Subcutaneous Ulnar Nerve Transposition Using Osborne's Ligament as a Ligamentodermal or Ligamentofascial Sling

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Author(s): Jeffrey Goldberg, MD
Jeremy M. Burnham, MD
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ABSTRACT

The ulnar nerve is most commonly compressed at the elbow in the cubital tunnel. Conservative and operative treatments have been applied for cubital tunnel syndrome. Surgical management options include decompression, medial epicondylectomy, and various anterior transposition techniques. We describe a novel technique of anterior transposition of the ulnar nerve by using Osborne's ligament as a sling to avoid subluxation. Osborne's ligament is incised posteriorly and medially on the olecranon to create a sling with 2 to 3 cm width. The sling is tailored to wrap around the ulnar nerve and attached to the flexor-pronator fascia or dermis to create a smooth gliding surface without causing compression. Ten patients with cubital tunnel syndrome, established by physical examination findings and electromyography/nerve conduction studies underwent ulnar nerve transposition using this technique and were able to participate in a phone survey. The average follow-up was 15.6 months (range, 4-28 months). The average time to become subjectively "better" after surgery was 4.2 weeks. The pain intensity was reduced from an average of 7.5 preoperatively to <1, on a 10-point scale, at the time of the survey. All patients had symptomatic relief without any complication. The proposed technique using Osborne's ligament as a ligamentofascial or ligamentodermal sling offers a unique way of creating a non-compressive sling with the component of the cubital tunnel itself and has an additional benefit of creating a smooth gliding surface for early return of function.

Continue to: Ulnar nerve compression at the elbow...

Ulnar nerve compression at the elbow is a common nerve compression syndrome in the upper extremity. There are multiple sites of compression of the ulnar nerve distal to the axilla. The most common site of ulnar nerve compression is at the cubital tunnel.[1] When ulnar nerve compression is clinically suspected, electromyography (EMG) and nerve conduction velocity studies (NCS) may be performed to help support the diagnosis. However, a false negative rate in excess of 10% is found in patients with clinical signs and symptoms of cubital tunnel syndrome.[2] Treatment of cubital tunnel syndrome involves nonsurgical treatments, including activity modification, use of nonsteroidal anti-inflammatory drugs, splinting, and physical therapy or surgical treatment.[3-5]

Surgical management of cubital tunnel syndrome is indicated after a failed nonsurgical management or a presentation with motor weakness. The most common surgical treatments include in situ decompression, subcutaneous transposition, intramuscular transposition, submuscular transposition, and medial epicondylectomy, or their combination.[6] However, optimal surgical management of cubital tunnel syndrome remains controversial.[2,7] The overall goal of surgery is to eliminate all sites of compression and obtain a tension-free nerve that glides smoothly.

After the initial concept of subcutaneous anterior ulnar nerve transposition was developed by Curtis[8] in 1898, many different techniques have been derived including epineurial suture, fasciodermal sling, and subcutaneous to fascia suture.[8-10] Common complications of subcutaneous ulnar nerve transposition include nerve fibrosis, recurrent subluxation, and inadequate division of the intermuscular septum.[9] Additionally, thin patients often have repeated trauma to their ulnar nerves after subcutaneous transposition.[3]

The anatomy of the cubital tunnel is well described, but it has multiple names and descriptions throughout the literature. Osborne[11] originally described a transverse fibrous band as the fascial connection between the 2 heads of the flexor carpi ulnaris that forms the roof of the cubital tunnel. O'Driscoll and colleagues[5] conducted a cadaver study and proposed calling Osborne's band as the cubital tunnel retinaculum. They described 4 different variations of anatomy and the retinaculum as a 4-mm wide band of tissue located proximally in the cubital tunnel that is distinct from the arcuate ligament and the fascia between the 2 heads of the flexor carpi ulnaris.[5] Green and Rayan[12] studied cubital tunnel anatomy and referred to the ligament that spans the medial epicondyle and the olecranon as the arcuate ligament, which is also distinct from the flexor carpi ulnaris aponeurosis. These variations in named anatomy make describing procedures around the cubital tunnel challenging. In this study, the fascial band between the 2 heads of the flexor carpi ulnaris, as originally described by Osborne,[11] will be referred to as Osborne's ligament.

We describe a novel technique of anterior subcutaneous ulnar nerve transposition, where Osborne's ligament is used as a sling to prevent ulnar nerve subluxation over the medial epicondyle. We also describe the results of our initial subset of patients who were treated with this technique.

Continue to: MATERIALS AND METHODS...

