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Endoscopic Cubital Tunnel Release in Leprosy Neuritis of the Ulnar Nerve

Liberação endoscópica do túnel cubital na neurite hansênica do nervo ulnar

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Abstract

Objectives To better characterize the role of endoscopic cubital tunnel release in leprosy neuritis and determine whether there is an improvement in pain, sensitivity, and strength with the use of this minimally invasive technique.

Methods A total of 44 endoscopic procedures for ulnar nerve decompression at the elbow were performed in patients who were previously diagnosed with leprosy neuritis. The inclusion criteria were surgical indication for ulnar nerve release and clinical treatment failure for 4 weeks in patients with cubital tunnel syndrome who had their ulnar nerve function, whether motor or sensitive, deteriorated progressively despite the treatment with prednisone 1 mg/kg/day and physiotherapy. For endoscopic release, the CTS Relief Kit (Linvatec. Largo, FL, USA) and a standard 4mm 30° arthroscope were used.

Results The study included 39 patients, 29 (74.4%) males and 10 (25.6%) females. The age of the patients ranged from 12 to 64 years (33 ± 14.97). Five patients underwent bilateral release. The release demonstrated a statistically significant improvement in pain (p 0.002), in sensitivity ($p < 0.001$), and in strength

Keywords
- endoscopy
- ulnar neuropathies
- leprosy

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($p < 0.001$). The best results were obtained when ulnar release was performed less than 6 months after surgery indication. None of the procedures were converted from endoscopic to open. No major complications (infection, vascular injury, and nervous injury) were reported. One patient had ulnar nerve subluxation.

Conclusion The endoscopic release of the ulnar nerve at the elbow in leprosy neuritis entails true and safe benefits for the patient, such as improvement in pain, sensitivity and strength.

Resumo

Objetivos Os objetivos deste estudo foram caracterizar melhor o papel da liberação endoscópica do túnel cubital na neurite hansênica e determinar se há melhora da dor, sensibilidade e força com esta técnica minimamente invasiva.

Métodos Um total de 44 procedimentos endoscópicos para descompressão do nervo ulnar no cotovelo foram realizados em pacientes previamente diagnosticados com neurite por hanseníase. Os critérios de inclusão foram indicação cirúrgica para liberação do nervo ulnar e insucesso do tratamento clínico por 4 semanas em pacientes com síndrome do túnel cubital que sofreram deterioração progressiva da função motora ou sensitiva do nervo ulnar apesar do tratamento de 1 mg/kg/dia de prednisona e fisioterapia. A liberação endoscópica foi realizada com CTS Relief Kit (Linvatec. Largo, FL, EUA) e um artroscópio padrão de 4 mm e 30°.

Resultados O estudo incluiu 39 pacientes, sendo 29 (74,4%) homens e 10 (25,6%) mulheres. A idade dos pacientes variou de 12 a 64 anos ($33 \pm 14,97$). Cinco pacientes foram submetidos à liberação bilateral. A liberação provocou melhora estatisticamente significativa de dor ($p = 0,002$), sensibilidade ($p < 0,001$) e força ($p < 0,001$). Os melhores resultados foram obtidos quando a liberação ulnar foi realizada em menos de 6 meses após a indicação da cirurgia. Nenhum procedimento foi convertido de endoscópico para aberto. Não foram relatadas complicações maiores (infecção, lesão vascular e lesão nervosa). Um paciente apresentou subluxação do nervo ulnar.

Conclusão A liberação endoscópica do nervo ulnar no cotovelo na neurite hansênica traz benefícios verdadeiros e seguros para o paciente, como melhora da dor, sensibilidade e força.

