Median nerve entrapment syndrome in the proximal forearm

Median nerve compression in the proximal forearm is relatively uncommon. This study reviews 71 cases over a 20 year period. Of the 71 in this series, 51 were treated surgically. The time of onset to definitive treatment ranged from 6 months to 5 years, with an average of 9 months. The ages of patients varied from 15 to 56 years and there were 13 males and 58 females. Past criteria for making the diagnosis are reviewed and an added series of clinical observations is made, including three definitive stress tests. In all cases surgically treated compression of the median nerve has been found at one of three levels, in the following order of frequency: the pronator teres, the flexor superficialis arch, and the lacertus fibrosus. Follow-up has been from 6 months to 19 years and four cases in the series were considered to be failures.

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The syndrome of paresthesia involving the thumb, index, middle, and radial half of the ring fingers, accompanied by weakness of the hand in gripping and by pain in the wrist and forearm, usually is attributed to compression of the median nerve at the wrist. Occasionally, surgical decompression of the median nerve within the carpal tunnel fails to relieve these symptoms because: (1) the compression syndrome did not originate at the wrist but, instead, at the pronator teres level; or (2) the compression occurred both at the wrist and at the proximal region of the forearm.

A total of 26 cases of compression of the median nerve in the proximal forearm has been reported in the literature.1-4 Our study reviews 71 cases of median nerve compression in the proximal forearm within a 20 year period. Of this number, 51 were decompressed surgically. Our clinical observations have led us to define more clearly the physical findings of median nerve compression in the proximal forearm and from our surgical observations and anatomical dissections to suggest a possible cause.

Clinical observations

Of the 71 cases studied, there were 13 male patients and 58 female patients whose ages ranged from 15 to 56 years. The mean age was more than 40 years.

Clinical findings in our series, associated with compression of the median nerve, included paresthesias and numbness in the thumb, index, middle and radial half of the ring fingers; pain in the proximal forearm, increased by resistance to pronation, with occasional proximal radiation to the elbow and to the upper arm; occasional radiation of pain into the axilla and neck; clumsy use of the hand which at times was associated with a feeling of weakness in gripping; a tender mass on the volar aspect of the proximal forearm. The time of onset of these findings to the time of definitive treatment ranged from 6 months to 5 years; the average time was 9 months.

The diagnosis of the median nerve compression syndrome in the forearm focused on the reports of others,2-7 including the following findings: negative Phalen's test, weakness of the median innervated thenar musculature and long flexor to the thumb, variable weakness of the extrinsic muscles innervated by the anterior interosseous nerve, conduction delay of the nerve in the proximal forearm as demonstrated by electromyographic study, and sensory abnormality of the median palmar cutaneous nerve.

Our clinical observations showed a more varied pattern of findings than the traditional one, which included: (1) either tenderness, firmness, or apparent enlargement of the pronator teres muscle (the latter condition often was accompanied by measurable circumferential enlargement of the forearm at the level of the pronator teres muscle); (2) a positive Tinel's sign on percussion of the proximal muscle mass (this sign was noted most frequently at the distal margin of the pro-
Anatomic relationships

In the elbow region the median nerve most frequently passes beneath the lacertus fibrosus. Continuing, the nerve traverses the interval between the humeral and ulnar heads of the pronator teres. Distal to the muscle the nerve passes under the cover of the flexor superficialis musculature. The variations of this pattern have been described thoroughly. To investigate the potential of a fibrous entrapment of the median nerve in the cubital region, 40 preserved cadaver specimens were dissected. In 50% of the dissections, there was a structurally distinct but variable fibrous band on the dorsum of the superficial head of the pronator teres muscle overlying the median nerve. Approximately 40% of the dissections demonstrated a fibrous band dorsal to the nerve. The fibrous band was either a component of the deep ulnar head of the pronator teres muscle when the latter was present, or, when the deep head was absent, a separate fibrous structure was attached to the coronoid process of the ulna proximally. Only 20% of the dissections showed fibrous bands both for the superficial and for the deep heads of the muscle. In these preceding instances, a definite fibrous arcade was formed which surrounded most of the median nerve in its passage through the muscle. In 50% of the dissections, there was an intramuscular fibrous element within the humeral head of the pronator teres muscle which did not overlie the median nerve directly as the nerve passed posterior to it (Fig. 1).

