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Endoscopic carpal tunnel release and nerve conduction studies

Accepted: 23 July 2000 / Published online: 5 December 2000
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Abstract We investigated the outcome of endoscopic carpal tunnel release (ECTR) for patients with carpal tunnel syndrome (CTS) in comparison with the results of preoperative nerve conduction studies. The compound muscle action potential (CMAP) of the abductor pollicis brevis muscle (APB) and the second lumbrical muscle (L2) was recorded following median nerve stimulation at the wrist. A total of 38 hands in 35 patients were classified into four categories. Hands with a similarly prolonged distal motor latency for the APB and L2 were classified as type 1 ($n=25$), while those with a more prolonged distal motor latency for the APB than for the L2 (>0.7 ms) were classified as type 2 ($n=10$). Hands with a CMAP for the APB, but not L2, were classified as type 3 ($n=1$), and hands with no CMAP for either the APB or L2 were classified as type 4 ($n=2$). After ECTR, all of the type 1 and 2 hands were improved. Patients with type 3 and type 4 hands did not show satisfactory improvement, which may have been due to anatomical variation of the recurrent motor branch of the median nerve.

Résumé Nous avons examiné la réaction à des opérations de libération du canal carpien endoscopique (LCCE) chez des patients souffrant d'un syndrome du canal carpien (SCC), en utilisant les résultats d'une étude de conduction des nerfs (ECN) préopératoire. La réaction des potentiels de l'action des muscles composés (PAMC) de l'abducteur pollicis brevis (APB) et du second muscle lombrical (L2) fut enregistrée suivant une stimulation du nerf médian au poignet. Un total de 38 mains de 35 patients fut divisé en quatre catégories. Les mains avec SCC présentant une latence motrice distale prolongée similaire dans APB et L2, furent classées en tant que type 1 (25 mains). Celles avec SCC présentant

une latence motrice distale plus prolongée dans APB que dans le L2 (>0.7 ms), furent classées en tant que type 2 (10 mains), celles avec SCC dont les PAMC de APB seuls furent mis en lumière, furent classées en tant que type 3 (1 main), et celles avec SCC dont les PAMC à la fois de APB et L2 ne furent pas mis en lumière, furent classées en tant que type 4 (2 mains). Après la LCCE, toutes les mains des types 1 et 2 furent bien améliorées. Patients de types SCC 3 et 4 n'ont pas présenté une amélioration satisfaisante, par suite probablement d'une variation anatomique d'une branche motrice récurrente.

Introduction

It has been reported that endoscopic carpal tunnel release (ECTR) gives mostly satisfactory results in the treatment of carpal tunnel syndrome (CTS). There are some unsatisfactory results, however. We classified CTS according to the degree of involvement of the recurrent motor branch of the median nerve, based on nerve conduction velocity (NCV) studies, and report the results and the indications for ECTR in patients with CTS.

Patients and methods

We studied 38 hands in 35 patients, with symptoms of carpal tunnel syndrome by ECTR. There were five men and 30 women with a mean age of 66 years (31–83 years). The mean follow-up period was 8 months (3–32 months).

We measured the compound muscle action potential (CMAP) of abductor pollicis brevis (APB) and the second lumbrical muscle (L2) after stimulating the median nerve 1.5 cm proximal to the palmar crease of the wrist joint. In addition, the CMAPs of the interosseous muscles (INT) were elicited by stimulating the ulnar nerve so as to compare the nerve conduction velocity with that after median nerve stimulation [6, 9].

In a normal hand, the latency of the CMAPs for APB, L2 and INT are all equal (Fig. 1). The latency of APB and L2 was also recorded from 20 normal hands. The following values (2.5 SD above the mean) were thus considered abnormal: APB latency ≥ 4.12 ms, L2 latency ≥ 3.68 ms, and APB-L2 latency ≥ 0.69 ms.

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The CTS patients could then be classified into four types according to the pattern of their CMAP data:

1. Equal damage type: the CMAP latency for both the APB and L2 was equally prolonged, indicating that the two nerves were similarly affected (Fig. 2a).
2. APB-dominant type: the distal motor latency of the APB was more prolonged than that of the L2 (Fig. 2b).
3. Severe APB damage type: it was not possible to elicit the CMAP of the APB but that of L2 was elicited, indicating that the recurrent motor branch was significantly affected (Fig. 2c).
4. Equal damage type: neither the CMAP for APB nor L2 could be elicited (Fig. 2d).

We compared the CMAP latency before and after each operation.

Results

Type 1 (equal damage) hands accounted for two-thirds of the patients. All had a satisfactory outcome following ECTR (Fig. 3a). Patients with type 2 (APB-dominant) hands (one-fourth) also had a satisfactory outcome. The difference in latency between APB and L2 decreased, as activity in the recurrent branch of the median nerve improved (Fig. 3b,c). One patient had severe damage to APB (type 3), and only the L2 latency had improved at 10 months after operation. Severe and equal damage (type 4) was seen in two patients, one of whom showed improvement of APB and L2 latency at 3 months after operation; the other showed slight improvement of L2 latency only at 6 months after operation.

