

Ulnar Neuropathy Caused by Muscular Arcade of Struthers

Godard C.W. de Ruiter¹, Japke G.H. de Jonge², Monique H.M. Vlask², Anandi E. van Loon-Felter³

Key words

- Cubital tunnel syndrome
- Decompression
- Entrapment
- Neuropathy

Abbreviations and Acronyms

CSA: Cross-sectional area
EMG: Electromyography
MAS: Muscular arcade of Struthers
US: Ultrasound

From the Departments of ¹Neurosurgery and ²Clinical Neurophysiology, Haaglanden Medical Center, The Hague; and ³Rehabilitation Medicine, Hand and Wrist Center, The Hague, The Netherlands

To whom correspondence should be addressed:
 Godard C.W. de Ruiter, M.D., Ph.D.
 [E-mail: g.de.ruiter@haaglandenmc.nl]

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INTRODUCTION

The arcade of Struthers is a tendinous or muscular structure that extends between the medial head of the triceps and the intermuscular septum (Figure 1).¹ It is located about 3–10 cm proximal to the medial epicondyle.² It was named after the Scottish anatomist John Struthers, who described this structure in 1854.³ The clinical significance of the arcade of Struthers was first mentioned by Spinner and Kane in 1976.⁴ Several studies have investigated the prevalence in cadavers.^{1-3,5-7} The percentage in which the arcade was found in these studies ranges from 0 to 100%^{6,7} but probably lies somewhere around 70%.^{3,5} In a recent cadaver study by Zhong et al,¹ the tendinous variant was found in 57% of the cases with an arcade of Struthers, the muscular variant in 43%.

Despite its presence in cadavers, there is still debate in the literature on the potential of the arcade of Struthers to cause ulnar neuropathy. Only a few cases

■ **BACKGROUND:** There is still debate in the literature on the existence of the arcade of Struthers and moreover the potential role of this structure to cause compression of the ulnar nerve.

■ **CASE DESCRIPTION:** In this article we present a patient with ulnar neuropathy caused by a muscular arcade of Struthers, which was detected preoperatively using ultrasound. Symptoms completely recovered following decompression of the nerve by transection of this muscular arcade.

■ **CONCLUSIONS:** This case demonstrates that a muscular arcade of Struthers can cause symptoms of ulnar neuropathy. Ultrasound in this case proved to be helpful in the preoperative workup, clearly demonstrating this unusual site of compression.

of ulnar nerve compression due to the arcade of Struthers have been reported.⁸⁻¹⁰ It was not encountered in a large series of ulnar nerve decompressions.^{6,11} Some authors therefore doubt it exists.⁶ This controversy has led to a variation in clinical practice: Not all surgeons look for potential compression at this site, and if they do, it remains questionable how far proximal they look.

In this article the authors describe a case of ulnar neuropathy caused by a muscular arcade of Struthers (MAS) with clear compression of the ulnar nerve, which was detected on preoperative ultrasound (US) imaging and confirmed during surgery.

CASE DESCRIPTION

A 48-year-old male patient was referred to our clinic with symptoms of left cubital tunnel syndrome. For 3 years he had had a tingling sensation in digits IV and V and the dorsal side of his left hand (area supplied by the dorsal cutaneous branch of the ulnar nerve). These complaints became present concurrently with shoulder complaints. He also noticed weakness and clumsiness in his left hand (patient right-handed). During neurologic examination he had decreased sensation measured with Semmes Weinstein monofilaments (volar side tip digit V 2.0 gm, ulnar side dorsum hand 1.5 gm) and

weakness of his intrinsic hand muscles, as well as the flexor digitorum profundus muscles of digits IV and V (all Medical Research Council 4). There was no atrophy or clawing of his left hand. No grip strength was measured with the Jamar hand dynamometer due to a contraindication after a recent shoulder operation.