MATERIALS AND METHODS

We performed a chart review of all patients operated on between January 2010 and March 2012 by the same surgeon. We recruited 15 consecutive patients who were diagnosed with ulnar nerve transposition for moderate to severe cubital tunnel syndrome through EMG/NCS and physical examination during this time frame. Operative reports were then reviewed. In 14 of these 15 cases, Osborne's ligament was used as a ligamentofascial or ligamentodermal sling. In the fifteenth patient, preoperative subluxation of the ulnar nerve was identified with movement of elbow, and Osborne's ligament was found to not be large enough to provide an appropriate sling. Three patients were unreachable, and 1 patient chose to not participate in the study. Of the initial 15 patients, 10 were given a telephone survey (**Appendix A**), which was prepared based on the recommendation of Novak and colleagues[13] and incorporated with questions regarding preoperative symptoms, satisfaction, smoking history, and employment status. This study was Institutional Review Board approved at our institution, and appropriate consent was obtained from the participants.

Appendix A. Ulnar Nerve Telephone Survey

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SURGICAL TECHNIQUE

A 10 to 12 cm incision centered over the cubital tunnel is made. The medial antebrachial cutaneous nerve is identified and protected. After dissection through superficial fascia, Osborne's ligament is identified. The ligament is then released posteriorly from the olecranon and is assessed. The ulnar nerve is then freed in a proximal to distal manner to preserve vascular structures that supply the epineurium. The medial intermuscular septum is examined and excised as a site of compression. The ulnar nerve is then mobilized. Once mobilized, the ulnar nerve is transposed anterior to the medial epicondyle and checked to ensure that no sharp curves are made and nothing is impinging on the nerve while passively flexing and extending the elbow. The Osborne's ligament is then passed over the top of the previously transposed ulnar nerve to create a sling that is ligamentofascial if sutured to the flexor/pronator fascia or ligamentodermal if sutured to dermis. Importantly, the flexor/pronator fascia is not incised. The remaining soft tissue and fascia of the cubital tunnel are then closed with 2-0 vicryl suture. The free end of the Osborne's ligament is sutured to flexor/pronator fascia or to dermis, anterior to the medial epicondyle with No. 0 vicryl suture. This process is conducted in a tension-free manner to prevent creating a new site of compression. The nerve is then rechecked for appropriate, tension-free gliding followed by closure of the wound in layers after irrigation (additional details are shown in **Figures 1-5**).

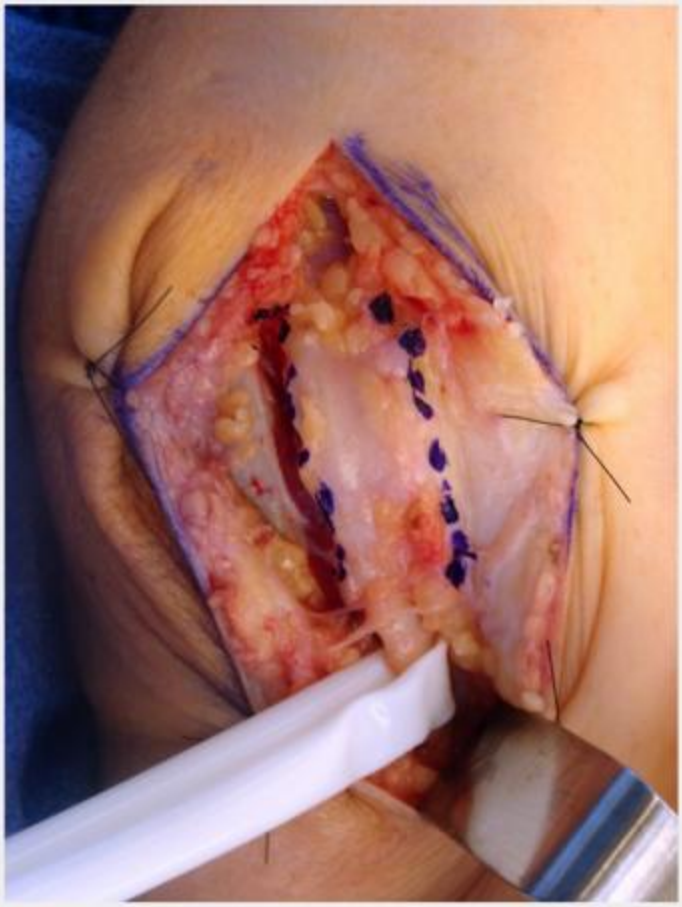

Figure 1. Osborne's ligament is identified, and the ulnar nerve is protected.

Figure 2. Osborne's ligament is released from the olecranon.

