Complete Removal of the Epitrochleoanconeus Muscles in Patients with Cubital Tunnel Syndrome: Results From a Small Prospective Case Series

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BACKGROUND: **Sometimes during surgery for cubital syndrome an anomalous muscle called the epitrochleoanconeus is encountered. Different surgical strategies on how to decompress the ulnar nerve in the presence of this muscle have been proposed, including transection of the muscle, resection, or subcutaneous transposition of the ulnar nerve. Because of the low incidence, there is no consensus on what type of surgical treatment can best be performed. In the present study, we prospectively followed a small series of patients, in which the muscle was resected.**

METHODS: **Five patients who presented to our clinic with cubital tunnel syndrome in the presence of an epitrochleoanconeus muscle were followed prospectively. Two patients had bilateral epitrochleoanconeus muscles, 1 patient had recurrent symptoms after previous myotomy. Clinical outcome after resection of the muscle was graded using the Likert scale. In addition, histopathologic analysis was performed on the resected muscles, including ATPase histochemistry.**

RESULTS: **Six of 7 cases had complete relief of symptoms (Likert 1) 6 weeks after excision of the epitrochleoanconeus muscle, including the case with recurrent symptoms after previous myotomy. Histopathologic analysis of the muscles showed grouped muscle fiber atrophy and type grouping in all cases, both signs of denervation that confirm the compressive pathophysiology of cubital tunnel syndrome in these patients.**

CONCLUSIONS: **The results of this small prospective case series show that excision of the epitrochleoanconeus muscle in patients with cubital tunnel syndrome frequently leads to complete recovery. Further support for this surgical strategy was found from histopathologic analysis of the resected muscles.**

INTRODUCTION

In about 3% of all surgical procedures for cubital tunnel syndrome the surgeon is faced with an anomalous muscle, called the epitrochleoanconeus or anconeus epitrochlearis.[1] This muscle, which is normally present in monkeys,[2] probably is a remnant of evolution that in most humans has evolved into the Osborne ligament.[3] The role of the muscle, if present in humans, is debatable. Some investigators have suggested that the muscle might compress the ulnar nerve,[4] whereas others have concluded, from a relatively higher occurrence in cadaver studies, that it might actually protect against cubital tunnel syndrome.[5]

Apart from its role, there is also debate on what type of surgical procedure can best be performed if the muscle is encountered during cubital tunnel surgery. Good outcome has been reported for complete excision,[1,6] but also for simple transection (myotomy)[7] and subcutaneous transposition.[8] Because the incidence of the epitrochleoanconeus muscle in patients with cubital tunnel syndrome is relatively low, it is difficult to investigate the effectiveness of these different surgical treatments in, for example, a randomized trial. In this study we prospectively followed 5 patients in which the epitrochleoanconeus muscle was completely removed. In addition, histopathologic analysis of the resected muscles was performed to find further evidence that might support this surgical strategy.

METHODS

Clinical Analysis

All patients that were treated between January 2014 and June 2016 for primary, persistent or recurrent symptoms of cubital tunnel,

Key words
- Anomalous muscle
- Decompression
- Myotomy
- Ulnar nerve

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and in whom an epitrochleoanconeus muscle was encountered before or during surgery, were included in this study after informed consent had been obtained. Sonographic analysis was performed (Figure 1A) if the presence of an epitrochleoanconeus muscle was suspected during clinical examination and if a mass was palpated between the medial epicondyle and olecranon during flexion and extension of the elbow (a maneuver that is standard in our clinic before cubital tunnel surgery to examine potential (sub)luxation of the ulnar nerve during flexion). An additional magnetic resonance imaging scan was done if the presence could not be ruled in or out on the basis of this analysis (Figure 1B). Intraoperatively, the ulnar was exposed just proximally to the 2 heads of the flexor carpi ulnaris muscle and was released in a proximal direction (according to the procedure previously described by Gervasio and Zaccone[1]). Specific attention was paid to the presence of a prominent medial head of the triceps and the absence of the Osborne ligament. The epitrochleoanconeus muscle was completely removed, in primary and revision cases, by coagulation and transection of, respectively, the insertion on the medial epicondyle and the origin on the olecranon (Figure 2B). After resection the elbow was flexed to determine whether there was (sub)luxation of the ulnar nerve over the medial epicondyle and/or residual compression by the prominent medial part of the triceps. In case of residual compression, also part of the medial triceps muscle was removed from the insertion on the olecranon to several inches proximally. In the revision case, special attention was paid to residual compression by the remnants of the epitrochleoanconeus muscle.

