres muscle and flexor carpi radialis had emerged from the proximal section of the median nerve in the arm region. This new variation holds important clinical implications especially in trauma patients presenting with weakness in forearm flexion.

Keywords: Anatomy; Case Reports; Median Nerve; Nonpenetrating Wounds

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1. Introduction

The median nerve (MN) forms from lateral and medial cords of the brachial plexus from the C5 to T1 nerve roots. The MN, placed medially to the coracobrachialis muscle and musculocutaneous nerve (MCN), runs through the medial bicipital groove and then passes between two heads of the pronator teres muscle deep to the bicipital aponeurosis and medial to the brachial artery at the elbow level. This nerve later crosses to run medial to the artery. Normally, MN has no branches in the upper arm area. The MN branches in the lower arm consist of an articular branch to the elbow joint and a branch to pronator teres muscle right above the elbow joint. Muscular branches to the palmaris longus, flexor carpi radialis, and flexor digitorum superficialis are given off in the cubital fossa. Anterior interosseous nerve (AIN) is later formed from the MN and supplies deep flexors of the anterior forearm (1, 2). Anatomy of the forearm's nerves can occasionally have physiological variations. Understanding these variations is crucial in order to avoid surgical complications. Electrodiagnostic testing is one of the main ways to assess damages to the brachial plexus following trauma. However, the timing of test conduction is very important and at least two weeks should pass after trauma to assess the damage and doing this imaging earlier can lead to misdiagnosis (3). Here, we report a case in which a rare variation has been defined. Informed consent was received form the patient for this presentation.

2. Case presentation

The patient was a 26-year-old man who had suffered a blunt injury four months before, following a right upper limb entrapment inside a machine while working. Patient's right upper limb was extensively strained and there was an intense direct pressure at the arm level. The patient was referred to an emergency room immediately after the injury, and at the time of the visit, the examination showed a blunt trauma and crushing in the right arm area where there was no open wound. The patient felt severe pain in his right upper limb. The patient's vascular pulses were normal and examinations for vascular damage with color Doppler sonography and computed tomography (CT) angiography appeared intact. He also had no bone fractures. Therefore, discharged on outpatient follow up.

Four months after the mentioned traumatic event, he was unable to perform straight upper limb movements. In physical exam, biceps, triceps, and supinator reflexes were all absent. He was able to perform shoulder movements but was unable to flex his elbow, and the flexion of the first finger was also impaired. The patient was able to flex his wrist to some extent and could perform abduction of the hand. Pronation of forearm was also feasible. Wrist extension was done very poorly. An electrodiagnostic testing was performed by a professional physiatrist before surgery, showed evidence of post ganglionic brachial plexus injury at the cord level superimposed by peripheral nerve damages including severe radial

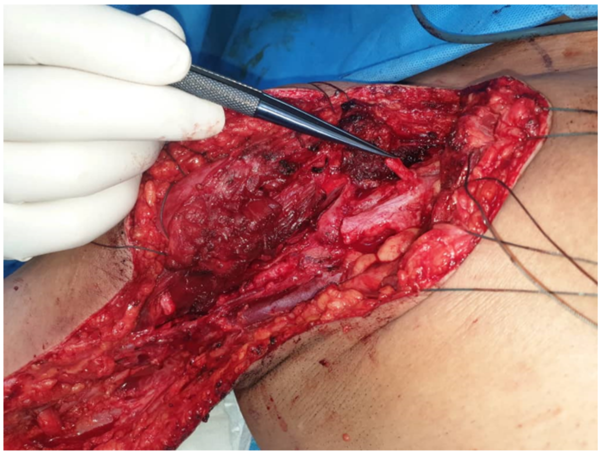

Figure 1 The proximal site of the severed median nerve

Figure 2 The distal site of the severed median nerve

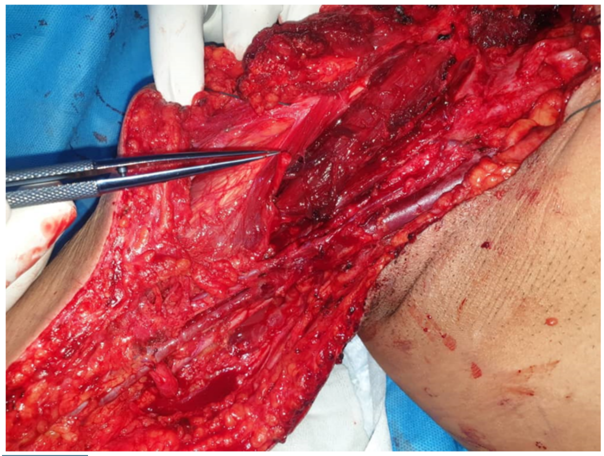

Figure 3 The location of musculocutaneous nerve injury

nerve damage with some sign of regeneration, severe MCN damage without evidence of regeneration, and severe MN damage. Then the patient underwent two stages of surgery by a reconstructive hand surgeon. In the first stage, lateral collateral ligament repair was performed to create stability in the elbow. Nerve exploration determined that the patient's MN and MCN were completely cut at arm level but the other nerves were intact. Median and musculocutaneous nerve repair was performed via sural nerve graft (Figures 1-3).

