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Clinical Article

Surgical Results of Selective Median Neurotomy for Wrist and Finger Spasticity

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Objective : This study aimed to evaluate the surgical outcomes of selective median neurotomy (SMN) for spastic wrist and fingers.
Methods : We studied 22 patients with wrist and finger spasticity refractory to optimal oral medication and physical therapy. The authors evaluated spasticity of the wrist and finger muscles by comparing preoperative states with postoperative states using the modified Ashworth scale (MAS). We checked patients for changes in pain according to the visual analog scale (VAS) and degree of satisfaction based on the VAS.
Results : The preoperative mean MAS score was 3.27±0.46 (mean±SD), and mean MAS scores at 3, 6, and 12 months after surgery were 1.82±0.5, 1.73±0.7, and 1.77±0.81 (mean±SD), respectively. On the last follow-up visit, the mean MAS score measured 1.64±0.9 (mean±SD). Wrist and finger spasticity was significantly decreased at 3, 6, and 12 months after the operation (p<0.01). The preoperative mean pain VAS score was 5.85±1.07 (mean±SD), and the mean pain VAS score on the last follow-up visit after surgery was 2.28±1.8 (mean±SD). Compared with the preoperative mean pain VAS score, postoperative mean pain VAS score was decreased significantly (p<0.01). On the basis of a VAS ranging from 0 to 100, the mean degree of patient satisfaction was 64.09±15.93 (mean±SD, range 30-90).
Conclusion : The authors propose SMN as a possible effective procedure in achieving useful, long-lasting tone and in gaining voluntary movements in spastic wrists and fingers with low morbidity rates.

Key Words : Median nerve · Surgical procedure · Muscle spasticity · Wrist · Fingers.

INTRODUCTION

Spasticity, caused by a lesion of the upper motor neuron pathway, develops due to loss of inhibition in the alpha motor neuron and gamma motor neuron. Spasticity results from a variety of causes, including a cerebrovascular accident (CVA), traumatic brain injury (TBI), cerebral palsy (CP), or multiple sclerosis (MS)[4]. Severe spasticity involving an upper limb disrupts the remaining motor function and restricts voluntary movement thereby limiting daily activity. Furthermore, it may cause severe pain, pressure sores, contraction of the joint, and deformity of the limb. Generalized non-operative treatments for spasticity include medical treatment, physical treatment, and botulinum toxin injections. However, if these treatments prove insufficient, physicians must consider more invasive neurosurgical operative treatments. Of these, selective peripheral neurotomy works effectively for some localized forms of spasticity. Most studies on the surgical treatment of spasticity have focused on the lower extremities, with very few studies examining spasticity of wrists and fingers[5,9]. We performed selective median neurotomy (SMN) on 22 patients with spasticity localized in the wrists and fingers. This study aimed to evaluate surgical outcomes of SMN for spastic wrist and fingers.

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MATERIALS AND METHODS

We studied 22 patients with spasticity of the wrists and fingers refractory to non-operative treatments. All patients underwent SMN between March 1999 and February 2008, including 15 male patients (68.18%) and 7 female patients (31.82%). The average age of the patients was 39.68 years (range 19-63 years). The mean follow-up duration was 39.64 months (range 14-93 months). Causes of the spasticity included CVA in 7 patients (31.82%), TBI in 7 patients (31.82%), CP in 7 patients (31.82%), and MS in 1 patient (1.54%) (Table 1). The patients had spasticity in other parts of the body, requiring micro-dorsal root entry zontomy (DREZotomy) and selective musculocutaneous neurotomy. In some cases, mainly caused by MS or CP, we could not identify the exact time of onset, but onset of such neurological disorders did not play a critical role in its treatment. The mean duration of spasticity lasted 101 months (range 19-367 months).

Table 1. Clinical characteristics in 22 patients with wrist and finger spasticity