Outcome was assessed in the outpatient clinic and graded using the Likert scale. Likert grade 1 (complete recovery) or 2 (almost complete recovery) were regarded as a good outcome.

Histopathologic Analysis

All epitrochleoanconeus muscles that were resected during the surgery were sent for histopathologic analysis (including the previously transected muscle). The muscle tissue was embedded in Tissuetek (Sakura, Zoeterwoude, the Netherlands), rapidly frozen in liquor-nitrogen-cooled isopentane and stored at −80°C (except in case 1, the muscle tissue was embedded in paraffin) (Table 1). Transverse sections (10 μm thick) were cut from the midlevel of the muscle and stained for myofibrillar ATPase at pH 9.4, according to the method described by Brook and Kaiser[9] staining slow (type I) muscle fibers "light" and fast (type II) muscle fibers "dark." Microscopic analysis of all sections was performed by the same pathologist (S.v.D.).

RESULTS

Outcome

The epitrochleoanconeus muscle was encountered in 5 patients who were referred for cubital tunnel surgery (of 7 cases, with bilateral epitrochleoanconeus muscles in 2 patients). Characteristics of the patients are presented in Table 1. In the first patient the presence of the muscle was suspected from the surgical note of the previous surgery performed 3 years before (presentation on the contralateral side; myotomy). In the second case the presence of the muscle was suspected during physical examination, but additional radiologic analysis at that time was not performed. In next 3 patients the presence of the epitrochleoanconeus muscle was confirmed with ultrasonography in 2 cases. In the other case preoperative ultrasonography was performed, but the muscle was missed (in retrospect the muscle was clearly visible; Figure 1A). Therefore, in this case the surgery was not performed under general anesthesia.

Surgery was performed in all patients by the same surgeon (G.d.R.). Intraoperatively, there was a prominent medial portion of the triceps that covered the ulnar nerve with absence of the Osborne ligament. Part of the medial triceps was resected in 4 of 7 cases. In the 1 patient with recurrence of symptoms after previous

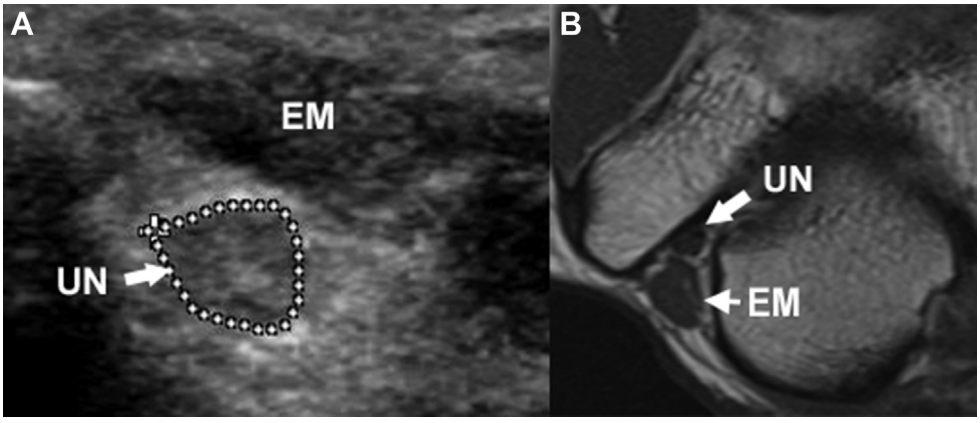

Figure 1. (**A**) Ultrasound image of the epitrochleoanconeus muscle (EM) and underlying ulnar nerve (UN). This case was initially missed, but in retrospect clearly shows the presence of the epitrochleoanconeus muscle. (**B**) Transverse T_1-weighted magnetic resonance imaging showing the EM and underlying UN.

