Oberlin Technique for Restoring Elbow Flexion: technical note and functional outcome

Técnica Oberlin para Restauração da Flexão do Cotovelo: nota técnica e resultado funcional

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ABSTRACT

Introduction: the Oberlin technique, developed by Philippe Oberlin, involves the transfer of ulnar nerve motor fascicles to the musculocutaneous nerve to restore forearm flexion in patients with high brachial plexus injuries. This paper provides a detailed description of the surgical procedure, accompanied by step-by-step illustrations, aiming to assist in the training of neurosurgeons. Objective: the primary aim is to present a detailed procedural guide and assess its effectiveness by evaluating the functional outcomes of a patient cohort. Methods: to conduct this study, a retrospective analysis was performed with 10 patients who underwent the Oberlin technique between 2020 and 2022. The patients’ ages ranged from 18 to 40 years, and their progress was tracked for an average period of 14.8 months. Elbow flexion strength was assessed using the Medical Research Council (MRC) power grading system, and pain levels were evaluated using the Visual Analogue Scale (VAS). Additionally, injury cause, injury level, time gap between injury and surgery, and pre- and post-operative physical therapy were also analyzed. Results: among the 10 patients, 4 achieved excellent elbow flexion strength (M4), 4 achieved moderate strength (M2), and 1 patient demonstrated weak strength (M1). Encouragingly, all patients experienced an improvement in paresthesia, and reduction in pain levels was observed post-surgery. On average, the interval between injury and surgery was approximately 7.4 months, and all patients received pre- and post-operative physical therapy. Conclusion: in conclusion, the findings of this study demonstrate the effectiveness of the Oberlin technique in restoring elbow flexion strength and reducing pain for patients with brachial plexus injuries. The sample size was limited, therefore, no statistical analysis was performed, the results strongly indicate that early surgical intervention within a few months of the injury yields superior functional outcomes. The detailed procedural description provided in this article serves as a valuable resource for the training of young neurosurgeons during their medical residency.

Keywords: Oberlin technique; Peripheral nerve; Brachial plexus injuries

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RESUMO

Introdução: a técnica de Oberlin, desenvolvida por Philippe Oberlin, envolve a transferência de fascículos motores do nervo ulnar para o nervo musculocutânneo para restaurar a flexão do antebraço em pacientes com lesões altas do plexo braquial. Este artigo fornece uma descrição detalhada do procedimento cirúrgico, acompanhada de ilustrações passo-a-passo, com o objetivo de auxiliar na formação de neurocirurgiões. Objetivo: o objetivo principal é apresentar um guia com procedimentos detalhados e avaliar sua eficácia avaliando os resultados funcionais de uma coorte de pacientes. Métodos: para a realização deste estudo, foi realizada uma análise retrospectiva com 10 pacientes submetidos à técnica de Oberlin entre 2020 e 2022. A idade dos pacientes variou de 18 a 40 anos, e sua evolução foi acompanhada por um período médio de 14,8 meses. A força de flexão do cotovelo foi avaliada usando o sistema de classificação de potência do Medical Research Council (MRC) e os níveis de dor foram avaliados usando a Escala Visual Analógica (EVA). Além disso, a causa da lesão, o nível de lesão, o intervalo de tempo entre a lesão e a cirurgia e a fisioterapia pré e pós-operatória também foram analisados. Resultados: dos 10 pacientes, 4 alcançaram excelente recuperação de força de flexão do cotovelo (M4), 4 alcançaram força moderada (M2) e 1 paciente demonstrou força fraca (M1). De forma encorajadora, todos os pacientes apresentaram uma melhora na parestesia e a redução nos níveis de dor foi observada após a cirurgia. Em média, o intervalo entre a lesão e a cirurgia foi de aproximadamente 7,4 meses, e todos os pacientes receberam fisioterapia pré e pós-operatória. Conclusão: os achados deste estudo demonstram a eficácia da técnica de Oberlin na restauração da força de flexão do cotovelo e na redução da dor em pacientes com lesões do plexo braquial. O tamanho da amostra foi limitado, portanto, nenhuma análise estatística foi realizada, os resultados indicam fortemente que a intervenção cirúrgica precoce dentro de alguns meses após a lesão produz resultados funcionais superiores. A descrição detalhada do procedimento fornecida neste artigo serve como um recurso valioso para a formação de jovens neurocirurgiões durante sua residência médica.

Palavras-chave: Técnica de Oberlin; Nervo periférico; Trauma do plexo braquial

INTRODUCTION

The surgical technique of transferring motor fascicles of the ulnar nerve for innervation of the biceps muscle was described in the 1990s by the French surgeon, Philippe Oberlin, and this procedure is known as Oberlin Surgery. Initially the technique was tested in animals, consisting of a direct end-to-end transfer of motor branches from the ulnar nerve to the musculocutaneous nerve. Due to the good results, Oberlin started to apply the technique in humans, and observed great results. Since then, it has been widely used around the world as a treatment option for patients with high brachial plexus injuries.

