Carpal Tunnel Syndrome Associated with Bifid Median Nerve and Palmaris Profundus - Case Report and Literature Review

Francesco Kostoris, Stefania Bassini, Emiliano Longo, Luigi Murena

Orthopaedics and Traumatology Unit, Cattinara Hospital, ASUITS, Trieste, Italy

The anatomic variations of the median nerve and of the muscles of the wrist have been widely reported in literature. It is essential for the surgeon to be familiar with these variations in order to avoid accidental injury to the nerve during surgery. We report a rare case of bifid median nerve accompanied by an anomalous tendon of palmaris profundus discovered during the surgical release of carpal tunnel. The transverse carpal ligament was dissected and the anomalous tendon was left in situ because any direct compression over the median nerve was noticed intraoperatively. The patient was evaluated one year postoperatively clinically and radiologically (with MRI). At the follow up the resolution of symptoms was complete and the sleep disturbance was solved. The patient achieved a postoperative QuickDASH score of 9.1 and a Michigan Hand Questionnaire outcome score of 90 points.

Keywords: *Carpal, Tunnel, Bifid, Median, Palmaris*

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy and carpal tunnel release is nowadays one of the most commonly surgical performed procedures.

Even if the surgical procedure is well standardized, some anatomic anomalies of the wrist can complicate the surgical technique. The surgeon should be familiar with variants of the vascular structures, nerves, tendons and muscles, to avoid any iatrogenic injury.

The bifid median nerve anomaly seems to have an incidence of 0.8% to 2.8%[1-3] in patients with CTS, even if other reports based on radiological studies suggest a possible much higher incidence of 18 to 19%.[2] Bifid median nerve is frequently associated with CTS because of its higher cross sectional area, as different imaging studies have revealed.[2]

The frequency of this anatomical variant in healthy subjects is reported to be approximately 8–15%.[4]

In up-to 45% of the cases a bifid median nerve has been described with concomitant persistent median artery,[3] but it has been rarely described with other anomalies such as arterovenous malformations, multiple motor branches, accessory muscles and divisions contained within separate tunnels.

While bifid median nerve is a relatively common variation, a palmaris profundus is a rare anomalous finding at surgery. This muscle is of interest because of its variable anatomy and because it does not exist in 15% of the general population.[5]

CASE REPORT

A Caucasian 79 year old, retired male presented to Orthopaedic Clinic of Trieste with a 3 year history of paraesthesia, a needling sensation, clumsiness, nocturnal symptoms, swelling, sensations of burning and cold, tightness, and pain/discomfort in the area of median

Accepted: May 2, 2018 Correspondence to: Francesco Kostoris
Orthopaedics and Traumatology Unit, Cattinara Hospital, ASUITS, Strada di Fiume 447, 34149 Trieste, Italy
Tel: +39-0403994730, Fax: +39-0403994544
E-mail: francesco.kostoris@gmail.com

nerve distribution of his right hand. The patient had a BMI of 33.41 (height 1.73 m, weight 100 kg) and suffered from moderate hypertensive-ischemic cardiopathy, well controlled with angiotensin antagonists and β blockers. His past medical history wasn't therefore noteworthy for any pathology related with carpal tunnel syndrome such as diabetes, rheumatoid arthritis or thyroid diseases.

He already had surgery for CTS (Carpal Tunnel Syndrome) in the left wrist some years before with complete recovery.

Physical examination revealed thenar atrophy, reduction of strength and sensibility in the median innervation area of the right hand. Provocative manoveures for CTS worsened symptoms while provocative testing for ulnar nerve and cervical spine pathology was negative.

Electro diagnostic testing confirmed median nerve compression at the wrist. The median sensory latency at the wrist was 7.55 ms, the motor latency was 8.75 ms.

Because non-surgical treatment options failed to provide sufficient relief, the patient wished to proceed with surgery.

Authors performed a 3 cm longitudinal incision ulnar to the palmaris longus tendon proximal to the distal volar wrist crease. The ante brachial fascia was dissected down in longitudinal fashion. But when the TCL (Transverse Carpal Ligament) was released Authors weren't able to identify the median nerve in his usual place.

Authors suspected a high division of the median nerve because the main branch was ulnar to the usual path, with a thin radial branch. There was no persistent median artery.

It was decided then to extend the incision proximally and distally.