Palavras-chave
- endoscopia
- neuropatias ulnares
- hanseníase

Introduction

Leprosy is primarily a skin and neurological disease but can become systemic in multibacillary patients. Neuropathy due to leprosy is still diagnosed and treated late, or ignored altogether, resulting in permanent disability.[1–3]

Common areas of ulnar nerve compression in leprosy neuritis include the Osborne ligament, flexor carpi ulnaris, arcade of Struthers, and medial intermuscular septum. The ulnar nerve is the most affected by leprosy neuritis, with a critical area around the elbow.[4,5]

Compressive syndrome results from neural edema, associated with the infectious inflammatory process caused by bacillary invasion and an immunological reaction. When combined with epineural thickening, which is inelastic and impermeable, it hinders passage through the ulnar sulcus in the medial epicondyle.[2] There is an increase in the intraneural pressure and compression of its axon. The affected nerve exhibits three stages of evolution: irritant (stage I), characterized by pain, paresthesia and hyperesthesia; compressive (stage II), characterized by hypoesthesia and paresthesia; and deficit (stage III), characterized by anesthesia, paralysis and atrophy.[2]

These lesions can initially be treated clinically with prednisone. In neuritis resistant to this drug, typically in stage II, decompressive surgery, microneurolysis, acts directly on the neuronal lesion, preventing sensory and motor damage that could lead to deformities.[1,6]

The hypertrophied ulnar nerve offers a remarkable risk of damage a very important policy when dealing with a hypertrophic peripheral nerve disease instead of the external compression commonly seen in ulnar tunnel syndrome. An important challenge remains in leprosy neuritis: can the procedure be performed using the endoscopic technique?

Thus, the aim of the present study is to better characterize the role of endoscopic cubital tunnel release in leprosy neuritis, determining whether there is an improvement in pain, sensitivity and strength with the use of this minimally invasive technique.

Materials and Methods

This study was a prospective case series, approved by the institution's research ethics committee and conducted in accordance with resolution 466/12 of the National Health

Council. Cubital tunnel syndrome was diagnosed based on a history of leprosy and physical examination. This research was all carried out in the same hospital, a reference center for the diagnosis and treatment of leprosy.

The inclusion criteria were surgical indications for ulnar nerve release, and clinical treatment failure for 4 weeks in patients with Cubital tunnel syndrome who had their ulnar nerve function, whether motor or sensitive, deteriorated progressively despite the treatment with prednisone 1 mg/kg/day and physiotherapy.

The exclusion criteria were medical history of previous elbow surgery and/or other causes of ulnar nerve entrapment syndrome.

A total of 44 endoscopic procedures for ulnar nerve decompression at the elbow were performed in patients who were previously diagnosed with leprosy neuritis between August 2014 and February 2015. A biopsy or bacilloscopy confirmed the diagnosis in all cases and patients were followed up clinically.

All surgical procedures were performed by the same surgeon and using the same operative technique.

Evaluation of Operative Results

The most common complaint was of elbow pain, and the visual analogue scale (VAS)[7] was used with values ranging between 0 and 10. It was considered positive for pain VAS score ≥ 5.

Sensitivity was quantified by the Semmes-Weinstein Monofilament test.[8] The sensitivity score was calculated as the sum of three points innervated by the ulnar nerve (►**Fig. 1**) through the color scale proposed by Bell-Krotoski[9]: with black indicating a score of zero, pink for 1, orange for 2, red for 3, purple for 4, blue for 5, and green for 6. The maximum score (normal sensitivity) was 18 and the minimum zero.

Ulnar motor performance was measured in: 1) the abductor muscle of the fifth digit (abductor digiti minimi); 2) first dorsal interosseous; 3) interosseous and lumbricals muscles of the fifth digit. The values varied between M0 and M5; with M0 indicating complete paralysis, M3 action against gravity, and M5 being normal strength, according to the Medical Research Council scale.[10] The strength score was calculated as the sum of the three muscle groups tested. The maximum score (normal strength) was 15 and the minimum zero.

In the present study, the following were considered minor complications: neuropathic scar pain, incomplete release, ulnar nerve subluxation, tendinous instability, and complex regional pain syndrome; and the major complications were infection, vascular injury, and nervous injury.

Operative Technique

Under sedation and axillary block, the patient is positioned on a standard hand table with the arm abducted 90^0, the external rotation and elbow in flexion. The tourniquet is placed as high as possible on the upper arm to allow full mobility of the elbow joint. The surgeon flexes and supinates the arm to face the cubital tunnel area. For endoscopic release the CTS Relief Kit (Linvatec, Largo, FL, USA) and a standard 4mm 30^0 arthroscope were used. Lines are drawn from anatomical points (olecranon-medial epicondyle) to accurately demarcate the cannula's entry portal and the end point (target), which allows total release of the retinaculum[11] (►**Fig. 2**). A 1.5cm incision is made with blade no.15; then, two small retractors are placed to keep the incision open. The ulnar nerve is inspected, and two small Kelly are inserted beside the Osborne ligament's bone attachment (cubital tunnel retinaculum) in order to expose the tunnel entrance. The two dilators (5.0–7.5mm) are inserted up to the target point to create a space, while the slotted cannula helps shield adjacent nerves from potential damage. Under