Preoperative workup consisted of both electromyography (EMG) and US imaging of the ulnar nerve at the elbow. Motor and sensory nerve conduction studies were performed with stimulation at the wrist, below the medial epicondyle, and 5 cm above the medial epicondyle. The EMG findings were normal and showed no conduction block or slowing of the conduction velocity of the ulnar nerve, also across the cubital tunnel. Therefore no inching was performed. The morphology of the ulnar nerve was examined by US with the elbow flexed at 70 degrees and the back of the hand resting on the table using a Philips Epic 5 Elite NZE2319, equipped with an eL4-i8 MHz linear array transducer with pure wave technology. In the lower arm the ulnar nerve showed a cross-sectional area of 7.2 mm². At the cubital tunnel, where most swelling of the ulnar nerve usually occurs, the nerve showed a cross-sectional area (CSA) of 9.7 mm² (upper limit of normal 10 mm²) (see Figure 2B). Approximately 3 cm proximal to the medial epicondyle, the CSA

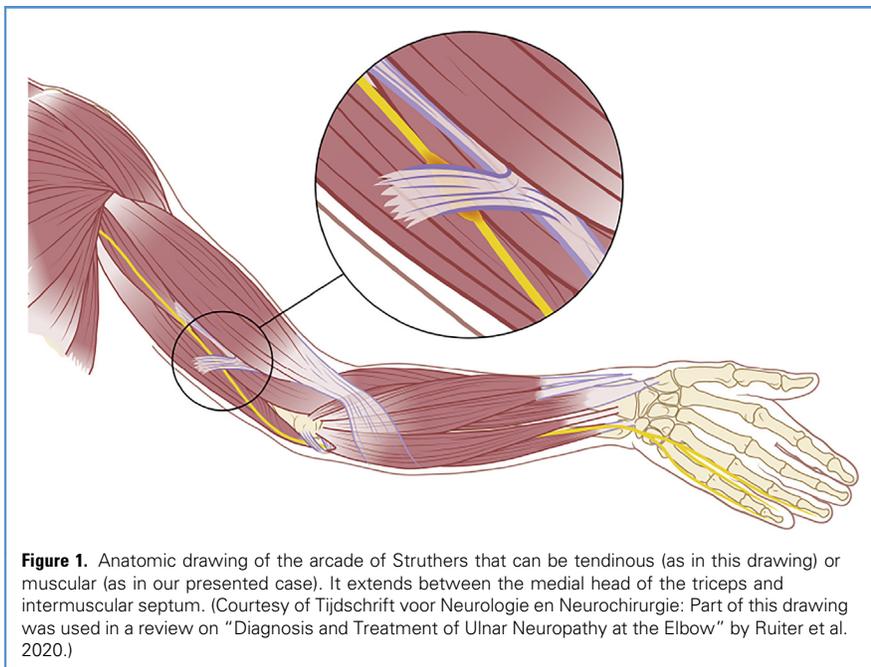


Figure 1. Anatomic drawing of the arcade of Struthers that can be tendinous (as in this drawing) or muscular (as in our presented case). It extends between the medial head of the triceps and intermuscular septum. (Courtesy of Tijdschrift voor Neurologie en Neurochirurgie: Part of this drawing was used in a review on "Diagnosis and Treatment of Ulnar Neuropathy at the Elbow" by Ruiter et al. 2020.)

further increased to 12.5 mm² with intraneural edema (Figure 2A). At the same site a hypoechogenic structure, characteristic for muscular tissue, was found and could be identified as a MAS (see Figure 2A). The MAS was attached to the medial head of the triceps with fibrous tissue forming an aponeurosis. The muscle was distinguishable from an epitrochleoanconeus muscle due to its location. More proximally in the upper arm the ulnar nerve continued with a normal CSA of 5.6 mm².