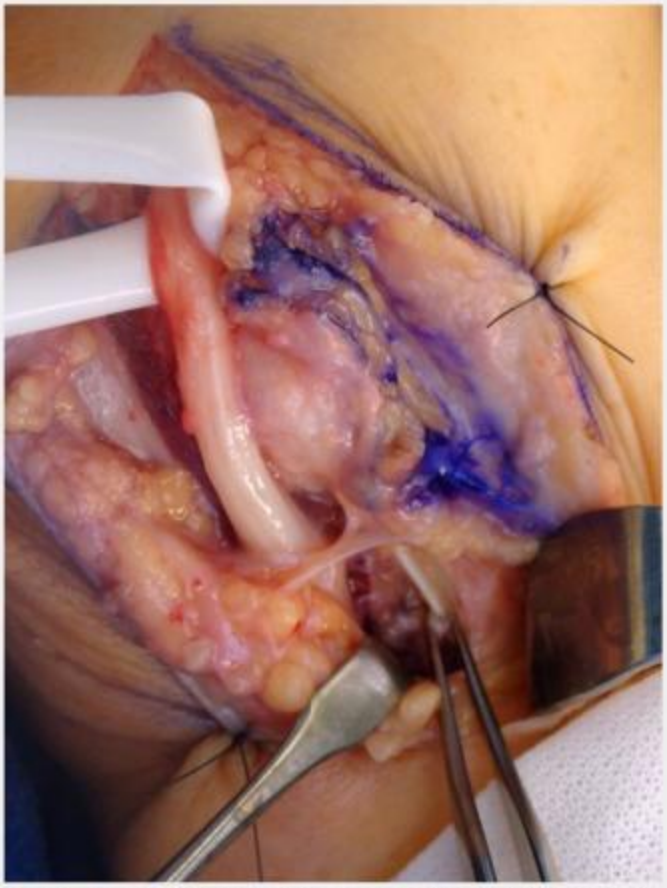

Figure 3. The ulnar nerve is released, and the medial intermuscular septum is identified and excised.

Figure 4. The ulnar nerve is transposed anteriorly.

Figure 5. Osborne's ligament is sutured to the pronator fascia. The cubital tunnel is closed, and the nerve is checked for tension-free excursion.

RESULTS

Ten of the 15 patients were available for telephone review. The results of the telephone survey are as follows. The average time to telephone survey was 15.6 months (range, 4–28 months). The average time to become subjectively "better" was 4.2 weeks (range, 2–6 weeks). The average time back to work was 1.6 weeks (range, 1 day to 3 weeks). Three patients were retired and did not go back to work. All patients stated they were subjectively "better" after surgery, and when asked, all patients stated that they would choose surgery again. The average pain prior to surgery was 7.5 (range, 5.5–9.5) on a 10-point scale. The average pain after surgery at final phone interview was 0.1 on a 10-point scale (range, 0–1). All patients stated that their sensation was subjectively better after the surgery. One patient said that his strength worsened, another patient said that his strength was the same, and the remaining patients said that their strength was better. One patient was a smoker, and no patients had acute traumatic injuries that caused their ulnar nerve symptoms.

Continue to: DISCUSSION...

DISCUSSION

Subcutaneous ulnar nerve transposition is an effective way to treat ulnar nerve compression at the cubital tunnel in appropriate patients. Many techniques have been described, including epineurial suture, fasciodermal sling, and using the medial intermuscular septum as a sling for the ulnar nerve.[9,10,14,15] Eaton and colleagues[14] described the creation of a 1 cm × 1 cm flap based on antebrachial fascial connected to the medial epicondyle. This flap is reflected medially and acts as a fasciodermal sling posterior to the transposed nerve at the medial epicondyle. This sling also acts like a septum to prevent posterior subluxation. Only subcutaneous fat is superficial to the nerve, in contrast to previous attempts at subcutaneous transposition. At an average of 18 months of follow-up, 14 patients showed improvement in their symptoms.[14] Pribyl and Robinson,[9] in 1998, described a procedure where a portion of the intermuscular septum is divided from a distance of 3 to 4 cm proximal to its insertion on the medial epicondyle; the portion is used as a sling and sutured to the fascia of the flexor/pronator mass or alternatively to the subcutaneous tissues. Tan and colleagues[15] modified Pribyl and Robinson's technique by creating a "V" sling with the intermuscular septum; this technique led to complete resolution of symptoms in 17 of 20 patients and improved the symptoms in the 3 remaining patients. Richmond and Southmayd[10] reported excellent results in 83% of patients who had epineurium sutured to the fascia during subcutaneous transposition. However, each aforementioned technique has its own unique theoretical set of problems. The shortcoming of Eaton and colleagues'[14] fasciodermal sling is the creation of a raw bed while creating the sling over the flexor-pronator fascia, which is prone to scarring. Moreover, given that the flexor-pronator fascia is incised, theoretically, the healing period is prolonged and the grip strength in the initial postoperative period decreases. Utilizing the medial intermuscular septum as a sling can create a narrow band, which creates sharp angles that limit nerve gliding. Suturing the epineurium to the fascia by using the technique of Richmond and Southmayd[10] creates a construct that is resistant to tension-free gliding.