Case No.	Age/Sex	Preop pain VAS	Last F/U pain VAS	Disease Origin & duration (Mo)	Preop MAS	Postop 3 Mo MAS*	Postop 6 Mo MAS†	Postop 12 Mo MAS‡	Last F/U MAS	F/U Duration (Mo)	VAS of Satisfaction§	Postop. Cx.	Preop DREZ-otomy
1	63/F	6	2	CVA (55)	4	1	1	1	1	56	90		
2	23/M	0	0	CVA (47)	3	2	2	2	2	24	70		
3	39/M	6	1	TBI (42)	3	2	1	1	1	69	70		
4	22/M	0	0	CP (254)	3	1	2	2	2	35	60		O
5	36/M	5	0	MS (86)	3	2	3	3	3	14	30	Wound infection	
6	31/M	0	0	CP (366)	4	2	2	2	2	44	50		
7	38/M	0	0	TBI (32)	4	3	3	3	3	27	40	Wound infection	
8	19/F	0	0	CP (217)	3	2	1	2	2	30	70		
9	58/F	4	1	CVA (40)	3	2	2	1	0	55	80		
10	29/M	0	0	CP (334)	3	2	2	2	2	26	60		
11	23/M	0	0	CP (265)	3	1	1	0	0	93	80		O
12	24/M	0	0	TBI (80)	3	2	2	1	1	35	80		
13	61/F	0	0	CVA (54)	3	2	1	2	1	37	70		
14	44/M	7	5	TBI (38)	4	2	3	3	3	19	40		
15	31/M	0	0	CP (352)	3	2	1	1	1	37	70		
16	27/M	0	0	TBI (19)	3	1	1	2	1	32	80		
17	32/F	0	0	CP (367)	3	2	2	2	2	29	60		
18	52/M	0	0	TBI (35)	3	2	2	3	3	40	60		
19	54/M	6	3	CVA (55)	4	2	2	2	2	25	70	Paresthesia	
20	57/M	0	0	CVA (46)	3	1	1	1	1	24	80		
21	59/F	0	0	CVA (30)	4	2	2	2	2	53	40	Dysesthesia	O
22	51/M	7	4	TBI (40)	3	2	1	1	1	68	60		

*p<0.01 compared with preop, †p<0.01 compared with preop, ‡p<0.01 compared with preop, §Degree of satisfaction based on a visual analog scale from 0 to 100. No. : number, Preop : preoperation, Postop : postoperation, Mo : month, MAS : modified Ashworth scale, F/U : follow-up, Cx : complication, CVA : cerebrovascular accident, TBI : traumatic brain injury, CP : cerebral palsy, MS : multiple sclerosis

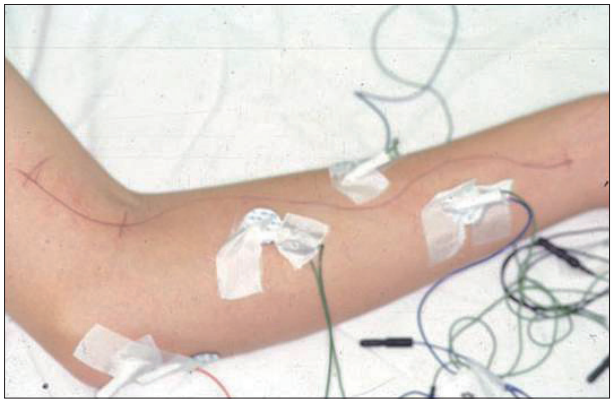

Fig. 1. Skin incision on the left forearm from the medial aspect of the biceps brachii at the level of the elbow.

We defined inclusion criteria as spasticity refractory to optimal oral medication and physical therapy, a positive temporary anesthetic nerve block test, and the absence of an active disease requiring other specific surgical or medical treatments. We performed temporary anesthetic nerve blocks to determine whether spontaneous deformities resulted from muscle spasticity alone or had an association with additional orthopedic complications. We also used the test to assess residual motor function of antagonist muscles, mainly extensor muscles[5]. Such blocks were obtained by injecting 3 mL of 0.25% bupivacaine in the vicinity of the median nerve trunks. We defined exclusion criteria as cooperative severe irreversible muscular contraction and osseous deformities, pure intrinsic hand muscle spasticity, negative temporary anesthetic nerve block test, and contraindication to surgery or anesthesia.

We induced general anesthesia without a long-acting muscle relaxant to detect motor responses elicited by bipolar electrical stimulation (Model OCS-1 Ojemann Cortical Stimulator, Radionics, Burlington, MA, USA) of motor branches during surgery. The skin incision begins 4 cm above the flexion line of the elbow. It passes down along the medial aspect of the biceps brachii, extends distally in the midline of the forearm, runs in a sinuous course to avoid skin retraction, and ends 5 cm above the wrist (Fig. 1). Thereafter, the median nerve lies medial to the brachial artery and is recognized at the elbow, deep under the lacertus fibrosus, which is cut. The pronator teres is retracted medially and distally so as to inspect its muscular branches. While pulling the flexor carpi radialis down and medially, this muscle is then retracted up and laterally. This allows us to find the muscular branches of the flexor carpi radialis and the flexor digitorum superficialis. Finally, the flexor digitorum superficialis is

retracted medially to find the branches of the deep flexor muscles, such as the flexor digitorum profundus and the flexor pollicis longus. After the dissection and identification of all motor branches by electrical stimulation, we marked those considered responsible for the harmful spasticity with colored tape (Fig. 2). According to the preoperative evaluation and subsequent program, about 50-80% of the isolated motor branches or fascicles are resected under the operating microscope.