During surgery a bulky muscular structure was found at the site of the arcade of Struthers, confirming the presence of a MAS (see Figure 2C). First, the ulnar nerve was decompressed in a proximal direction by transection of the MAS. Afterward, the ulnar nerve was released in a distal direction. There was no compression of the ulnar nerve at the site of the Osborne ligament or aponeurosis between the humeral and ulnar caput of the flexor carpi ulnaris (FCU) muscle. Postoperatively the patient experienced complete relief of pain symptoms within the course of 6 weeks. Neurologic examination performed 3 months after the surgery showed a recovery of sensation with Semmes Weinstein monofilaments (volar side tip digit V 0.1 gm, ulnar side dorsum hand 0.2 gm, and a 2PD of 5 mm; all normal) and also a normalization of

strength in the hand (Medical Research Council 5 of intrinsic hand muscles and flexor digitorum profundus muscles of digits 4 and 5) and a grip strength of 44 kg measured with the Jamar hand dynamometer. On the level of activities and participation, he had returned to work and resumed activities of daily life. Postoperative US (also performed 3 months after the surgery) showed complete transection of the MAS, replaced by granulation tissue (hypoechogenic tissue above the ulnar nerve) of the healing process (see Figure 2D). There was no residual compression, and there was a significant reduction of the cross-sectional area to 10.7 mm² at the site of the previous compression (see Figure 2D).

DISCUSSION

To our best of knowledge this is the first case that clearly shows compression of the ulnar nerve by a MAS, which was detected on preoperative US. In the literature only a few cases of ulnar neuropathy in the presence of a tendinous arcade of Struthers have been described.⁸⁻¹⁰ There was no compression of the ulnar nerve at the usual compression sites (Osborne ligament or aponeurosis of the FCU). Clear compression by the MAS was confirmed intraoperatively. Transection of the MAS resulted in complete recovery of nerve

function and a reduction in CSA of the ulnar nerve 3 months after the surgery. Only a few cases of ulnar neuropathy in the presence of a tendinous arcade of Struthers have been reported in the literature.^{8,9} One case was also detected with preoperative US.¹⁰

Considering the high prevalence of the arcade of Struthers in some cadaver studies, it seems surprising that it is not detected more frequently during surgery for cubital tunnel syndrome. Possible explanations for this discrepancy could be that 1) the arcade is frequently located high in the upper arm and 2) intraoperative distinction from the brachial fascia can be difficult, especially for the tendinous variant. In our case it was relatively easy to detect the arcade because 1) it was muscular and 2) it was located more distally, closer to the medial epicondyle. It is unknown how frequently more proximally located arcades lead to compression of the ulnar nerve. The arcade probably more frequently causes symptoms after anterior transposition of the ulnar nerve due to kinking at this site,^{4,12,13} although the latter might also be caused by condensations of the brachial fascia, if this fascia is not released sufficiently in a proximal direction before transposition of the ulnar nerve is performed.¹¹

In clinical practice not every peripheral nerve surgeon looks for potential compression at the arcade of Struthers. Moreover, the question also remains how far proximal to look for it. Spinner and Kane stated that "if there are no muscular fibers crossing the nerve 5–7 cm proximal to the medial epicondyle, then the arcade is not present."⁴ Zhong et al¹ more recently stated that based on the results of a cadaver studies, "it is necessary to free the ulnar nerve at least 9.5 cm proximal to the medial epicondyle in the depression of the ulnar nerve entrapment caused by the arcade of Struthers." Especially when performed as a standard open procedure, this means that a relatively large incision has to be made at the elbow to inspect for potential compression by the arcade of Struthers.

We have shown that compression by a MAS can be detected preoperatively with US. Previously, Sivak et al¹⁰ have already described that compression of the ulnar nerve by a tendinous arcade of Struthers can also be detected on preoperative US.