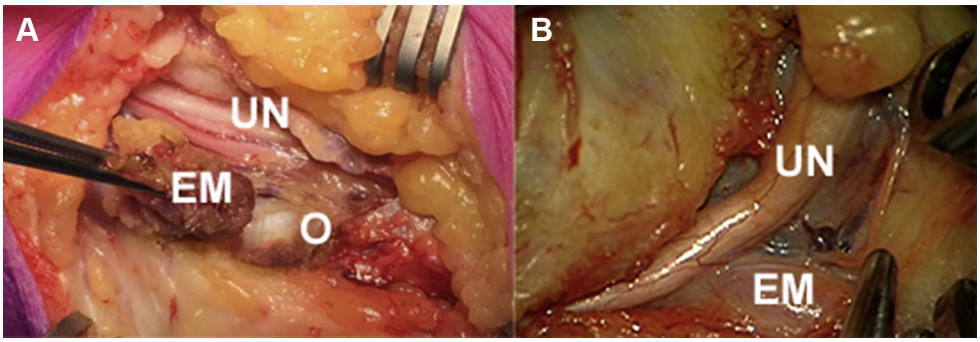

Figure 2. (**A**) Intraoperative image after release of the insertion of the epitrochleoanconeus muscle (EM) from the medial epicondyle and partial transection from the origin on the olecranon (O) to decompress the ulnar nerve (UN). (**B**) Microscopic image of the innervating branch to the EM. The insertion of the muscle has been released and the muscle has been turned to show the underlying UN. Forceps points at the small nerve branch that runs parallel to the UN and innervates the EM. This was confirmed intraoperatively with bipolar stimulation, which showed contraction of the epitrochleoanconeus muscle.

myotomy, residual compression of the ulnar nerve was observed by remnants of the transected epitrochleoanconeus muscle. After resection of these remnants, the ulnar nerve was sufficiently decompressed and, therefore, transposition was not performed. The mean duration of surgery for all procedures was 38 minutes. The duration of the procedure that was performed under local anesthesia was slightly longer (49 minutes), primarily due to discomfort of the patient. Because of this discomfort, part of the medial triceps covering the nerve was not resected. There was no (sub)luxation of the ulnar nerve after resection of the epitrochleoanconeus muscle during flexion of the elbow in all cases. Most patients (4 of 5) had complete relief of symptoms (Likert grade 1) at the first follow-up (6 weeks). Only 1 patient (case 4) had persistence of symptoms, which in his case consisted of numbness and weakness (McGowan grade II).[10] The other patients had relatively mild symptoms consisting of paresthesias (McGowan grade I). Electrophysiologic analysis performed after 6 months in case 4 showed improved nerve conduction over the cubital tunnel. There was no recurrence of symptoms in any of the patients at a mean follow-up of 6 months.

Histopathologic Analysis

Histopathologic analysis of the resected epitrochleoanconeus muscles showed muscle fiber hypertrophy (diameter, 80–150 μm) in all cases, except the case in which the muscle had previously been transected. In addition, 2 other distinct phenomena were observed 1) atrophy of groups of muscle fibers and 2) grouping of muscle fibers of the same fiber type (either type I or type II) (Figure 3).

DISCUSSION

The results of this small prospective case series show that complete resection of the epitrochleoanconeus muscle frequently

Table 1. Patient Characteristics

Patient Number	Age (year)/Sex	Arm	Sport	Preoperative Dellon Grade	Preoperative MRI/US	Anesthesia	Osborne's Ligament	Prominent Triceps/ Resection	Pathologic Analysis	Likert
1	36/F	L		I		General	No	Yes/no	Only paraffin	1
		R		I		General	*	Yes/no	GA, TG	1
2	34/F	L	Judo	I		General	No	Yes/yes	H, GA, TG	1
3	52/M	L		I	US	General	No	Yes/yes	H, GA, TG	1
		R		I	MRI	General	No	Yes/yes	H, GA, TG	1
4	74/M	R		II	US†	Local	No	Yes/no	H, GA, TG	3
5	23/M	R	Tennis	I	US	General	No	Yes/yes	H, GA, TG	1

GA, grouped atrophy; H, hypertrophy; TG, type grouping of type I and/or II muscle fibers; MRI, magnetic resonance imaging.
*Case of recurrence after previous myotomy.
†Initially missed on US.