On deep dissection it was identified a bifid median nerve running with an aberrant tendineous structure that

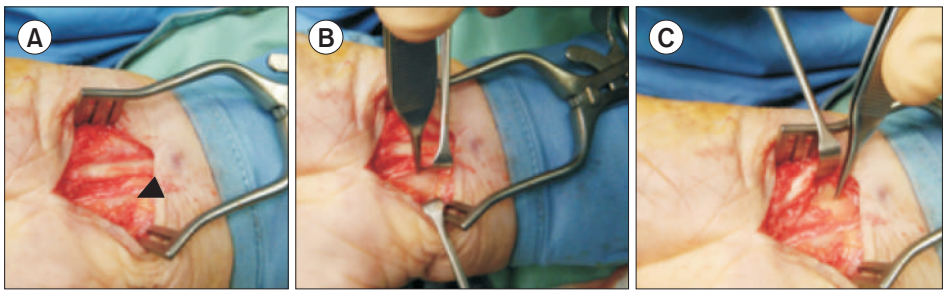

Fig. 1. Surgical appearance of the structures. The tendons of the palmaris longus and palmaris profundus (arrow head) are exposed (A). The ulnar branch of the median nerve is exposed after retracting the tendon of the palmaris profundus and sectioning the transverse carpal ligament (B). Both the branches of the median nerve could be seen (C).

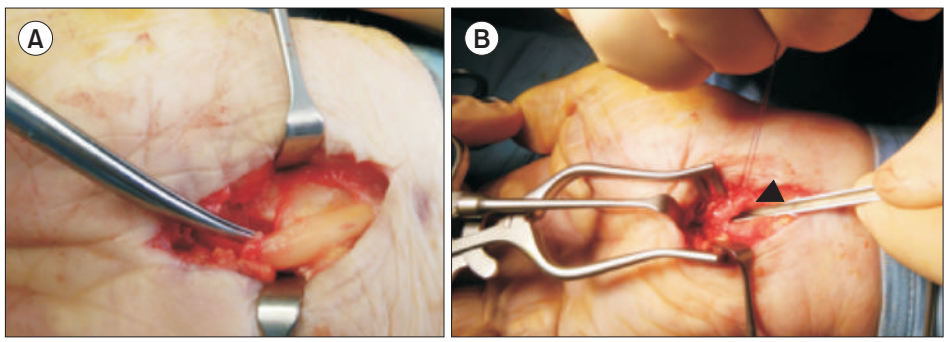

Fig. 2. The radial and the ulnar branch of the bifid median nerve ara exposed (A) A traction is applied to the tendon of the palmaris profundus (arrow head) (B). The tendon tendon was passing through the carpal tunnel following the median nerve and going deeply.

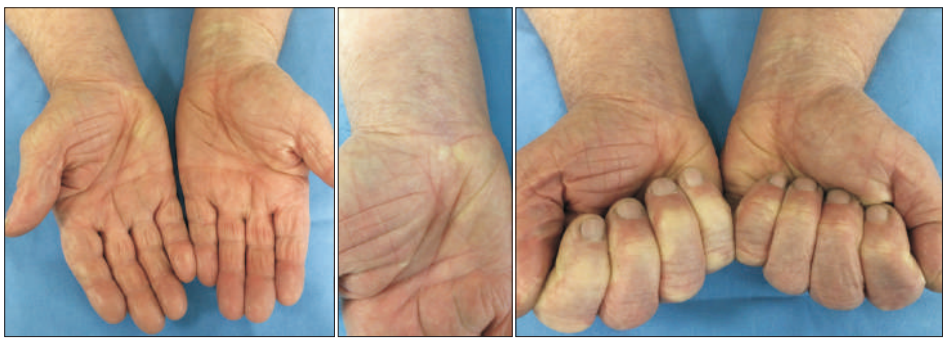

Fig. 3. Clinical aspect at the follow up.

was passing through the carpal tunnel and was going deeply following the median nerve (Fig. 1).

When a proximal traction was applied on the aberrant tendon any noticeable digital or wrist flexion occurred (Fig. 2).

The nerve appeared ischemic with a clear impairment of the epineural vascular network .

After the TCL dissection, no residual direct compression on the median nerve was noticed and there was a visible recovery of the blood flow in the epineural vessels, so the aberrant tendon was then left in situ.

The patient had an uneventful postoperative course with almost complete resolution of preoperative symptoms in the 2 weeks postoperative visit.

The patient was clinically evaluated 1 year after surgery (Fig. 3). The resolution of symptoms was complete and even the sleep disturbance was solved. He was able to perform heavy duties in his countryside.

Authors evaluated the clinical outcome with QuickDASH score and Michigan Hand Questionnaire.

The QuickDASH score was 9.1 and the Michigan Hand Questionnaire outcome score was 90, the appearance score was 100 and the work score was 90 (Table 1).

An MRI was performed 1 year after surgery to evaluate the anomalous structures and any direct compression on the median nerve was noticed (Fig. 4).