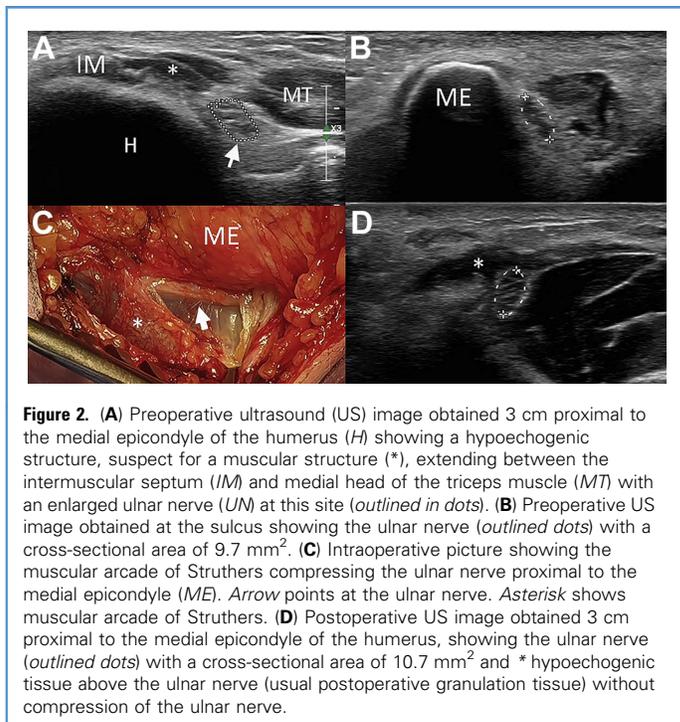


Figure 2. (A) Preoperative ultrasound (US) image obtained 3 cm proximal to the medial epicondyle of the humerus (*H*) showing a hypoechoic structure, suspect for a muscular structure (*), extending between the intermuscular septum (*IM*) and medial head of the triceps muscle (*MT*) with an enlarged ulnar nerve (*UN*) at this site (*outlined in dots*). (B) Preoperative US image obtained at the sulcus showing the ulnar nerve (*outlined dots*) with a cross-sectional area of 9.7 mm². (C) Intraoperative picture showing the muscular arcade of Struthers compressing the ulnar nerve proximal to the medial epicondyle (*ME*). *Arrow* points to the ulnar nerve. *Asterisk* shows muscular arcade of Struthers. (D) Postoperative US image obtained 3 cm proximal to the medial epicondyle of the humerus, showing the ulnar nerve (*outlined dots*) with a cross-sectional area of 10.7 mm² and * hypoechoic tissue above the ulnar nerve (usual postoperative granulation tissue) without compression of the ulnar nerve.

The fascicular structure of a tendon, characterized by multiple, closely spaced echogenic parallel lines on longitudinal scanning, can be captured by US imaging, but with the arcade of Struthers being often a thin structure it can be overlooked. As our case has shown, nerve conduction studies can be normal, even in the presence of a neuropathy and US is therefore of added value. However, high-resolution US and trained US technologists remain essential in detecting unusual anatomic structures causing compression of the ulnar nerve.

We advocate for gaining more experience with preoperative US and striving for the standard use of US in preoperative workup for ulnar neuropathy in addition to EMG. US can not only localize the site of compression but also provide information on anatomic structures causing compression of the ulnar nerve, such as the arcade of Struthers, but also other potential anatomic variants, such as a *musculus epitrochleoanconeus*.^{10,14} Moreover, dynamic US can also be applied to detect (sub)luxation of the ulnar nerve during flexion of the elbow and sometimes a snapping of the medial part of the triceps muscle.¹⁵ Detailed

information on the anatomy of the ulnar nerve increases the chance on a successful surgery outcome and reduces the need for revision. Therefore US is now standard in our preoperative workup of patients with ulnar neuropathy.

CONCLUSIONS

This case confirms the results from previous reports that the arcade of Struthers can indeed cause compression of the ulnar nerve proximal to the elbow. In addition, our case shows the value of preoperative workup with US in the detection of the arcade of Struthers as a potential compression site.

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