Fig. 1 Equal latency of the APB, L2, and INT in normal individuals

Fig. 2 **a** An equal damage type of hand shows similar latency of the APB and L2. **b** An APB-dominant type of hand shows a longer latency of the APB than that of L2. **c** A severe APB damage type of hand. The CMAP of the APB cannot be elicited. **d** A severe equal damage type of hand. The CMAP of both the APB and L2 cannot be elicited

Fig. 3 **a** In all cases of type 1 CTS, the latency of the APB was decreased after the operation. **b** In all cases of type 2 CTS, the latency of the APB was decreased after the operation. **c** In all cases

of type 2 CTS, the difference in latency between the APB and L2 was also decreased

Discussion

Sheen et al. reported that the CMAP of L2 could be elicited even in patients with very severe symptoms of CTS [10]. This can be interpreted as indicating that the nerve to L2 suffers neither axonotomesis nor conduction block when compared with the nerve to APB. However, Sunderland has reported that the different effects of compression may be due to variations in the course of the nerves to APB and L2 [12]. The recurrent motor branch is more affected in the carpal tunnel than the L2 nerve. However, due to anatomical variations of the recurrent branch, it may be compressed in the distal portion of the carpal tunnel [2, 7, 13]. Paralysis of APB may be the main presenting symptom in patients with CTS, suggesting that anatomical variations of the recurrent motor branch occur frequently, and that the motor branch to APB may only be affected [2, 4, 15]. Inadequate release of the transverse ligament may be the cause of a poor outcome after surgery [5, 11, 14]. Other factors contributing to a poor outcome may include compression of the recurrent branch at two sites in the distal portion of the carpal tunnel, or there may be adhesions around the nerve within the tunnel.

A good outcome may be expected after ECTR in the equal damage and the APB-dominant types. When the CMAP of APB cannot be elicited, compression of the recurrent branch or severe adhesion formation should be considered, and an open operation may be more suitable in these cases. After ECTR improvement was recognized in more than 95% of patients, based on nerve conduction studies; and such studies are clearly useful [1, 3, 8]. Further investigation is required to assess the indications for ECTR in type 3 and type 4 hands where the CMAP of APB is not elicited.

References

1. Agee JM, McCarroll HR Jr, Tortosa RD, Berry DA, Szabo RM, Peimer CA (1992) Endoscopic release of the carpal tunnel: a randomized prospective multicenter study. *J Hand Surg [Am]* 17:987-995
2. Bennett JB, Crouch CC (1982) Compression syndrome of the recurrent motor branch of the median nerve. *J Hand Surg [Am]* 7:407-409
3. Chow JC (1990) Endoscopic release of the carpal ligament for carpal tunnel syndrome: 22-month clinical result. *Arthroscopy* 6:288-296
4. Crowley B, Gschwind CR, Storey C (1998) Selective motor neuropathy of the median nerve caused by a ganglion in the carpal tunnel. *J Hand Surg [Br]* 23:611-612
5. Forman DL, Watson HK, Caulfield KA, Shenko J, Caputo AE, Ashmead D (1998) Persistent or recurrent carpal tunnel syndrome following prior endoscopic carpal tunnel release. *J Hand Surg [Am]* 23:1010-1014
6. Logigian EL, Busis NA, Berger AR, Bruyninckx F, Khalil N, Shahani BT, Young RR (1987) Lumbrical sparing in carpal tunnel syndrome: anatomic, physiologic, and diagnostic implications. *Neurology* 37:1499-1505
7. Mackinnon SE, Dellon AL (1988) Anatomic investigations of nerve at the wrist. I. Orientation of the motor fascicle of the median nerve in the carpal tunnel. *Ann Plast Surg* 21:32-35
8. Okutsu I, Ninomiya S, Takatori Y, Ugawa Y (1989) Endoscopic management of carpal tunnel syndrome. *Arthroscopy* 5:11-18
9. Preston DC, Logigian EL (1992) Lumbrical and interossei recording in carpal tunnel syndrome. *Muscle Nerve* 15:1253-1257
10. Sheen GL, Houser MK, Murray NM (1995) Lumbrical-interosseous latency comparison in the diagnosis of carpal tunnel syndrome. *Electroencephalogr Clin Neurophysiol* 97:285-289
11. Strasberg SR, Novak CB, Mackinnon SE, Murray JF (1994) Subjective and employment outcome following secondary carpal tunnel surgery. *Ann Plast Surg* 32:485-489
12. Sunderland S (1978) *Nerves and nerve injury*, 2nd edn. Churchill Livingstone, Edinburgh, pp 672-675
13. Tountas CP, Bihle DM, Macdonald CJ, Bergman RA (1987) Variations of the median nerve in the carpal tunnel. *J Hand Surg [Am]* 12:708-712
14. Varitimidis SE, Herndon JH, Sotereanos DG (1999) Failed endoscopic carpal tunnel release. Operative findings and results of open revision surgery. *J Hand Surg [Br]* 24:465-467
15. Yamanaka K, Horiuchi Y, Yabe Y (1994) Compression neuropathy of the motor branch of the median nerve due to an anomalous thenar muscle. *J Hand Surg [Br]* 19:711-712