In this study, Osborne's ligament was successfully used as a ligamentofascial or ligamentodermal sling in our subset of patients. We believe this is partially due to the large smooth gliding surface of Osborne's ligament that helps to minimize sharp curves and allows for the ulnar nerve to glide tension free. This could be seen with other techniques as described previously. Furthermore, our technique is different because the flexor pronator fascia is not incised, which results in less soft tissue trauma and less pain generation; we suspect that the patients were able to have an early return to work and did not complain of decreased strength because the flexor pronator fascia was not disturbed. Our surveyed patients essentially had complete cessation of pain and were able to return to work in about 10 to 11 days. The patients reported that they felt subjectively "better" in approximately 4 weeks and reported no complications. Sensation was also subjectively "better" in all of the patients surveyed.

This study presents several limitations. The study was retrospective in nature and did not include randomization or a control group. In addition, there is a possibility of significant recall bias in the telephone survey that relies on patient recollection. Finally, the telephone survey is an invalidated outcome measure, and no formal statistical analysis was performed.

CONCLUSION

Subcutaneous ulnar nerve transposition using Osborne's ligament as a ligamentofascial or ligamentodermal sling is a novel technique that creates a broad based, smooth-gliding sling for tension-free excursion of the ulnar nerve and showed success in our subset of patients.

This paper will be judged for the Resident Writer's Award.

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Author and Disclosure Information

Authors' Disclosure Statement: The authors report no actual or potential conflict of interest in relation to this article.

Dr. Goldberg and Dr. Burnham were Resident Physicians at the time the article was written, and Dr. Dhawan is a Professor and Attending Orthopaedic Surgeon, Department of Orthopaedic Surgery and Sports Medicine, University of Kentucky, Lexington, Kentucky.

Address correspondence to: Jeremy M. Burnham, MD, Department of Orthopaedic Surgery and Sports Medicine, University of Kentucky, 740 S. Limestone, K401, Lexington, KY 40536 (tel, 859-218-3044; email, jburnh@gmail.com).

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Author(s)
Jeffrey Goldberg, MD
Jeremy M. Burnham, MD
Vikas Dhawan, MD, PhD
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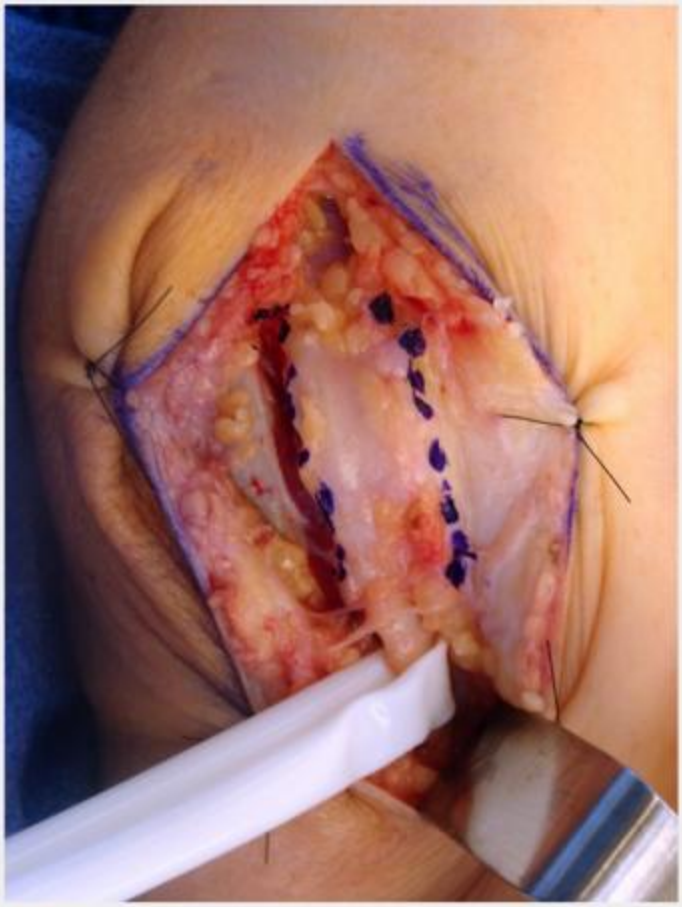