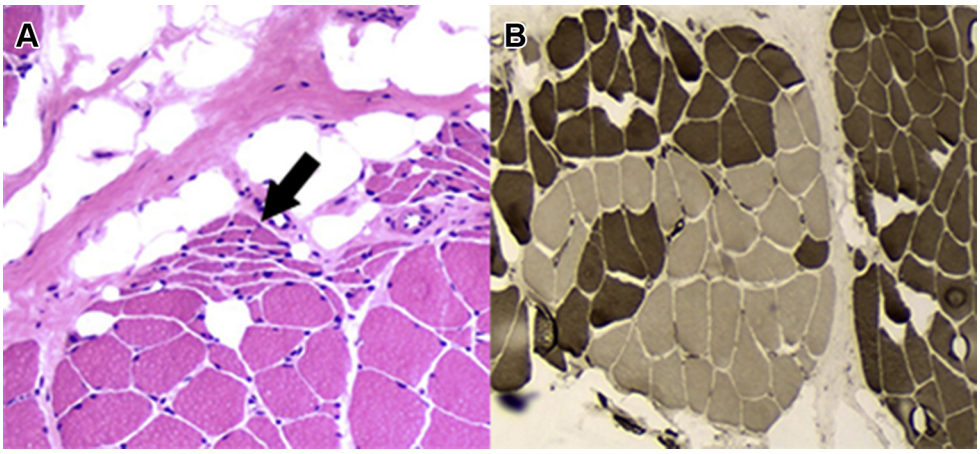

Figure 3. (**A**) Microscopic image (hematoxylin and eosin, ×10 magnification) of a transverse section of a resected epitrochleoanconeus muscle; *arrow* points at cluster of atrophied muscle fibers. (**B**) Microscopic image of transverse section of a resected epitrochleoanconeus muscle stained with ATPase histochemistry showing clustering of type I (*white*, slow) muscle fibers.

leads to complete recovery of symptoms (Likert grade 1) in patients with cubital tunnel syndrome, even with recurrence of symptoms after previous transection. Only 1 patient in our study still had residual symptoms (loss of sensation and weakness, McGowan grade II[10]), but recovery of sensation and weakness usually take more time to recover than symptoms of paresthesias, and nerve conduction over the cubital tunnel had improved in this case.

Complete resection of the epitrochleoanconeus muscle is the procedure that most frequently has been reported in the literature,[1,6,11-13] Other methods are the simple transection (myotomy), medial epicondylectomy,[14] submuscular, subfascial transposition,[15] and subcutaneous transposition of the ulnar nerve.[8,16,17] The main reason is luxation of the ulnar nerve over the medial epicondyle after decompression. This was found in 7 of 8 cases in the series by Chalmers.[8] In our series we found no luxation after excision of the muscle. Although this may be merely a coincidence, it can be explained by the technique of ulnar nerve decompression. In the present study, we used the technique described by Gervasio and Zaccone.[1] Their procedure starts with identification of the nerve distal to the epitrochleoanconeus muscle, with subsequent decompression of the nerve in a proximal direction by resection of the muscle, which is in a reverse direction than usually performed in decompression of the ulnar nerve in cubital tunnel syndrome. When the surgeon is not aware of the potential presence of the epitrochleoanconeus muscle, he or she might identify the nerve proximal to the entry into the cubital tunnel where the nerve is often covered by a prominent medial head of the triceps muscle.[18] In an attempt to find the nerve, the surgeon might thereby divide the arcade of Struthers. In addition, the surgeon might decompress the nerve in a distal direction by dividing the confluence of the flexor carpi ulnaris aponeurosis. Considering that the cause of compression is the presence of the epitrochleoanconeus muscle, it is not necessary to divide these structures. Actually, as suggested by Gervasion and Zaccone,[1] this might lead to luxation of the nerve, subsequently requiring transposition. In addition special attention should be paid to the potential presence of a prominent head of the triceps muscle, which frequently occurs simultaneously with the epitrochleoanconeus muscle.[18,19] This prominent part of the triceps may compress the nerve against the posterior aspect of the epicondyle during flexion of the elbow.[19] In our series we detected a prominent head of the triceps, in various degrees, in all patients. We partially resected the medial head in 4 of 7 cases. In the other patients, this procedure was not performed because it either had not been discussed with the patient before the surgery or because the procedure was performed under local anesthesia. It can be debated whether the medial head of the triceps should be resected after myectomy or myotomy of the epitrochleoanconeus muscle. Especially, when a transposition is performed, specific attention should be paid to this potential secondary compression, similar to potential secondary compression of the ulnar nerve after transposition in the presence of a snapping triceps.[20]

Because resection of the epitrochleoanconeus muscle, and sometimes of a prominent medial head of the triceps, can be extremely painful for the patient when performed with local anesthesia, we recommend general anesthesia for these procedures. The latter is an important reason why we now generally perform ultrasonographic analysis in all patients with symptoms of cubital tunnel syndrome, in addition to electrophysiologic analysis. As illustrated in **Figure 1**, the presence of the epitrochleoanconeus muscle can easily be detected with ultrasound, although it requires some experience. In our study the presence of the epitrochleoanconeus muscle was missed in 1 patient (case 4). As a consequence, the surgery was performed under local anesthesia, which prolonged the procedure due to discomfort of the patient.

