

Role of ultrasonography in the evaluation of traumatic injury to peripheral nerves

Traumatic injury of peripheral nerve accounts for about 3-5% of limb trauma, but if not diagnosed it can be associated with negative outcomes, especially in major trauma, with economic and social damage when working-age subjects are involved.

The clinical-instrumental evaluation, after an accurate medical history, is made with the electromyography (EMG) and nerve conduction velocity test (NCV), identifying the traumatic nerve and providing a quantification of the damage from a functional point of view (classification by Seddon and Sunderland).

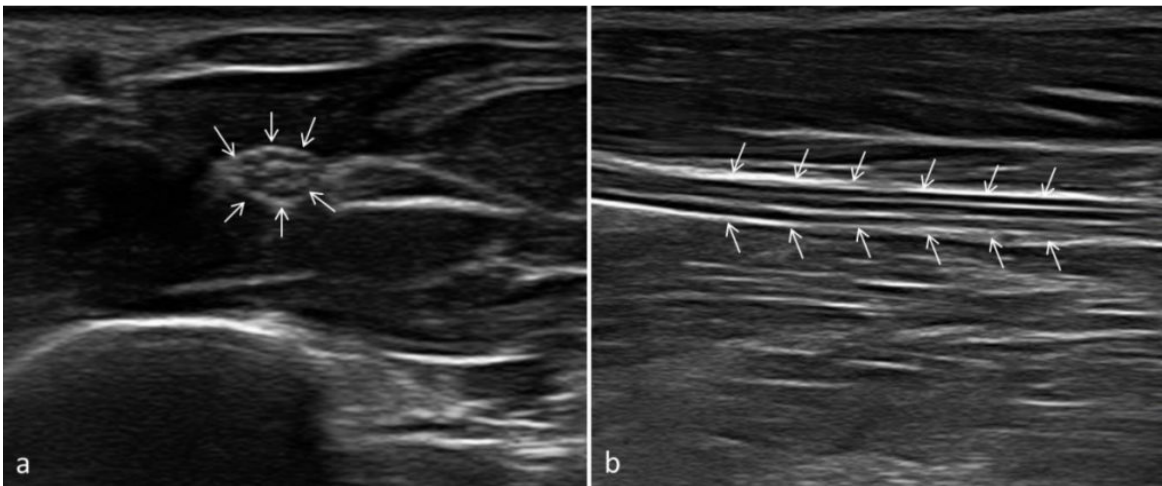


Fig. 1. An example of a normal peripheral nerve. a) Transverse US scan: “honeycomb” echotexture, with tiny hypoechoic rounded areas, which represent nerve fascicles, surrounded by hyperechoic strands of connective tissue. b) Longitudinal US scan: tubular “striated” echotexture with multiple parallel hyperechoic lines separated by hypoechoic bands.

The anatomical evaluation of the damage and the degree of trauma, however, require morphological-structural imaging and can be obtained with ultrasonography (US) and magnetic resonance imaging (MRI). While MRI is an expensive and timing consuming technique, US is cheap, easy to perform after a short adequate training and highly diagnostic. US provides an accurate assessment of the nervous structure demonstrating the normal fascicular pattern and consequently the alterations.

Technically it must be performed with high-frequency, linear-array probe (5-13MHz) exploiting the lower frequencies for the nerves with a deep course (sciatic nerve and brachial plexus) and the higher frequencies for the more superficial nerves (radial, ulnar, median, tibial and peroneal nerves). Compound US and extended field-of-view (e-FOV) are specific advantages of US, improving the former the resolution and the tissue definition, the latter allowing a panoramic view of the injured nerve. The use of color/power Doppler also allows demonstrating the vascularization of the nerve and surrounding tissues. The technical procedure must be accurate, taking care to position the probe perpendicular to the course of the nerve to avoid anisotropy

artifacts. During US procedure, advantages are obtained from the dynamic evaluation of limb flexion and extension or muscle contraction, maneuvers that allow differentiating the tendons (moving structures) from the nerves (immobile or involved by passive movement).