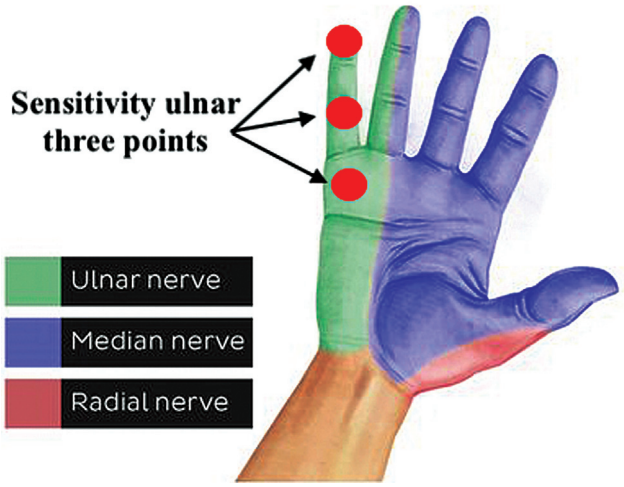

Fig. 1 Three points of sensitivity innervated by the ulnar nerve (red circles).

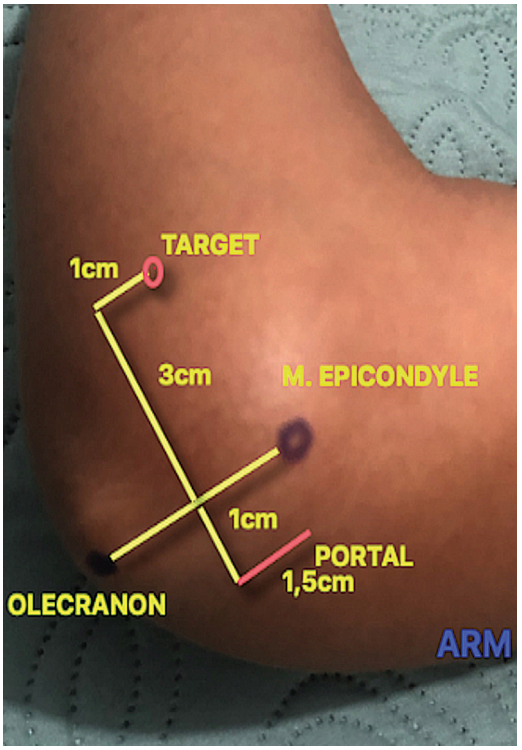

Fig. 2 Anatomical points (olecranon-medial epicondyle) to accurately demarcate the cannula entry portal and the end point (target).

direct arthroscopic visualization, the pen-like knife cuts the ligament and the first part of the flexor carpi ulnaris fascia. In the same fashion, the intermuscular fascia and the Struthers arcade (if present) are separated from 8 to 10cm. The skin is closed with a Vicryl Rapide (Ethicon US, LLC. Cincinnati, OH, USA) polyglactin 910 running suture. A bandage is applied, and the tourniquet released. No rigid immobilization is required. The patients were evaluated by two occupational therapists and an orthopedic surgeon immediately before the surgical procedure, as well as at 30, 60, and 90 days of follow-up.

Statistical Analysis

Categorical and numerical variables were tabulated and analyzed using the Statistical Package for the Social Sciences (SPSS, Inc. Chicago, IL, USA) software, version 16.0, and the R (R Foundation for Statistical Computing, Vienna, Austria) software, version 3.3.1.

To determine whether ulnar nerve release has an effect on pain, sensitivity, and strength, the null hypothesis of "marginal homogeneity" was verified by the McNemar test.

Normality was verified using the Shapiro-Wilk normality test. The homogeneity of group variances was verified by the Levene test. The comparison of means of the groups, single sample and two independent samples, to reject or not a null hypothesis, was made using the t-test for parametric data and the Mann-Whitney U test for non-parametric data.