The ulnar head of the pronator teres muscle was observed to be in various stages of development. In only 55% of the dissections could a well defined ulnar head of the pronator teres be identified. A distinct ulnar head of the pronator teres consisted of a thin straplike structure with linear fasciculi which measured approxi-
The anterior interosseous nerve was seen to separate distal to the pronator muscle. In all other observations, the median nerve usually occurred from 3 to 10 mm distal to its passage through the pronator teres muscle.

A fibrous arcade was observed in 30% of the dissections at the proximal margin of the flexor superficialis muscle to the middle finger. Of our total observations, 20% showed a strong fibrous band belonging to the flexor carpi radialis. These foregoing fibrous bands always were seen in conjunction with the presence of fibrous elements for both the pronator teres and for the flexor superficialis. In fact, all three fibrous components of the muscles united proximally with each other and appeared as an intramuscular septum which either surrounded or covered the median nerve in this region.

In 25% of our observations, there were no fibrous bands relating to the passage of the median nerve through the cubital region.

In approximately 90% of the dissections, the anterior interosseous nerve separated from the median nerve distal to its passage through the pronator teres muscle. The anterior interosseous nerve accompanied the median nerve through the pronator muscle on the posterior radial aspect of the median nerve. Both nerves through the pronator tunnel were sheathed together by epineurium. Branching of the anterior interosseous nerve from the median nerve through the cubital region varied from mild to marked in degree, however, the compression could not be correlated with the severity of preoperative clinical findings. The source of the nerve compression was variable. The lacertus fibrosus accounted for only two cases and a fibrous arch at the margin of the flexor superficialis appeared responsible for seven instances of compression. A markedly thickened fibrous band on the dorsum of the pronator teres muscle compressed the nerve in 39 cases. In three instances an accessory origin of the flexor carpi radialis from the ulna was found passing over the nerve. Operative findings in addition to compression of the median nerve by fibrous bands included hypertrophy of the pronator teres muscle, vascular anomalies about the median nerve in the region of the pronator, and intramuscular fibrous bands deep within the substance of the superficial head of the pronator teres.

All apparent fibrous bands were released and removed. The pronator tunnel was enlarged to allow the passage of the surgeon's finger proximally through the tunnel to the antecubital region.

Results

Follow-up studies have been made from 6 months to 19 years. All patients who had decompression of the median nerve in the forearm for only sensory complaints had relief the day following operation. In one instance paresthesias persisted at the tip of the thumb for 5 weeks, then gradually disappeared. Physical findings such as those outlined in the diagnostic criteria usually were absent by the time of suture removal.

Four cases in the total surgical series were considered to be failures. These resulted from either a misdiagnosis or a recurrent scarring around the nerve associated with a new injury.

Clinically, the pronator tunnel syndrome has been noted predominantly in women. The syndrome occurs with equal frequency in either extremity and is not related to handedness.

Summary

Median nerve compression in the proximal region of the proximal forearm, a condition usually caused by the presence of fibrous bands, has been found at three distinct levels and in the following order of frequency: the pronator teres, the flexor superficialis arch, and the lacertus fibrosus. The potential for fibrous compression of the median nerve at the pronator tunnel was substantiated from a series of anatomical dissections.

Three resistive tests have been found to be helpful in making a diagnosis of median nerve compression at the above-mentioned levels: (1) pronation of the forearm against resistance with the elbow flexed and then gradually extended; this localizes the lesion to the pronator teres; (2) independent flexion of the flexor superficialis of the long finger with reproduction of paresthesias or numbness in the radial three and half fingers localizes the entrapment level at the fibrous arcade of the flexor superficialis; (3) flexion-supination of
the elbow against resistance demonstrates the presence or absence of entrapment of the nerve by the lacertus fibrosus.

REFERENCES

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