Although our study shows excellent results for complete removal, we did not prove that this procedure is better than other

procedures, such as simple transection (myotomy). There were 2 additional findings in our study, however, that favor the myectomy versus the myotomy procedure. First, we reoperated on 1 patient who had undergone a previous myotomy. In this patient, residual compression of the ulnar nerve was found by remnants of the epitrochleoanconeus muscle. The other finding was obtained from histopathologic analysis of the resected muscles demonstrating that grouped muscle fiber atrophy and type grouping in all patients, even in the case where the muscle had previously been transected. Grouped muscle fiber atrophy and type grouping are signs of denervation. These occur after partial denervation of a muscle and subsequent sprouting of adjacent axons to reinnervate the denervated muscle fibers. Because the muscle fiber type (slow, type I, or fast, type II) is determined by the type of innervating axon, this grouped reinnervation of muscle fibers by the same axon leads to clustering of muscle fibers from the same fiber type (**Figure 3B**), which is called type grouping.[21,22] The presence of grouped muscle fiber atrophy and type grouping thus demonstrate that the epitrochleoanconeus muscle in patients with cubital tunnel syndrome leads to axonal disturbance. One explanation for this disturbance may be that the nerve innervating the epitrochleoanconeus muscle is compressed. As reported previously[18] (and shown in one of our cases intraoperatively; **Figure 2B**), this innervation of the epitrochleoanconeus muscle comes from a separate branch of the ulnar nerve that runs parallel to the ulnar nerve and innervates the epitrochleoanconeus muscle from below. One theory could be that the muscle compresses its own innervation, which could occur with muscle hypertrophy, which was found in all of our patients in various degrees. This theory would explain the relation, often reported in the literature, between the presence of this muscle and heavy use of the affected arm[23] (e.g., baseball pitchers[24] and weightlifters[13]). It would also explain why the prevalence of the epitrochleoanconeus muscle in cadavers is relatively higher than the frequency with which it is encountered during cubital tunnel surgery. As recently stated by Wilson et al,[5] the epitrochleoanconeus muscle may protect from developing symptoms of cubital tunnel syndrome unless it hypertrophies due to repetitive use. Questions still remain, such as why, if the epitrochleoanconeus muscle protects the ulnar nerve, has this muscle largely disappeared during evolution in humans, whereas the muscle is still present in most mammals, including monkeys?[2] Possibly, because our ancestors used their arms more heavily than we do at present. And, why is the epitrochleoanconeus muscle not always found bilaterally? Nevertheless, our findings confirm previous suggestions that the epitrochleoanconeus muscle in patients with cubital tunnel syndrome compresses the ulnar nerve, which would support the surgical strategy of complete resection.

CONCLUSIONS

The results of this prospective study show that complete excision of the epitrochleoanconeus muscle in patients with cubital tunnel syndrome often leads to complete recovery of symptoms.

Further support for resection of the epitrochleoanconeus muscle was found from histopathologic analysis of the resected muscles, which showed grouped muscle fiber atrophy and type grouping in all patients. These are signs of denervation, probably caused by compression of the underlying innervating nerve branch.

The consequences of applying this surgical strategy of resection of the epitrochleoanconeus muscle, and frequently also the prominent medial part of the triceps, are that the procedure becomes more complex than simple transection (myotomy), which requires careful preoperative workup with ultrasound and/or magnetic resonance imaging and performance of surgery under general anesthesia in case an epitrochleoanconeus muscle is detected.