To compare the three independent samples (Virchowian, tuberculoid, and dimorphous clinical forms) in relation to sensitivity and strength, the Kruscal-Wallis technique was used as a non-parametric test and analysis of variance (ANOVA) as a parametric test.

Analyzes were considered statistically significant with a 95% confidence interval and p-value less than 0.05.

Results

The study included 39 patients, 29 (74.4%) males and 10 (25.6%) females. The age of the patients ranged from 12 to 64 years (33 ± 14.97). Five patients underwent bilateral release.

Of the total of 39 patients, 9 (23.1%) presented with tuberculoid, 10 (25.6%) Virchowian, and 20 (51.3%) dimorphous leprosy. With respect to operational classification, 31 (79.5%) exhibited the multibacillary and 8 (20.5%) the paucibacillary form. There was a 51.3% decrease in type I reactions and 15.0% in type II was observed after surgery.

The McNemar test demonstrated a statistically significant ($p = 0.002$) improvement in pain (VAS score < 5) after ulnar nerve release (►**Table 1**).

Regarding sensitivity and strength, ulnar nerve release showed statistically significant improvement ($p < 0.001$). The delay between indication and surgery was the main factor for negative outcomes. The best results were obtained when ulnar release was performed less than 6 months after surgery indication (►**Tables 2** and **3**).

Patients who underwent early treatment (less than 6 months after indication of the ulnar release) achieved higher rates of strength recovery to the point of maximum score (►**Table 3**).

Statistical analysis revealed no significant relationship between the clinical form of leprosy and motor strength (►**Table 4**), nor with the levels of recovery of sensitivity.

No macroscopically visible nerves or vessels were injured during the procedure. One patient had ulnar nerve subluxation over the medial epicondyle of the elbow flexion. There was no scar, discomfort, and deep infection was not observed despite high oral doses of corticosteroids, whose use progressively decreased at clinical discretion. No procedure was converted from endoscopic to open.

Table 1 Data from the 39 patients

Gender	29 (74.4%) males and 10 (25.6%) females
Age	33 ± 14.97 years
Laterality	5 bilateral and 34 unilateral
Type of leprosy	9 (23.1%) tuberculoid, 10 (25.6%) Virchowian and 20 (51.3%) dimorphous
Operational classification	31 (79.5%) multibacillary and 8 (20.5%) paucibacillary
Pain status (VAS) – before surgery	8.54 ± 1.07
Pain status (VAS) – 90 days after surgery	4.12 ± 2.76
Sensitivity Score – Before Surgery	13.44 ± 4.85
Sensitivity score – 90 days after surgery	15.75 ± 3.95
Strength score – before surgery	11.23 ± 2.23
Strength score – 90 days after surgery	13.56 ± 1.28

Note: The Visual Analogue Scale (VAS)[7] was used with values ranging between 0 and 10. It was considered positive for pain VAS score ≥ 5. The sensitivity score was calculated as the sum of three points innervated by the ulnar nerve (►**Fig. 1**) through the color scale proposed by Bell[9]: with black for a score of zero, pink for 1, orange for 2, red for 3, purple for 4, blue for 5, and green for 6. The maximum score (normal sensitivity) was 18 and the minimum zero. The strength score was calculated as the sum of the three muscle groups tested: (1) the abductor muscle of the fifth digit (abductor digiti minimi), (2) first dorsal interosseous; (3) interosseous and lumbricals muscles of the fifth digit. The values vary between M0 and M5, with M0 indicating complete paralysis, M3 action against gravity and M5 normal strength according to the Medical Research Council scale.[10] The maximum score (normal strength) was 15 and the minimum zero.

Table 2 Sensitivity score and time between surgery indication and ulnar release

Sensitivity Score	Time between surgery indication and ulnar release		*p*-value
	< 6 months	≥ 6 months	
Before Surgery	15.20 ± 4.76	10.88 ± 5.12	0.084
30 days after surgery	16.40 ± 2.19	12.35 ± 5.07	0.064
60 days after surgery	17.80 ± 0.45	12.65 ± 5.21	0.021
90 days after surgery	17.80 ± 0.45	12.94 ± 5.25	0.030

Note: The sensitivity score was calculated as the sum of three points innervated by the ulnar nerve (►**Fig. 1**) through the color scale proposed by Bell[9]: with black for a score of zero, pink for 1, orange for 2, red for 3, purple for 4, blue for 5, and green for 6. The maximum score (normal sensitivity) was 18 and the minimum zero.