A multidisciplinary team of neurosurgeons, physical therapists, and occupational therapists assessed patients and recorded the degrees of spasticity according to the MAS[1]. All of the patients were examined as outpatients at 3, 6, and 12 months after surgery, followed by a last follow-up visit. All follow-up visits took place in our hospital's department of rehabilitation and neurosurgery. We checked the patients for changes in pain according to the VAS and degree of satisfaction based on the VAS of the last follow-up visit.

This study compared preoperative and postoperative MAS scores using the Wilcoxon SPSS 17.0 test and considered a probability value of less than 0.05 as statistically significant.

RESULTS

The preoperative mean MAS score was 3.27±0.46 (mean±SD), and the mean MAS scores at 3, 6, and 12 months after surgery were 1.82±0.5, 1.73±0.7, and 1.77±0.81 (mean±SD), respectively. On the last follow-up visit, the mean MAS score measured 1.64±0.9 (mean±SD). Compared with the preoperative mean MAS score, postoperative MAS scores were decreased significantly (p<0.01) (Fig. 3). The Kaplan-Meier curves depict the diminution of the mean MAS score after surgery (Fig. 4). The mean pain VAS scores before the operation and on the last follow-up visit after surgery were 5.85±1.07 and 2.28±1.8 (mean±SD), respectively. Compared with the preoperative mean pain VAS score, the postoperative mean pain VAS score decreased significantly (p<0.01).

On the basis of a VAS ranging from 0 to 100, the mean degree of patient satisfaction was 64.09±15.93 (mean±SD, range 30-90). The patients had no recurrences during the follow-up period. We did, however, report two cases of postoperative wound infection, one case of paresthesia, and one case of dysesthesia. Patients with postoperative complications had lower satisfaction (p<0.01, p=0.005). Before SMN, three patients had a previous DREZotomy, and seven patients had preoperative pain. However, we found no statistical significance between DREZotomy and satisfaction (p=0.73) (Table 1).

DISCUSSION

Spasticity, characterized by a velocity-dependent increase in tonic stretch reflexes (i.e., muscle tone) with exaggerated tendon jerks, results from hyperexcitability of the stretch reflex[8]. Spasticity therapy aims to improve neurological function by decreasing the effects of spasticity. Widely used treatment modalities include oral medication, botulinum toxin injection, alcoholization, intrathecal baclofen infusion, microsurgical DREZotomy, and selective peripheral neurotomy-each of which has advantages and disadvantages. While simple to use, oral antispastic

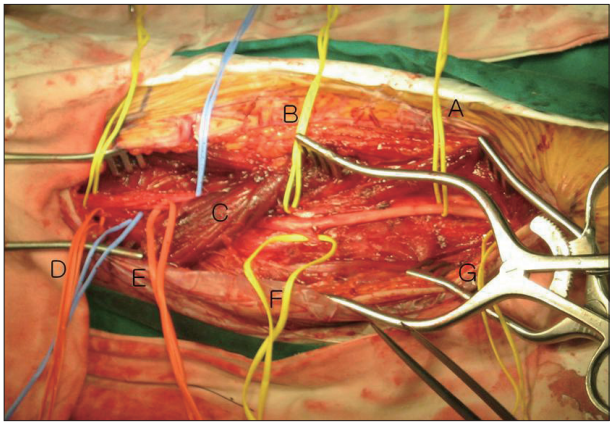

Fig. 2. Intraoperative finding of selective median neurotomy. The nerve retracted by A is the median nerve. Retracted by B is the anterior interosseous nerve, and C is the pronator teres muscle. Retracted by D, E, F, and G are the pronator teres nerve, flexor carpi radialis, flexor digitorum profundus, and flexor digitorum supercialis, respectively.

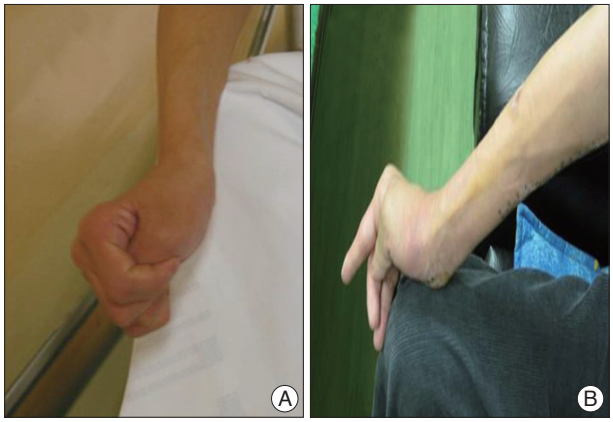

Fig. 3. Spasticity on the fingers and wrist. Postoperative status (B) showing improvement compared to preoperative status (A).