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REFERENCES

1. Gervasio O, Zaccone C. Surgical approach to ulnar nerve compression at the elbow caused by the epitrochleoanconeus muscle and a prominent medial head of the triceps. *Neurosurgery*. 2008;62:186-192 [discussion: 192-193].
2. Gruber W. Ueber den anomalen Verlauf des Nervus ulnaris vor dem Epitrochleus [in German]. *Arch Anat Physiol*. 1867:560-564.
3. Von Clemens H. Zur morphologie des ligamentum epi-trochleoanconeum [in German]. *Anat Anz*. 1957;104:343-344.
4. Morgenstein A, Lourie G, Miller B. Anconeus epitrochlearis muscle causing dynamic cubital tunnel syndrome: a case series. *J Hand Surg Eur*. 2016;41:227-229.
5. Wilson TJ, Tubbs RS, Yang LJ. The anconeus epitrochlearis muscle may protect against the development of cubital tunnel syndrome: a preliminary study. *J Neurosurg*. 2016;125:1533-1538.
6. Masear VR, Hill JJ Jr, Cohen SM. Ulnar compression neuropathy secondary to the anconeus epitrochlearis muscle. *J Hand Surg Am*. 1988;13:720-724.
7. Fernandez J, Camuzard O, Gauci MO, Winter M. A rare cause of ulnar nerve entrapment at the elbow area illustrated by six cases: the anconeus epitrochlearis muscle. *Chir Main*. 2015;34:294-299.
8. Chalmers J. Unusual causes of peripheral nerve compression. *Hand*. 1978;10:168-175.
9. Brooke MH, Kaiser KK. Muscle fiber types: how many and what kind? *Arch Neurol*. 1970;23:369-379.
10. McGowan A. The results of transposition of the ulnar nerve for traumatic ulnar neuritis. *J Bone Joint Surg Br*. 1950;32-B:293-301.
11. Dahners LE, Wood FM. Anconeus epitrochlearis, a rare cause of cubital tunnel syndrome: a case report. *J Hand Surg Am*. 1984;9:579-580.
12. Gessini L, Jandolo B, Pietrangeli A, Occhipinti E. Ulnar nerve entrapment at the elbow by persistent epitrochleoanconeus muscle. Case report. *J Neurosurg*. 1981;55:830-831.
13. Hirasawa Y, Sawamura H, Sakakida K. Entrapment neuropathy due to bilateral epitrochleoanconeus muscles: a case report. *J Hand Surg Am*. 1979;4:181-184.
14. Hodgkinson PD, McLean NR. Ulnar nerve entrapment due to epitrochleo-anconeus muscle. *J Hand Surg Br*. 1994;19:706-708.
15. Uscetin I, Bingol D, Ozkaya O, Orman C, Akan M. Ulnar nerve compression at the elbow caused by the epitrochleoanconeus muscle: a case report and surgical approach. *Turk Neurosurg*. 2014;24:266-271.

16. Lee HJ, Kim JY, Jeon IH. Cubital tunnel syndrome due to the anconeus epimedialis muscle. *J Shoulder Elbow Surg*. 2013;22:e20-e22.

17. Wachsmuth W, Wilhelm A. The musculus epitrochleoanconaeus and its clinical significance [in German]. *Monatsschr Unfallheilkd Versicher Versorg Verkehrsmed*. 1968;71:1-22.

18. Dellon AL. Musculotendinous variations about the medial humeral epicondyle. *J Hand Surg Br*. 1986; 11:175-181.

19. O'Hara JJ, Stone JH. Ulnar nerve compression at the elbow caused by a prominent medial head of the triceps and an anconeus epitrochlearis muscle. *J Hand Surg Br*. 1996;21:133-135.

20. Spinner RJ, Gabel GT. Latrogenic snapping of the medial head of the triceps after ulnar nerve transposition. *J South Orthop Assoc*. 2001;10: 236-240.

21. Karpati G, Engel WK. "Type grouping" in skeletal muscles after experimental reinnervation. *Neurology*. 1968;18:447-455.

22. Vleggeert-Lankamp CL, de Ruiter GC, Wolfs JF, Pego AP, Feirabend HK, Lakke EA, et al. Type grouping in skeletal muscles after experimental reinnervation: another explanation. *Eur J Neurosci*. 2005;21:1249-1256.

23. Byun SD, Kim CH, Jeon IH. Ulnar neuropathy caused by an anconeus epitrochlearis: clinical and electrophysiological findings. *J Hand Surg Eur*. 2011;36:607-608.

24. Li X, Dines JS, Gorman M, Limpisvasti O, Gambardella R, Yocum L. Anconeus epitrochlearis as a source of medial elbow pain in baseball pitchers. *Orthopedics*. 2012;35:e1129-e1132.

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