3. Discussion

The MN originates from the brachial plexus and descends down the arm to the forearm. In the forearm level, the nerve passes between the flexor digitorum superficialis and flexor digitorum profundus muscles. Anterior interosseous nerve (AIN) and palmar cutaneous nerve emerge from the MN in this area. In the forearm, muscles in the superficial (pronator teres, flexor carpi radialis and palmaris longus) and intermediate layers (flexor digitorum superficialis) are directly supplied by the MN. AIN innervates deep flexors (pronator quadratus, flexor pollicis longus, and the lateral half of the flexor digitorum profundus). Later, the MN enters the hand through the carpal tunnel and gives off two final branches including recurrent branch and palmar digital branch. Recurrent branch supplies the thenar muscles (4). Anatomical variations of the brachial plexus and specifically MN are not uncommon. These variations are most prevalent at the carpal tunnel level (5). Anatomical variations and anomalies of the MCN and the MN often accompany each other. There can be a wide range of alterations in communicating branches between these two nerves. The communicating branch can either be proximal or distal to the coracobrachialis muscle (6, 7). Beheiry et al., in an attempt to discover variations of the MN, dissected 30 cadavers. In one of the 60 limbs, MN gave a branch to brachialis muscle (normally supplied by MCN) and a branch to both heads of biceps from its lateral root. Simultaneously, the MCN was absent and coracobrachialis muscle was innervated by a branch from the lateral cord of brachial plexus. Moreover, there was a communicating branch between the MN and the MCN in the three limbs (8).

Singhal et al., reported variations in the right side of brachial plexus divisions. In their case, median nerve was located lateral to axillary artery (9). Henry et al., showed that several variations occurred in the course of the thenar motor branch of MN and recommended ulnar side approach in the carpal tunnel release surgery (10). There has been a case report of absence of MCN. The area commonly innervated by MCN was supplied by MN and branches to coracobrachialis muscle, the biceps brachii muscle, and the brachialis muscle had emerged from MN (11).

To the best of our knowledge, there has never been a report of altered location of median nerve branches without changes in the MCN. Since the first motor branch of the MN in the lower arm is the branch of the pronator teres and flexor carpi radialis, the initiation of regeneration process is usually based on the presence of active motor unit in these muscles on examination with a needle during electrodiagnostic testing. In this patient, while examining with a needle, the patient had an active motor unit in these two muscles but the response was weaker than normal and had a neurogenic pattern. At the time of surgery, it was found that the MN was completely cut in the middle of the arm. These findings meant that there was an anatomical variation and the nerves of these muscles were separated from the upper part of the MN in the proximal arm and their neurogenic pattern had occurred due to the isolated crushing of nerves of these muscles in the middle of the arm. This finding, may be the first report of isolated MN motor branches alterations. The presence of this anatomical variation has clinical significance for emergency physicians, surgeons, orthopaedicians, radiologists, physiatrists, and anesthesiologists performing surgeries, pain management, or regional anesthesia in the upper limb region.

Since traumatic injuries to the brachial plexus are very frequent, the evaluation of its anatomical variations is very important. Injuries to the proximal section of the MN can cause weakness of the forearm flexors. The presented case entails considerable importance related to the soft tissue injuries of the coracobrachialis, biceps, and pronator teres muscles, and also fractures of the proximal humerus, which can lead to an injury to the MN. Considering the presented variation and being aware of possible proximal branches emerging from MN are crucial for avoiding surgical errors.

4. Conclusion

The presence of anatomical variations in the nerve's pathways can interfere with accurate interpretation of the electrodiagnostic testing. This case report showed that anatomical variations should be considered when examining brachial plexus injuries with electrodiagnostic testing, so that the most accurate results can be reached.

5. Declarations

5.1. Acknowledgment

None.

5.2. Authors' contribution

All the authors met the standards of authorship based on the recommendations of the International Committee of Medical Journal Editors.

5.3. Conflict of interest

Authors declare no conflict of interest.

5.4. Funding

None declared.

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