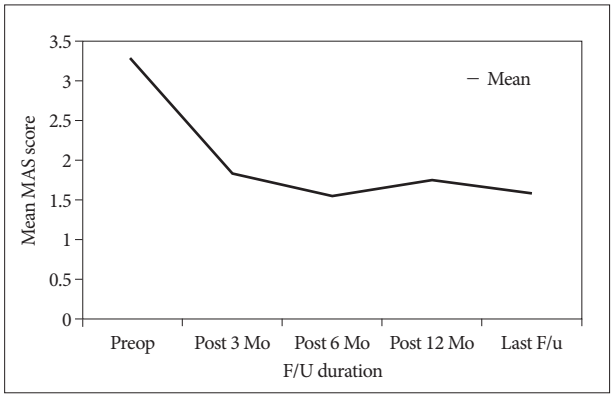

Fig. 4. Kaplan-Meier curves depicting diminution of the mean MAS score after SMN. MAS : modified Ashworth scale, SMN : selective median neurotomy, F/U : follow-up.

agents have a limited, short-term effect and frequently cause side effects such as confusion, sedation, dry mouth, and weakness[3]. Botulinum toxin injection, a less invasive approach than surgical treatment, does not require hospital admission and has almost no complications. However, the injection has the limitations of temporary effect and high cost. Furthermore, the injections become less effective with each application, and given the large molecular size of botulinum toxin, the treatment can cause an immune reaction[5]. Neurolysis by phenol and alcohol offers short procedural time at low cost, but its main complications include pain and inflammation, and it is not a selective treatment[11]. Effects of intrathecal baclofen therapy, a nondestructive and reversible procedure, mainly affect the lower limbs; the therapy can cause adverse reactions such as headaches, nausea, vomiting, excessive weakness, and transient urinary retention[2]. Posterior rhizotomy and DREZotomy are ineffective for local spasticity in the wrist and finger[6], with diffused effects when it affects all the extremities. Selective peripheral neurotomy works well for spasticity innervated by one or only a few nerves. It also has a permanent, satisfactory effect and a low morbidity rate[5,7,10]. While wrist and finger spasticity represents a common and severe problem, a limited number of published studies have dealt with this issue. In this study, we determined that SMN may offer a very effective treatment for spastic wrists and fingers. Mean MAS scores at 3, 6, and 12 months after surgery were improved, as with MAS score on the last follow-up visit (Fig. 4). Therefore, SMN provides long-term positive effects for spasticity of wrists and fingers. However, comprehensive vigorous exercise program is mandatory in improving motor power after postoperative decrement of spasticity. In addition, because tenotomy can be added during the SMN, it could have a positive effect on decrement of spasticity or improvement of satisfaction. Maarrawi et al.[5] also reported clinical improvement of spastic wrists and fingers from SPN, indicating that SPN leads to long-term satisfactory improvements in limb function and comfort by keeping sensory components and tenotomy on the pronator teres tendon. The current study included more cases receiving SMN than the Marraw et al. study. In addition, in four cases with contraction of pronator teres tendon, we simultaneously added Z-shaped tenotomy with SMN. These patients showed more significant improvement with satisfaction.

All of our patients had spasticity of the wrists and fingers refractory to any medications and they did not use medication before and after surgery. The patients were under rehabilitation program only after surgery.

In our series, there were four cases of postoperative complications : wound infections (2), paresthesia (1), and dysesthesia (1). Patients with complications showed less satisfaction than other patients, which may have resulted from postoperative wound care and minute damage to the sensory branches manipulated during the operation. There was no statistical significance between preoperative DREZotomy and postoperative satisfaction. However, given the small number of patients with preoperative DREZotomy, we cannot rely on such result. Further evaluation with more cases will provide more information in future.

This study has several limitations. First, we retrospectively evaluated the results of SMN, so we will need to pursue prospective, long-term studies and follow-up results. Furthermore, we could not evaluate the exact effect of SMN only, because our patients with multiple spasticities received SMN with other SPNs. Finally, the surgical results of cases of SMN including Z-shaped tenotomy are not reported here, and we will need more prospective data to validate the statistical significance.

CONCLUSION

We suggest that SMN is considered as a selective and effective procedure in achieving useful, long-lasting tone and in gaining voluntary movement in the spastic wrist and finger with low morbidity rates. However, a prospective study with more patients is required to fully validate this conclusion.

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