Table 1. Functional Postoperative Scores

Injured Hand	Right
Dominant Hand	Right
Quick Dash Score	9.1
Michigan Hand Questionnaire General Score	89.7
Michigan Hand Questionnaire Work Score	90
Michigan Hand Questionnaire Pain Score	85
Michigan Hand Questionnaire Appearance Score	100
Michigan Hand Questionnaire Outcome Score	90
Michigan Hand Questionnaire Final Score	87.5
VAS	0

DISCUSSION

The median nerve, consisting of both motor and sensory fibers, originates from the spinal roots of the brachial plexus at the level of C5—T1. At the level of the wrist, the median nerve passes through the carpal tunnel, deep to the transverse carpal ligament (TCL), together with the four tendons of the flexor digitorum superficialis, the four tendons of the flexor digitorum profundus and the tendon of the flexor pollicis longus. At TCL exit, the median nerve splits into medial and lateral branches. The medial ones end into two common palmar digital nerves, giving motor innervation to the IInd lumbrical and sensory innervation to the palm and fingers. The lateral branches give origin to the thenar motor branch (responsible of motor innervation of the opponens pollicis, abductor pollicis brevis and superficial part of flexor pollicis brevis) and proper palmar digital nerves (responsible of motor innervation of the Ist lumbrical and sensory innervation to the lateral side of the hand).

The first classification of the median nerve anomalies was proposed by Poisel in 1974, later reviewed by Lanz in 1977 (Table 2).[1)]

Henry's meta-analysis,[6)] published on Plos One in 2015, found that the pooled prevalence of Ist Lanz group among 31 of the major studies on CT anomalies, was 75.2% (extra-ligamentous), 13.5% (sub-ligamentous) and 11.3% (trans-ligamentous). The prevalence of IInd Lanz group was 4.6%, IIIrd Lanz group was 2.6% and IVth Lanz Group was 2.3%.

According to Lanz classification, then, our patient has a bifid median nerve (Group Three of Lanz classification) with a thick ulnar part.

As cited by Fatah,[7)] Frohse and Frankel first described the palmaris profundus anatomic structure in 1908. It was initially thought to be an anomalous pal-

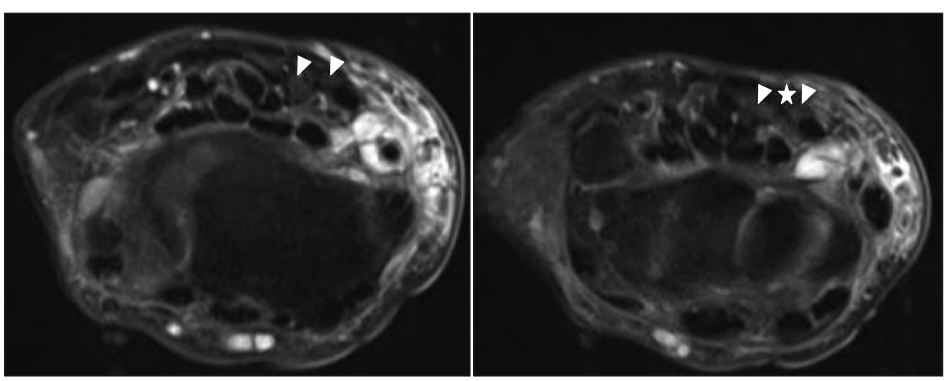

Fig. 4. Postoperative MRI imaging of the wrist. The two branches of the median nerve (arrows head) and the tendon of the palmaris profundus (star) are well recognizable.

Table 2. Groups and Subtypes of Median Nerve Variants

Median nerve variants	Subtypes
I[st] Group (Variation of the course of the TMB)	Extra-ligamentous TMB
	Sub-ligamentous TMB
	Trans-ligamentous TMB
	TMB leaves the MN at its ulnar side, piercing FR
	TMB leaves the MN at its ulnar side, running on the surface of FR
II[nd] Group (Accessory motor branches at distal CT)	Double motor thenar branch (Accessory brach origins from volar or, more frequently, ulnar side of MN)
III[rd] Group (High division of the MN, "bifid MN") (Fig. 3)	High subdivision of MN into radial and ulnar parts, TMB originates tipically
	High subdivision of MN + persistent median artery
	High subdivision of MN + additional lumbrical muscle
IV[th] Group (Accessory motor braches at proximal CT)	Additional branch arises from a trunk of the MN, enters in the CT and runs between fibres of FR, fusing with TMB
	Additional motor branch arises proximally, enters CT, piercing the FR
	Additional motor branch arises from ulnar part of MN, crosses nerve anteriorly running toward radial side, enters in the CT and pierces FR fusing with first palmar common digital nerve

CT: Carpal Tunnel, MN: Median Nerve, FR: Flexor Retinaculum, TMB: Thenar Motor Branch.

maris longus but later was acknowledged to be a separate structure as it coexisted with the said tendon, only to differ in its origins. To indicate its close association with the median nerve, the palmaris profundus was also named 'musculus comitans nervi mediani' by Sahinoglu et al. in 1994,[8] highlighting the potential patho-anatomic consequences of this relationship.