Table 3 Strength Score and time between surgery indication and ulnar release

Strength Score	Time between surgery indication and ulnar release		*p*-value
	< 6 meses	≥ 6 meses	
Before Surgery	12.40 ± 1.34	8.91 ± 4.03	0.065
30 days after surgery	14.00 ± 1.22	10.10 ± 3.88	0.035
60 days after surgery	14.20 ± 0.84	10.40 ± 3.77	0.044
90 days after surgery	15.00 ± 0.00	10.70 ± 3.86	0.011

Note: The strength score was calculated as the sum of the three muscle groups tested: (1) the abductor muscle of the fifth digit (abductor digiti minimi), (2) first dorsal interosseous; (3) interosseous and lumbricals muscles of the fifth digit. The values vary between M0 and M5, with M0 indicating complete paralysis, M3 action against gravity, and M5 normal strength according to the Medical Research Council scale.[10] The maximum score (normal strength) was 15 and the minimum zero.

Table 4 Strength score and clinical form of leprosy

Strength Score	Clinical Form			*p*-value
	DIMORPHOUS	TUBERCULOID	VIRCHOWIAN	
Before Surgery	8.91 ± 4.03	12.40 ± 1.34	12.40 ± 1.34	0.466
30 days after surgery	10.15 ± 3.88	14.00 ± 1.22	14.00 ± 1.22	0.425
60 days after surgery	10.47 ± 3.77	14.20 ± 0.84	14.20 ± 0.84	0.259
90 days after surgery	10.74 ± 3.86	15.00 ± 0.00	15.00 ± 0.00	0.183

Note: The strength score was calculated as the sum of the three muscle groups tested: (1) the abductor muscle of the fifth digit (abductor digiti minimi), (2) first dorsal interosseous; (3) interosseous and lumbricals muscles of the fifth digit. The values vary between M0 and M5, with M0 indicating complete paralysis, M3 action against gravity, and M5 normal strength according to the Medical Research Council scale.[10] The maximum score (normal strength) was 15 and the minimum zero.

Discussion

The main finding of the present study was to demonstrate that the endoscopic release of the ulnar nerve at the elbow in leprosy neuritis entails true and safe benefits for the patient, such as sensory and motor improvement.

Several different open release techniques have been described, including simple cubital tunnel decompression, anterior subcutaneous transposition, and anterior submuscular and intramuscular transposition. There is no consensus as to the best treatment.[12]

Endoscopic nerve decompression under bone-fibrous tunnels has been increasingly studied after the publication of the paper by Chow in 1989.[13] The author described a technique involving endoscopic release of the median nerve in the carpal tunnel using two portals.[13]

The uniportal endoscopic release of the carpal tunnel was developed by Agee et al.[11] This technique provides patients with better hand sensitivity when compared with its conventional and biportal counterparts, and results in an earlier recovery of normal daily routine for patients.[11]

In 1995, Tsai et al.[14] presented a new uniportal endoscopic technique for cubital tunnel decompression using an instrument with glass tubes. In 2005, Bain & Bajhau carried out the same cadaveric endoscopic study on the elbow, using the uniportal access and the Agee device.[15] A systematic review of outcomes and complications screened 344 endoscopic cubital tunnel and 150 open *in situ* releases. The

complication rates for both techniques showed a combined odds ratio of 0.280, indicating that endoscopic patients are less likely to experience complications. The excellent and good combined rate was 92.0% for endoscopic and 82.7% for open releases. According to the authors, the endoscopic technique was superior in terms of complication rates and patient satisfaction.[16]

Pondé et al.[17] presented a mini-open technique for leprosy neuritis in carpal tunnel syndrome, without an endoscopic device. It was a safe and easy method with minimal morbidity, appropriate for developing countries where leprosy is prevalent.