The injured nerve undergoes morphological and structural changes concerning the type of trauma such as contusion, compression, stretching, and partial or total rupture.

In a contusion injury, the nerve appears swollen and hypoechoic due to edema with loss of the normal fascicular echo-texture. Sometimes the fascicles are present and appear spaced apart, as a consequence of the edema. Since recent edema is reversible, an early US diagnosis enables a quick treatment and an easier recovery.

In compressive trauma from hematomas or edema of the surrounding tissues, especially if inveterate, US shows a thinned and hyperechoic nerve compared to normal. If the diagnosis of compression from hematoma is made, US can also be a valid aid for the guide to drainage.

In the stretching trauma, the nerve can partially or totally tear. In partial tears, US demonstrates the interruption of hyperechoic fascicles and it is possible to demonstrate even small neuromas in the laceration sites.

Neuromas are small homogeneous hypoechoic nodules that can form both in partial lacerations and complete nerve transection. In the first case, they develop around the nerve, in the second case at the end of the nerve stump. Continuity between nodule and nerve is the diagnostic element that differentiates the post-traumatic neuroma from other nodules.

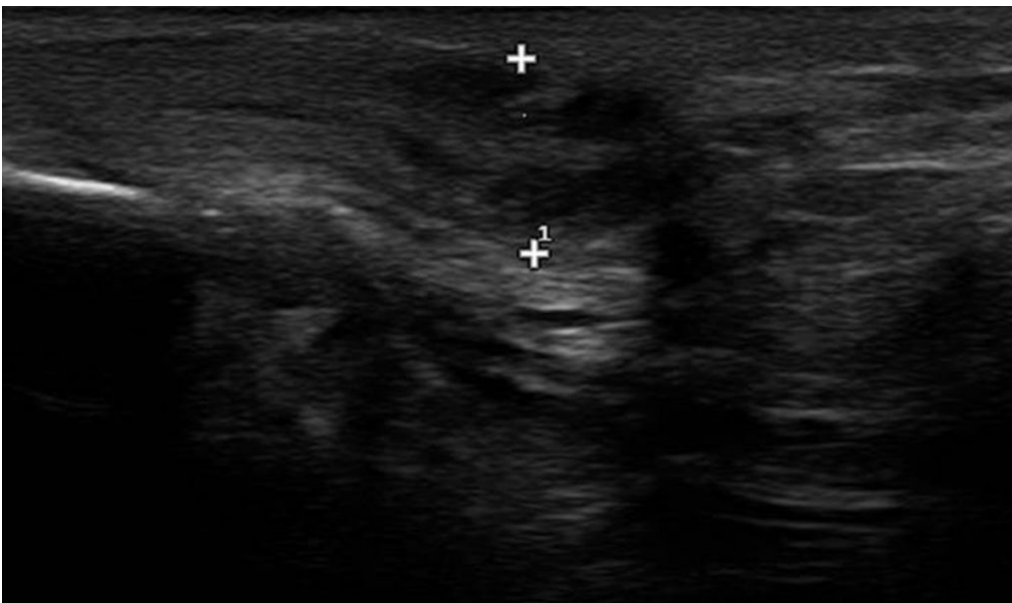


Fig. 2. Traumatic ulnar nerve. Example of peripheral lacerations which appear irregular and hypoechoic.

In the complete rupture, US demonstrates the transection, the gap between the two stumps and the structural alterations involving the sectioned nerve (swelling, edema). If surgical treatment will be needed, the measurement of the distance between the nerve ends and the cross-sectional diameter of nerve stumps are crucial information for the surgery of the graft, for the choice of the thickness and length of the nerve to be grafted.

US is an effective test to diagnose traumatic lesions of the peripheral nerve. It provides anatomic and pathological information which, in addition to EMG and clinical findings, enables to plan an appropriate surgical or conservative treatment in a short time.

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