The ulnar nerve is one of the main nerves of the arm and forearm, responsible for providing sensory and motor innervation to the hand and some muscles of the forearm. It originates from the brachial plexus, formed by the C8 and T1 nerve roots. After passing through the elbow, the ulnar nerve goes to the hand, where it divides into several nerve branches that innervate the intrinsic muscles of the hand, as well as the medial portion of the hand muscles. It also provides sensory innervation for a small region of skin on the lateral surface of the forearm.

Nerve transfers involve the transfer of an expendable, healthy nerve to a distal denervated nerve with a higher functional priority. The donor nerves must provide redundant function to avoid functional deficits and be synergistic to the recipient nerve to facilitate motor rehabilitation.

Currently, Oberlin's technique consists of transferring ulnar nerve motor fascicles, intended for the ulnar flexor carpi muscle, to the musculocutaneous nerve in order to recover forearm flexion.

It can be indicated in cases of severe musculocutaneous nerve damage in the arm and in upper brachial plexus injuries and can help to restore muscle function in the affected limb. Among the advantages of the technique are short distance to the denervated motor plates, anatomical proximity between donor and recipient, as well as size compatibility between the anastomosed segments.

Although there are many papers in the literature about Oberlin's technique, with numerous case series, there is a lack of detailed descriptions of the procedure, with well illustrated images and step-
by-step techniques, especially to help in the training of neurosurgeons during medical residency. This paper aims to discuss the technique in detail, as well as to illustrate the procedure step-by-step, and finally to analyze the results of a series of cases operated with this procedure.

METHODS

A retrospective study was made with patients who suffered brachial plexus trauma, resulting in loss of forearm flexion, and underwent surgery in which the Oberlin technique was used in an attempt to recover the movement.

Patients who were victims of obstetric trauma, patients who did not return for follow-up care, and patients in whom a nerve other than the ulnar was used as a donor for the musculocutaneous nerve were excluded from the study. In total, the study included 10 patients who underwent surgery between 2020 and 2022 and were followed-up, however, one was excluded as he did not return for follow-up appointments. On average, the follow-up time was 14.8 months.

For strength analysis, the Medical Research Council (MRC) power grading system was used in which M0 corresponds to the absence of muscle contraction, M1 flicker or trace of contraction, M2 movement exists but is not able to overcome gravity, M3 movement is able to overcome gravity, M4 movement is able to overcome submaximal resistance imposed by the examiner, and M5 when the movement is able to overcome the maximum resistance imposed by the examiner. To examine flexion strength, patients were asked to remain seated, with the trunk straight and stable.

The strength gain of M3 was considered good and M4 and M5 excellent, as classified by Terzis et al.\textsuperscript{11}.

To determine preoperative and postoperative pain, the Visual analogue scale (VAS) was used, in which pain is reported by the patient on a scale from 0 to 10, with 0 being no pain at all and 10 being the worst pain imaginable.

Besides strength, other variables analyzed were trauma mechanism, level of injury, pain and paresthesia before and after surgery, time between injury and surgery, and pre- and postoperative physical therapy.

The study was approved by the hospital’s ethics committee, and all patients agreed to provide their data for the study.

**Surgical procedure**

**Positioning and incision**

The patient is positioned in dorsal decubitus with the upper limb to be operated on positioned in abduction, exposure of the medial aspect of the arm. The incision should be 10-15 cm, between the middle and upper third of the medial side of the arm, below the pectoralis major muscle tendon (Figure 1).

**Soft-tissue dissection**

After dissection, identification and incision of the brachial fascia (Figures 2 and 3), we proceeded to dissect the deep planes in a blunt fashion, identifying the ulnar and median nerves, the basilic vein, and eventually the lateral cutaneous nerve of the forearm, which follows through to the forearm (Figure 4).

**Identifying the musculocutaneous nerve**

After separation of these structures, we proceed to the inferior displacement of them, to identify the medial intermuscular septum (Figure 5), incision and opening of it, and then to identify the biceps brachii muscle (Figure 6). Dissection of the biceps muscle fibers was performed for identification of the musculocutaneous nerve motor branch destined to this muscle, and then proceeded the dissection in retrograde until we identified...
the musculocutaneous nerve trunk, where it is divided into the motor branch for the brachial biceps muscle and a larger branch containing fibers for the brachial muscle and the sensitive portion of the nerve (Figure 7).

**Preparation of the donor segment**

After isolating the motor branch of the musculocutaneous nerve destined to the biceps, the ulnar nerve was dissected, the closest to the receptor, opening the epineurium and identifying the motor fascicles destined to the flexor carpi ulnaris muscle, tested with the help of nerve stimulation (Figure 8).

**Preparing the segments for anastomosis**

Then it was proceeded to section the ulnar donor segment as distally as possible, and then the Musculocutaneous muscle recipient segment as proximally as possible, ideally near its bifurcation, thus allowing a suture with tension-free approximation (Figure 9).

**End-to-end neurorrhaphy**

A neurorrhaphy (end-to-end) was performed between the fascicles of the ulnar nerve and the motor branch of the musculocutaneous muscle for the biceps with 9-0 nylon and fibrin glue. After the suture, the subcutaneous and skin was closed by layers (Figure 11).