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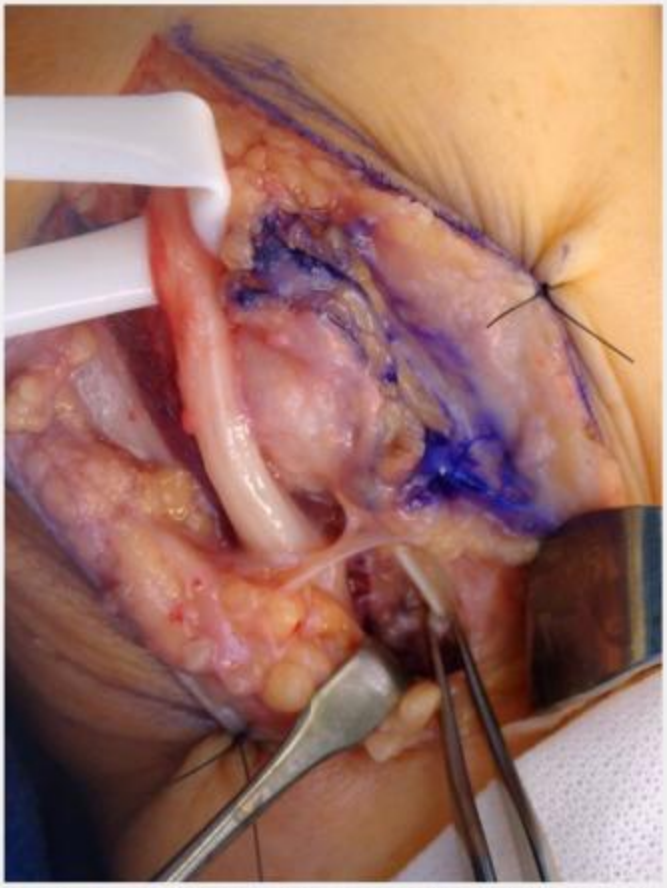

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RESULTS

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ABSTRACT

The ulnar nerve is most commonly compressed at the elbow in the cubital tunnel. Conservative and operative treatments have been applied for cubital tunnel syndrome. Surgical management options include decompression, medial epicondylectomy, and various anterior transposition techniques. We describe a novel technique of anterior transposition of the ulnar nerve by using Osborne's ligament as a sling to avoid subluxation. Osborne's ligament is incised posteriorly and medially on the olecranon to create a sling with 2 to 3 cm width. The sling is tailored to wrap around the ulnar nerve and attached to the flexor-pronator fascia or dermis to create a smooth gliding surface without causing compression. Ten patients with cubital tunnel syndrome, established by physical examination findings and electromyography/nerve conduction studies underwent ulnar nerve transposition using this technique and were able to participate in a phone survey. The average follow-up was 15.6 months (range, 4-28 months). The average time to become subjectively "better" after surgery was 4.2 weeks. The pain intensity was reduced from an average of 7.5 preoperatively to <1, on a 10-point scale, at the time of the survey. All patients had symptomatic relief without any complication. The proposed technique using Osborne's ligament as a ligamentofascial or ligamentodermal sling offers a unique way of creating a non-compressive sling with the component of the cubital tunnel itself and has an additional benefit of creating a smooth gliding surface for early return of function.

Continue to: Ulnar nerve compression at the elbow...

Ulnar nerve compression at the elbow is a common nerve compression syndrome in the upper extremity. There are multiple sites of compression of the ulnar nerve distal to the axilla. The most common site of ulnar nerve compression is at the cubital tunnel.[1] When ulnar nerve compression is clinically suspected, electromyography (EMG) and nerve conduction velocity studies (NCS) may be performed to help support the diagnosis. However, a false negative rate in excess of 10% is found in patients with clinical signs and symptoms of cubital tunnel syndrome.[2] Treatment of cubital tunnel syndrome involves nonsurgical treatments, including activity modification, use of nonsteroidal anti-inflammatory drugs, splinting, and physical therapy or surgical treatment.[3-5]

Surgical management of cubital tunnel syndrome is indicated after a failed nonsurgical management or a presentation with motor weakness. The most common surgical treatments include in situ decompression, subcutaneous transposition, intramuscular transposition, submuscular transposition, and medial epicondylectomy, or their combination.[6] However, optimal surgical management of cubital tunnel syndrome remains controversial.[2,7] The overall goal of surgery is to eliminate all sites of compression and obtain a tension-free nerve that glides smoothly.

