Evaluation of Bifid Median Nerve with Sonography and MR Imaging

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Bifid median nerve is an anatomic variation that may be associated with carpal tunnel syndrome. It is important for the surgeon to be aware of the existence of this condition preoperatively in order to plan the carpal tunnel release. We report the correlation between ultrasonographic findings and magnetic resonance imaging results in six patients with bifid median nerve, selected from a population of 294 patients with carpal tunnel syndrome, who were studied by ultrasonography using a high frequency transducer. Sonography showed two structures inside the carpal tunnel with the same pattern as the median nerve in all six patients. Magnetic resonance imaging confirmed the sonographic findings. The patients underwent open surgery, and a bifid median nerve was found. In conclusion, bifid median nerve is an anatomic variant that can be demonstrated ultrasonographically. It is important to be aware of this anomaly when planning carpal tunnel release surgery. KEY WORDS: Carpal tunnel, sonography; Carpal tunnel syndrome; Median nerve; Tunnel, carpal; Bifid median nerve.

Carpal tunnel syndrome is a well-described neuropathy caused by compression of the median nerve in the wrist. CTS may result from any pathologic condition that causes either reduction in the size of the carpal tunnel or an increase in its content because of inflammatory or degenerative changes.1 Cases of CTS associated with anatomic variations of the median nerve inside the carpal tunnel have been described.2-7 These anatomic variants have also been described and classified into four groups by Lanz:8

I: Variations of the course of the thenar branch
II: Accessory branches at the distal portion of the carpal tunnel
III: Divided or duplicated median nerve inside the carpal tunnel
IV: Accessory branches proximal to the carpal tunnel.

Group III of the Lanz classification is associated more frequently with CTS.8 Lanz found seven duplicated median nerves in 246 cases of carpal tunnel release.

The two branches of the nerve, which run parallel inside the tunnel, were sometimes separated by a persistent median artery or an accessory muscle.3,4

ABBREVIATIONS
MR, Magnetic resonance; CTS, Carpal tunnel syndrome

Received December 10, 1999, from the Department of Radiology, II Chair (E.I., G.A.C., V.S., M.A., P.R.), and the Department of Emergency Surgery (G.M.), University “La Sapienza,” Rome, Italy. Revised manuscript accepted for publication April 11, 2000.

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and subsequently rejoined distal to the transverse carpal ligament, or sometimes one of the two branches could appear in an accessory compartment situated under the retinaculum of the flexor tendons.2,6

Surgical decompression by transection of the transverse carpal ligament often is indicated in the treatment of CTS.9,10 Currently endoscopic carpal tunnel release is the treatment of choice, but the risk of median nerve injury increases when anatomic variation is present, because of difficulty in seeing the branches at operation.

Furthermore the two branches may be separately constricted and require separate decompression.

We report six cases of anatomic variation of the median nerve (group III of Lanz), which we have detected by a sonographic study of 294 cases of CTS. Our aim is to emphasize the importance of the role of ultrasonography in the demonstration of bifid median nerve in the carpal tunnel.

MATERIALS AND METHODS

The six patients (four women, two men; age range, 30 to 55 years; mean age, 38 years) revealed a proximal bifurcation of the median nerve within the carpal tunnel (group III of Lanz). This anatomic variant was detected by an ultrasonographic study performed by two radiologists between March 1996 and July 1999 in 294 patients with CTS. Patients enrolled in this study were referred because of a clinical diagnosis of CTS assessed by two clinicians; most of them showed positive findings on nerve conduction studies.

In a preliminary phase of our study 50 healthy volunteers (25 men, 25 women; age range, 18 to 60 years; mean age, 45 years) were examined by ultrasonography to assess the sonographic parameters of normal anatomy of soft tissues of the carpal tunnel.

The sonographic study was carried out using mechanic sectorial and linear array transducers operating at 10 to 13 MHz, with AU 530 and AU 5-EPI (Esaote, Genova, Italy).

The examination was performed with longitudinal and transverse scans of the wrist evaluating morphology, echotexture, and size of the median nerve. In particular, the cross-sectional area of the median nerve was evaluated at three levels: before the median nerve enters the carpal tunnel and at two sites along the carpal tunnel. We used the following as reference points: (1) the osseous profile of the radiocarpal joint, (2) the first row of carpal bones, and (3) the second row of carpal bones. We measured the height and width of the nerve on transverse scans, and the area was calculated by the sonographic software package.

The six patients who had bifid median nerve at sonographic examination underwent MR imaging using a 0.2 T unit (Artoscan, Esaote, Genova, Italy) with spin echo T1-weighted and T2-weighted sequences by the following parameters: spin echo T1-weighted sequences with TR/TE, 620/24; spin echo T2-weighted sequences with TR/TE, 2030/80; number of excitations, one; slice thickness of 3 to 4 mm; gap, 0.3 mm. Axial scans were obtained to evaluate the morphology, the course, and the signal intensity of the median nerve. Scans were obtained in additional coronal planes to assess carpal bone anomalies. MR imaging findings were interpreted by the same two radiologists (E.I., V.S.) who had performed the sonographic examinations.