In the literature, the course of the palmaris profundus muscle and tendon is variable.

As Pirola reports in her review,[9] this accessory muscle has been classified by Yoshida in 1983 and Schmidt and Lanz in 2004 according its origin into different subtypes (Table 3). The innervation is given from the anterior interosseous nerve in Types 1, 2, and 3 or from the ulnar nerve in Type 4.

In most cases described in the literature, the palmaris profundus arises as a separate muscle in the middle third of the forearm, deep to the superficialis muscles. The tendon passes beneath the flexor retinaculum and after traversing the carpal canal, broadens to insert into the

Table 3. Palmaris Profundus Subtypes

Subtype	Origin	Innervation
1	Proximal/mid third of the radius: flexor carpi radialis profundus	Anterior interosseous nerve
2	Proximal/mid third of the radius: palmaris profundus radialis	Anterior interosseous nerve
3	Flexor digitorum superficialis fascia	Anterior interosseous nerve
4	Distal ulna anterior surface	Ulnar Nerve

deep surface of the flexor retinaculum and/or of the palmar aponeurosis. Variations of its insertion (such as into the third metacarpal or lateral carpal bones), although, have been described. The tendon itself may lie on the radial or ulnar surface of the median nerve through the carpal canal; separate tendons or tendinous insertions have also been reported.

We classified our surgical intra-operatory finding as the coexistence of two anatomic variants: number III[rd] Group median nerve anomaly and number III palmaris profundus subtype.

In literature there is just one single case reporting the coexistence of bifid median nerve and palmaris profundus, associated with CTS.

David P. Gwynne Jones[10] described in fact a case of failed bilateral CT release as a result of bilateral anomalous palmaris profundus that split the median nerve proximal to the flexor retinaculum. The aberrant tendon split the medial nerve into 2 branches (thin ulnar one and thick radial one), compressing the ulnar half of the median nerve. The palmaris profundus tendon was detached distally and a 5 cm portion was excited, solving the patient's symptoms.

In our case, we found a thick ulnar part of bifid median nerve and it was not compressed by palmaris profundus tendon.

Once we made sure that the anomalous tendon was not compromising the median nerve, we decided to leave it in its place, avoiding possible iatrogenic injuries. As confirmed by the long term follow up, the symptoms disappeared and the functional outcome was excellent.

In conclusion, carpal tunnel release is a simple, quick and well-standardized procedure, but it can be complicated by different anatomic anomalies. The surgeon should be familiar with variants of nervous, tendineous and vascular structures to avoid iatrogenic injuries. Cutting transverse carpal ligament fibres, in fact, the surgeon should be careful not to damage structures with unexpected placement or biforcations.

As demonstrated in our case report, aberrant struc-

tures are not always the main responsible of Carpal Tunnel Syndrome.

The decision to leave or cut the aberrant structures should be taken after a careful evaluation of the single case.

CONFLICT OF INTEREST

All Authors declare have no conflicts of interest to disclose.

REFERENCES

1. Lanz U. Anatomical variations of the median nerve in the carpal tunnel. J Hand Surg Am. 1977;2(1):44-53.
2. Bayrak IK, Bayrak AO, Kale M, Turker H, Diren B. Bifid median nerve in patients with carpal tunnel syndrome. J Ultrasound Med. 2008;27(8):1129-36.
3. Ahn DS, Yoon ES, Koo SH, Park SH. A prospective study of the anatomic variations of the median nerve in the carpal tunnel in Asians. Ann Plast Surg. 2000;44(3):282-7.
4. Granata G, Caliandro P, Pazzaglia C, et al. Prevalence of bifid median nerve at wrist assessed through ultrasound. Neurol Sci. 2011;32(4):615-8.
5. Reimann AF, Daseler EH, Anson BJ, Beaton LE. The palmaris longus muscle and tendon. A study of 1600 extremities. Anat Rec. 1944;89(4):495-505.
6. Henry BM, Zwinczewska H, Roy J, et al. The prevalence of anatomical variations of the median nerve in the carpal tunnel: a systematic review and meta-analysis. The PLoS One. 2015:1-18.
7. Fatah MF. Palmaris profundus of Frohse and Frankel in association with carpal tunnel syndrome. J Hand Surg Am. 1984;9B:142-3.
8. Sahinoglu K, Cassell MD, Miyauchi R, Bergman RA. Musculus comitans nervi mediani (M. palmaris profundus). Ann Anat. 1994;176(3):229-32.
9. Pirola E, Hébert-Blouin MN, Amador N, Amrami KK, Spinner RJ. Palmaris profundus: one name, several subtypes, and a shared potential for nerve compression. Clin Anat. 2009;22(6):643-8.
10. Jones DPG. Bilateral palmaris profundus in association with bifid median nerve as a cause of failed carpal tunnel release. J Hand Surg Am. 2006:741-3.