After the initial concept of subcutaneous anterior ulnar nerve transposition was developed by Curtis[8] in 1898, many different techniques have been derived including epineurial suture, fasciodermal sling, and subcutaneous to fascia suture.[8-10] Common complications of subcutaneous ulnar nerve transposition include nerve fibrosis, recurrent subluxation, and inadequate division of the intermuscular septum.[9] Additionally, thin patients often have repeated trauma to their ulnar nerves after subcutaneous transposition.[3]

The anatomy of the cubital tunnel is well described, but it has multiple names and descriptions throughout the literature. Osborne[11] originally described a transverse fibrous band as the fascial connection between the 2 heads of the flexor carpi ulnaris that forms the roof of the cubital tunnel. O'Driscoll and colleagues[5] conducted a cadaver study and proposed calling Osborne's band as the cubital tunnel retinaculum. They described 4 different variations of anatomy and the retinaculum as a 4-mm wide band of tissue located proximally in the cubital tunnel that is distinct from the arcuate ligament and the fascia between the 2 heads of the flexor carpi ulnaris.[5] Green and Rayan[12] studied cubital tunnel anatomy and referred to the ligament that spans the medial epicondyle and the olecranon as the arcuate ligament, which is also distinct from the flexor carpi ulnaris aponeurosis. These variations in named anatomy make describing procedures around the cubital tunnel challenging. In this study, the fascial band between the 2 heads of the flexor carpi ulnaris, as originally described by Osborne,[11] will be referred to as Osborne's ligament.

We describe a novel technique of anterior subcutaneous ulnar nerve transposition, where Osborne's ligament is used as a sling to prevent ulnar nerve subluxation over the medial epicondyle. We also describe the results of our initial subset of patients who were treated with this technique.

Continue to: MATERIALS AND METHODS...

MATERIALS AND METHODS

We performed a chart review of all patients operated on between January 2010 and March 2012 by the same surgeon. We recruited 15 consecutive patients who were diagnosed with ulnar nerve transposition for moderate to severe cubital tunnel syndrome through EMG/NCS and physical examination during this time frame. Operative reports were then reviewed. In 14 of these 15 cases, Osborne's ligament was used as a ligamentofascial or ligamentodermal sling. In the fifteenth patient, preoperative subluxation of the ulnar nerve was identified with movement of elbow, and Osborne's ligament was found to not be large enough to provide an appropriate sling. Three patients were unreachable, and 1 patient chose to not participate in the study. Of the initial 15 patients, 10 were given a telephone survey (**Appendix A**), which was prepared based on the recommendation of Novak and colleagues[13] and incorporated with questions regarding preoperative symptoms, satisfaction, smoking history, and employment status. This study was Institutional Review Board approved at our institution, and appropriate consent was obtained from the participants.

Appendix A. Ulnar Nerve Telephone Survey

appendix_a_ulnar_nerve_telephone_survey_1.pdf

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SURGICAL TECHNIQUE

A 10 to 12 cm incision centered over the cubital tunnel is made. The medial antebrachial cutaneous nerve is identified and protected. After dissection through superficial fascia, Osborne's ligament is identified. The ligament is then released posteriorly from the olecranon and is assessed. The ulnar nerve is then freed in a proximal to distal manner to preserve vascular structures that supply the epineurium. The medial intermuscular septum is examined and excised as a site of compression. The ulnar nerve is then mobilized. Once mobilized, the ulnar nerve is transposed anterior to the medial epicondyle and checked to ensure that no sharp curves are made and nothing is impinging on the nerve while passively flexing and extending the elbow. The Osborne's ligament is then passed over the top of the previously transposed ulnar nerve to create a sling that is ligamentofascial if sutured to the flexor/pronator fascia or ligamentodermal if sutured to dermis. Importantly, the flexor/pronator fascia is not incised. The remaining soft tissue and fascia of the cubital tunnel are then closed with 2-0 vicryl suture. The free end of the Osborne's ligament is sutured to flexor/pronator fascia or to dermis, anterior to the medial epicondyle with No. 0 vicryl suture. This process is conducted in a tension-free manner to prevent creating a new site of compression. The nerve is then rechecked for appropriate, tension-free gliding followed by closure of the wound in layers after irrigation (additional details are shown in **Figures 1-5**).