All six patients were treated by decompression of the median nerve on open surgery.

RESULTS

Sonographic Anatomy of Carpal Tunnel

The median nerve, examined with a high-frequency probe, has a fascicular hypoechoic echotexture and is easily differentiated from tendons, which show a typical fibrillar hyperechoic pattern; the median nerve is located between the flexor pollicis longus and flexor digitorum tendons, lying anterior to the latter. On transverse scans, the median nerve appears as an oval structure with long axis oriented parallel to the flexor retinaculum. The flexor retinaculum encloses the carpal tunnel anteriorly and is seen as a hyperechoic band separating the flexor tendons and the median nerve from the subcutaneous and cutaneous layers. Posterior to the tendons, the radial epiphysis and the carpal bones are seen as a hyperechoic line (Fig. 1A, B).

Normal values of the cross-sectional area of the median nerve measured at the three different levels were as follows: at the radiocarpal joint, 8.2 mm² (range, 8 to 9 mm²); at the first row of carpal bones, 8.3 mm² (range, 8 to 9 mm²); at the second row of carpal bones, 8.1 mm² (range, 8 to 10 mm²).

Pathologic Findings

In the six patients with anatomic variation of the median nerve, ultrasonographic axial scans showed two close oval formations with a fascicular hypoechoic structure (Figs. 2A, B, 3A). Structurally this echotexture was similar to that of nervous tissue and consistent with early bifurcation of the median nerve. The single median nerve was clearly identified in the distal forearm and subsequently had split.
In four cases the two branches had same dimensions (Fig. 2); in two cases the areas of the transverse sections were less than the normal values (4 to 5 mm²), and in the other two cases the areas were higher (9 to 10 mm²). In the remaining two cases, one branch had a greater volume than the other (Fig. 3). In all cases axial MR images confirmed the sono-
graphic findings showing two structures in the normal anatomic site of the median nerve, attributable
to a bifid median nerve (Fig. 2C, 3B).
Furthermore, in four cases the signal intensity of the
two branches was increased in spin echo T2-weighted
sequences, presumably indicating a compression-
induced edema (Fig. 3B). No other pathologic findings
were detected within the carpal tunnel.
The open surgical treatment confirmed the early
bifurcation of the nerve inside the carpal tunnel (III
group of Lanz). No other anomalies were found.
All patients who underwent surgical treatment
became symptom free 15 to 20 days after operation.

DISCUSSION

Bifid median nerve is a variation of nerve anatomy in
the carpal tunnel, well described by Lanz in 1977;
this variant is classified as group III, which can be
associated with CTS. It is important for the surgeon
to be aware of the existence of this anatomic varia-
tion preoperatively, because the surgical approach
for carpal tunnel release may have to be altered.
At the present time endoscopic release is consid-
ered the most convenient treatment because of its
lower cost, shorter operative time, and quick func-
tional recovery of the patients. This therapeutic pro-
cedure is successful when performed in selected
patients.
Awareness of anatomic variations of the median
nerve should be a part of the preoperative planning,
in order to avoid the risk of median nerve
injury or incomplete decompression at operation,
because sometimes a separate decompression may
be necessary.

Imaging is helpful in defining the anatomic struc-
tures within the carpal tunnel. In particular, ultra-
sonography performed with a high-frequency probe
enables the operator to obtain a detailed sonographic
evaluation of the carpal tunnel soft tissues. The median
nerve is well depicted owing to its fascicular hypo-
echoic structure and can be differentiated easily from
the surrounding hyperechoic tendons. Ultrasonog-
raphy has proved to be useful in the evaluation of
those patients with CTS by detecting typical anatomic
changes of the median nerve. The cross-sectional areas
of the median nerve we have detected in a healthy
population were similar to those reported by other
authors. In accordance with what was described
previously, we found that these measurements show
significant differences between patients with CTS and
subjects without CTS.
In our experience ultrasonography allowed
detection of anatomic variations of the median
nerve in 6 of 294 patients. In these six patients, MR
imaging and open surgery confirmed a duplication
of the median nerve. On the whole, surgical decom-
pression of the median nerve was performed in 267
of 294 patients, and no additional bifid median
nerves were found.
REFERENCES


Figure 2 Bifid median nerve. A, Axial ultrasonogram at the level of the first row of carpal bones show the two branches of the nerve that have the same diameter (arrows). B, Axial spin echo T1-weighted MR image confirms the presence of the two branches of the median nerve (arrows).

Figure 3 A, Axial ultrasonogram at the level of the first row of carpal bones shows a bifid median nerve in the carpal tunnel, with one of the two branches being greater in diameter than the other (arrows). B, Axial spin echo T2-weighted MR image confirms the sonographic findings and shows increased signal intensity of the two branches of the nerve (arrows).