According to Pondé et al.,[17] the transverse carpal ligament cannot be sectioned in leprosy using the endoscopic technique. In order to avoid complications, a small incision and minor open surgery are required to achieve the best results, although endoscopic release of the median nerve in the carpal tunnel exhibited a complication rate of 0.19 and 0.4% using the biportal and uniportal techniques, respectively.[11,13]

Preliminary studies have demonstrated the safety and efficacy of biportal endoscopic median and ulnar nerve decompression in cadaveric models using the Dyonic ECTRA Carpal Ligament System (Smith & Nephew. Watford, Hertfordshire, UK).[18] The senior author used the carpal and cubital tunnel release kit to perform uniportal endoscopic median or ulnar nerve decompression in leprosy patients.

Applying Tsai et al.'s concepts for endoscopic cubital tunnel release of the ulnar nerve, a novel approach involving minimally invasive surgery, it enables us to see and release the entire tunnel through a smaller incision than those used in standards techniques.[14] The endoscopic technique used in leprosy patients required no conversion to its open counterpart, and we observed no major ulnar nerve lesions, even in a 12-year-old child. Based on the criteria established by the Public Health Care System of Brazil for surgical release in leprosy, we found that the absence of a response to corticosteroids after four weeks was the most significant parameter (74.4%) for cubital tunnel endoscopy.

Pain relief was reported by all the patients ($p = 0.002$). There was also an immediate and gradual reduction of pain after surgery when the conventional technique was performed.[1,19]

A statistically significant difference in neuritis duration was observed before and after six months, in relation to sensitivity gain 60 and 90 days after endoscopic surgery. Jambeiro et al.[1] found that 60% of the patients showed improvement in sensitivity, and that the Virchowian form exhibited the least improvement in sensitivity, which differs from our finding. We found no correlation between the clinical form and sensitivity recovery levels. Virmond et al.[20] also reported a sensitivity gain in 80% of their study population after one year of follow-up.

Comparing the strength gain in patients with neuritis before and after six months with the subsequent 30, 60 and 90 days of follow-up, we noted a distinct improvement in strength in all patients; however, those who waited less than six months achieved higher recovery rates, as observed for the open technique.[21]

Although the surgical procedure itself induces the occurrence of leprosy reactions, we observed a 51.3% decrease in type I and 15% in type II reactions after surgery. No clinical form has been shown to be a determinant for the loss of neural function, but it could be more related to mechanical compression than an exacerbated immunological component. This may explain why the surgical technique employed was able to decrease the use of corticosteroids and mitigate their harmful effects on the patient.

A meta-analysis was then performed involving 226 endoscopic cubital tunnel and 429 open release surgeries. In the endoscopic release cohort, the authors demonstrated a significant reduction in patient-reported scar tenderness and lower rates of elbow pain, but a higher incidence of postoperative hematomas.[22] In 90% of these hematomas, the authors used the retractor-integrated endoscope and transected the fibrous bands overlying the nerve. The Hoffmann technique allows a large area of ulnar nerve release when compared to the Cobb method, which uses slotted cannulas.[23–26] In our series, we did not observe postoperative hematomas, and overall pain intensity declined.

Endoscopic decompression is a less extensive and more feasible procedure. None of the surgeries were converted from endoscopic to open, and no macroscopically visible ulnar nerves were injured; however, one dysesthesia in the territory of the medial antebrachial cutaneous nerve was found. It seems appropriate to leave the nerve in its normal anatomical position since the recovery process depends on the extrinsic blood supply of the nerve, although one patient had ulnar nerve subluxation over the medial epicondyle of the elbow flexion. Soon after endoscopic release, all the patients displayed total recovery of elbow movements, except for one individual, who exhibited limited extension. To the best of our knowledge, this is the first study on endoscopic cubital tunnel release in leprosy patients, and these three smaller events do not render it unviable.

We believe that this minimally invasive surgical procedure, performed in a day clinic in leprosy-endemic countries, will be able to mitigate disabilities and deformities such as movable claw, rigid claw, atrophy of the first interosseous space, and resorption. There is no literature study to support this assertion, and our sample and follow-up times are small. However, its large-scale use as preventive surgery will certainly modify the outcome of the natural evolution of this disease.

Conclusion

The endoscopic release of the ulnar nerve at the elbow in leprosy neuritis entails a true and safe benefit for the patient, as an improvement in pain, sensitivity and strength.

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Conflict of Interests
The authors have no conflict of interests to declare.

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