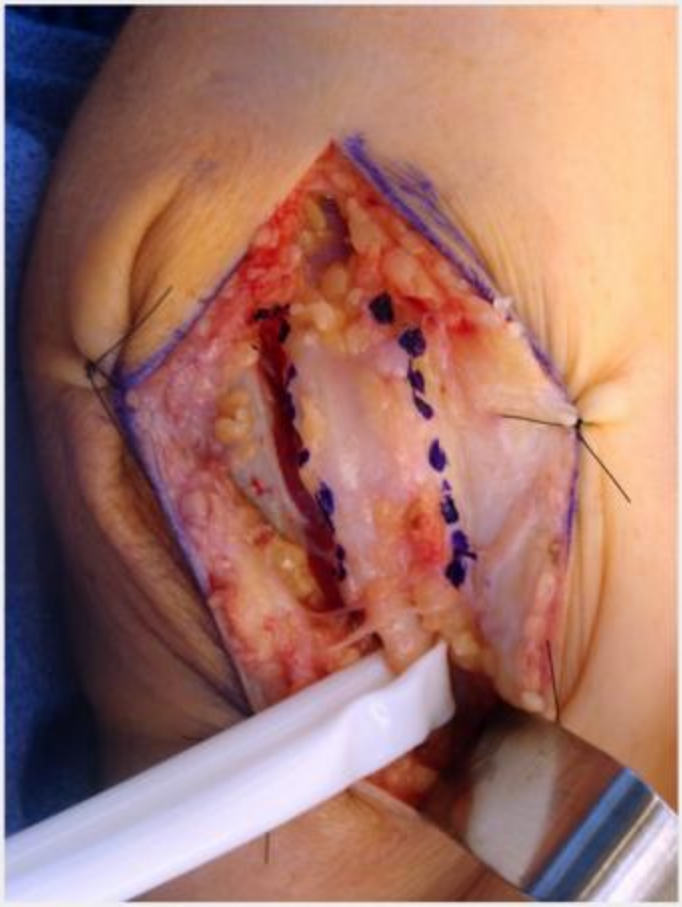

Figure 1. Osborne's ligament is identified, and the ulnar nerve is protected.

Figure 2. Osborne's ligament is released from the olecranon.

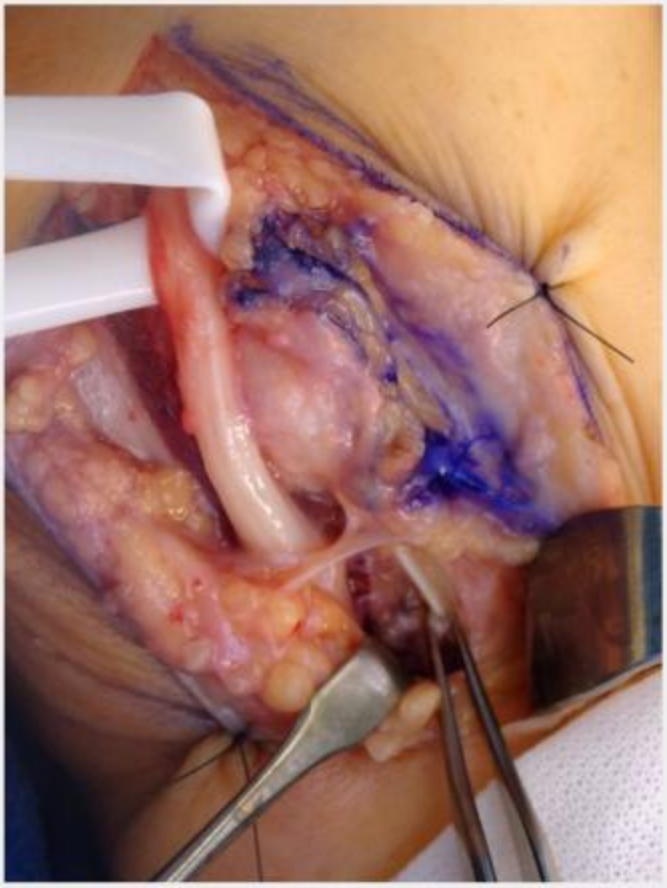

Figure 3. The ulnar nerve is released, and the medial intermuscular septum is identified and excised.

Figure 4. The ulnar nerve is transposed anteriorly.

Figure 5. Osborne's ligament is sutured to the pronator fascia. The cubital tunnel is closed, and the nerve is checked for tension-free excursion.