**Postoperative follow-up**

After the procedure, the patient must remain with the upper limb immobilized for two weeks, starting motor physiotherapy after this period. Some degree of mild motor or sensory deficit in wrist flexion and forearm region is expected.
RESULTS

A total of 9 patients, operated between 2020 and 2022 were included in the study, all were male and the mean age was 30.7 years. Only two trauma mechanisms were identified, the main one being motorcycle accidents, corresponding to 88.8%, and physical aggression, 11.2%.

As for the level of the injuries, 7 of them occurred in the upper trunk, 1 in the lateral cord, and 1 in the roots of C5-C6. All patients had M0 strength after the accident. After surgery four were able to achieve M4 strength, four M2 and one M1.

Eight patients reported paresthesia after the accident, but all had improvement after surgery, and there was also improvement in
the pain level, with the mean value before surgery being 9 and after surgery decreasing to 4.

The average time between injury and surgery was 231 days (7.4 months), and all patients reported that they had performed physiotherapy before and after surgery.

**DISCUSSION**

In several studies, including this one, traffic accidents were the main cause of brachial plexus injuries, with the frequency varying among different countries, reaching 91% in the study conducted in Thailand by Songcharoen, 88% in this one done in Brazil, and 60% in the one done in Belgium by Dubuisson and Kline.

The relationship between strength recovery and age is still discussed in the literature, once some studies, like the ones conducted by Samardzic et al. did not find a statistically significant correlation between these two variables. Despite the fact that statistical analysis was not performed due to the limited number of patients, this relation was also observed in the present study, in which it was noted that the mean age of patients who had excellent strength recovery was higher than that of those who had not (39.5 x 26.2 years).

In Sharma et al. study, in which 18 people were divided into group A, formed by 10 patients between 18 and 40 years of age, and group B, formed by 7 patients over 40 years of age, a statistically significant difference in strength gain between the 2 groups was observed, with group A having a better result. Moreover, it is known that the reinnervation speed ranges from 1-2.5 mm per day, being lower the older the patient is.

Due to the limited number of patients, it was not possible to perform a statistical analysis of the data, however, we noticed strength gain in all patients, with 4 (44%) having significant gain (strength M4 or more).

The outcome found for strength gain, although the mean age of the patients (30.7 x 39.2 years) and the time between the accident and surgery (7.4 x 11.7 months) shorter in this study, was below the one found in the 10-case series done by Verdins and Kapickis, in which 90% of the patients achieved a strength gain of M4 or more.

Although the value was lower than in the series by Verdins and Kapickis, it was similar to that found in the series published by de Azevedo et al., in which 9 (50%) of 18 patients had M4 strength regain, and it was higher than the one found in the series with 49 patients published by Cho et al., in which 16 (41%) had M4 strength gain.

A possible reason for this difference is that the mean follow-up time in Verdins and Kapickis’ series was 43.6 months, significantly longer than the 14.8 months in this series and the 22.5 months in the Cho et al. series.

A variable that influences strength recovery is the time between the accident and the surgery, as shown by Liu et al., who found a statistically significant difference in strength gain between the group operated on before 4 months and after 4 months, with 96% of the first group having strength gain M3 or more, while in the second group this number was 43%. Some studies, such as the one by Jivan et al., suggested that surgery should be performed at an even shorter interval of 2 months.

These results were also seen in the systematic review made by Martin et al., which showed that approximately 90% of the patients operated on within 3 months had strength gains of M3 or higher, while in the group operated on after 12 months this number decreased to 35.7%. In addition, the group that was treated earlier had shorter recovery time.

The reason for earlier operated patients achieving better functional results is related to less fibrosis at the site of injury and the importance of neurotrophins produced by target tissues and Schwann cells, which are essential for neuron survival, as concluded by Carlstedt who showed in their study that up to half of the lower motor neurons die within 2 weeks after nerve root avulsions.

Although the best results are obtained in patients treated before 6 months, there are studies that show it is possible to recover strength even in patients operated on after this period. Of the 18 patients operated on 12 months after the accident by...
Khalifa et al., 10 managed to score M4 or higher. Verdis and Kapikis also had good results operating on 3 patients after 12 months, with 2 scoring M4 and 1 scoring M5.

The known contraindications for Oberlin surgery are: (1) patients with complete axonal injury, surgery is not recommended for patients with complete axonal injuries of the musculocutaneous nerve because in these cases, there are no nerve connections available for the ulnar nerve to connect to; (2) low brachial plexus lesions (involving the C7-C8-T1 roots); (3) advanced age, since in elderly patients, nerve regeneration may be slower and less effective, which may affect recovery after surgery; (4) concomitant neurological diseases when patients with concomitant neurological diseases, such as multiple sclerosis or diabetic neuropathy, may have less satisfactory results after Oberlin surgery; (5) circulatory problems, when patients with circulatory problems or impaired vascularization in the arm or hand area may have an increased risk of complications after Oberlin surgery.

CONCLUSION

The Oberlin technique is efficient in the recovery of forearm flexion, with the functional results of the surgery being associated with variables such as patient age and time between the injury and the surgery. Moreover, the surgery is also able to promote improvement in pain perception.

REFERENCES


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