RESULTS

Ten of the 15 patients were available for telephone review. The results of the telephone survey are as follows. The average time to telephone survey was 15.6 months (range, 4–28 months). The average time to become subjectively "better" was 4.2 weeks (range, 2–6 weeks). The average time back to work was 1.6 weeks (range, 1 day to 3 weeks). Three patients were retired and did not go back to work. All patients stated they were subjectively "better" after surgery, and when asked, all patients stated that they would choose surgery again. The average pain prior to surgery was 7.5 (range, 5.5–9.5) on a 10-point scale. The average pain after surgery at final phone interview was 0.1 on a 10-point scale (range, 0–1). All patients stated that their sensation was subjectively better after the surgery. One patient said that his strength worsened, another patient said that his strength was the same, and the remaining patients said that their strength was better. One patient was a smoker, and no patients had acute traumatic injuries that caused their ulnar nerve symptoms.

Continue to: DISCUSSION...

DISCUSSION

Subcutaneous ulnar nerve transposition is an effective way to treat ulnar nerve compression at the cubital tunnel in appropriate patients. Many techniques have been described, including epineurial suture, fasciodermal sling, and using the medial intermuscular septum as a sling for the ulnar nerve.[9,10,14,15] Eaton and colleagues[14] described the creation of a 1 cm × 1 cm flap based on antebrachial fascial connected to the medial epicondyle. This flap is reflected medially and acts as a fasciodermal sling posterior to the transposed nerve at the medial epicondyle. This sling also acts like a septum to prevent posterior subluxation. Only subcutaneous fat is superficial to the nerve, in contrast to previous attempts at subcutaneous transposition. At an average of 18 months of follow-up, 14 patients showed improvement in their symptoms.[14] Pribyl and Robinson,[9] in 1998, described a procedure where a portion of the intermuscular septum is divided from a distance of 3 to 4 cm proximal to its insertion on the medial epicondyle; the portion is used as a sling and sutured to the fascia of the flexor/pronator mass or alternatively to the subcutaneous tissues. Tan and colleagues[15] modified Pribyl and Robinson's technique by creating a "V" sling with the intermuscular septum; this technique led to complete resolution of symptoms in 17 of 20 patients and improved the symptoms in the 3 remaining patients. Richmond and Southmayd[10] reported excellent results in 83% of patients who had epineurium sutured to the fascia during subcutaneous transposition. However, each aforementioned technique has its own unique theoretical set of problems. The shortcoming of Eaton and colleagues'[14] fasciodermal sling is the creation of a raw bed while creating the sling over the flexor-pronator fascia, which is prone to scarring. Moreover, given that the flexor-pronator fascia is incised, theoretically, the healing period is prolonged and the grip strength in the initial postoperative period decreases. Utilizing the medial intermuscular septum as a sling can create a narrow band, which creates sharp angles that limit nerve gliding. Suturing the epineurium to the fascia by using the technique of Richmond and Southmayd[10] creates a construct that is resistant to tension-free gliding.

In this study, Osborne's ligament was successfully used as a ligamentofascial or ligamentodermal sling in our subset of patients. We believe this is partially due to the large smooth gliding surface of Osborne's ligament that helps to minimize sharp curves and allows for the ulnar nerve to glide tension free. This could be seen with other techniques as described previously. Furthermore, our technique is different because the flexor pronator fascia is not incised, which results in less soft tissue trauma and less pain generation; we suspect that the patients were able to have an early return to work and did not complain of decreased strength because the flexor pronator fascia was not disturbed. Our surveyed patients essentially had complete cessation of pain and were able to return to work in about 10 to 11 days. The patients reported that they felt subjectively "better" in approximately 4 weeks and reported no complications. Sensation was also subjectively "better" in all of the patients surveyed.

This study presents several limitations. The study was retrospective in nature and did not include randomization or a control group. In addition, there is a possibility of significant recall bias in the telephone survey that relies on patient recollection. Finally, the telephone survey is an invalidated outcome measure, and no formal statistical analysis was performed.

CONCLUSION

Subcutaneous ulnar nerve transposition using Osborne's ligament as a ligamentofascial or ligamentodermal sling is a novel technique that creates a broad based, smooth-gliding sling for tension-free excursion of the ulnar nerve and showed success in our subset of patients.

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TAKE-HOME POINTS

- Optimal management of cubital tunnel syndrome is controversial.
- There are many different techniques for ulnar nerve transposition, each with their own set of pitfalls.
- Goal of any surgery for ulnar nerve compression is to eliminate all sites of compression and create a tension-free nerve that glides freely.
- Osborne's ligament is a transverse fibrous band as the fascial connection between the 2 heads of the flexor carpi ulnaris that forms the roof of the cubital tunnel.
- Osborne's ligament can be used in ulnar nerve transposition to create a broad based, smooth-gliding sling for tension-free excursion of the ulnar nerve.