TOUCH ALLODYNIA FOLLOWING ENDOSCOPIC (SINGLE PORTAL) OR OPEN DECOMPRESSION FOR CARPAL TUNNEL SYNDROME

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We investigated if single-portal endoscopic carpal tunnel decompression equipment (Agee®, 3M, USA) would cause increased carpal tunnel pressure during the release and if endoscopic release would reduce postoperative touch allodynia. Measurements on cadavers of the pressure produced during endoscopic release showed similar pressures to those produced during maximal range of motion. One hundred patients underwent either open or endoscopic decompressions. Twenty normal individuals served as controls. At 1 month after surgery both groups had significant allodynia compared with the controls, but at 3 months the endoscopic group had returned to normal though the open group was still significantly abnormal. The reported endoscopic release may therefore be of particular advantage to patients who would seriously be disadvantaged if postoperative touch allodynia should develop. The Agee® endoscope is unlikely to cause disturbance of the nerve function due to increased carpal pressure during the release.

Open surgical treatment of entrapment neuropathy of the median nerve in the carpal tunnel is one of the most frequent surgical procedures on hands (Phalen, 1970) and may result in significant postoperative touch allodynia of the operated hand which may persist for several months in many of the treated cases (Brown et al, 1993; Das and Brown, 1976; Povlsen and Tegnell, 1996). As single-portal endoscopic techniques have now been described which leave the palmar skin intact (Agee et al, 1995) or with a minimal palmar incision (Chow, 1990), it was therefore of interest to evaluate the natural history of postoperative allodynia following endoscopic carpal tunnel release. In order to eliminate any incision in the palm of the hand we chose to use the single-portal instrument (Agee®, 3M, USA; Agee et al, 1995). However, no previous studies have evaluated the extent of the increased pressure in the carpal tunnel during such an endoscopic release. As an acute increase in pressure on the median nerve can have a negative effect on the postoperative conduction ability, this matter is also of great interest. We therefore decided to evaluate the pressure increase in the carpal tunnel during the introduction of the endoscope compared with the pressure increase during maximal range of motion of the wrist. It was also the purpose of this study to evaluate patients who had surgical release (open or endoscopic) of the carpal ligament due to median nerve entrapment and follow these patients prospectively with measurements of touch allodynia over the thenar and the hypothenar eminences up to 3 months after surgery.

METHODS

Pressure measurements

Thirteen cadavers were used for measuring of pressure changes during maximal range of motion (flexion, extension, radial and ulnar deviation) and during the introduction of the endoscope in the carpal tunnel of the wrist. These pressure changes were measured with a transducer tipped fibreoptic catheter (Camino 420®; Crenshaw et al, 1990) inserted in the carpal tunnel and calibrated in neutral wrist position.

Touch allodynia measurements

This part of the study received approval from the ethical committee for human research and informed consent was obtained from each patient.

The diagnosis of carpal tunnel syndrome was made on the basis of pain, numbness, paraesthesia or weakness in the distribution of the median nerve at the wrist (Brown et al, 1993). The Tinel and Phalen provocative tests were used in the diagnosis (Gellman et al, 1986), and electrophysiological tests were used as described by Stevens (1987) when necessary to confirm the diagnosis. Patients who had other neurological or degenerative diseases at the time of surgery or during the postoperative period were excluded from the study. One hundred patients were included in the study: 50 patients were treated with the open technique and 50 patients were operated on by the endoscopic method. Both groups had the wrist immobilized in a plaster for 2 weeks postoperatively. Twenty normal controls served as references. The definition of touch allodynia according to the International Association for the Study of Pain was used in this study (Wahren, 1991). A previously described featherweight instrument was used to measure the pressure pain thresholds (Povlsen and Tegnell, 1996). The flat knob of the instrument was pressed against the point of interest, and the pressure generated was directly recorded on a scale ranging from 0 to 50 newton. The instrument can thus measure a linear change and at higher thresholds than with monofilaments. One test

Table 1—Carpal tunnel pressure changes (mmHg) during maximal range of motion and introduction of the endoscope

Pressure			Maximal range of motion				
	Flexion	Extension	Radial deviation			Ulnar deviation	
Mean(SD)	60(37)	122(124)	49(33)			33(16)	
			Endoscope depth				
	2 cm	2.5 cm	3 cm	3.5 cm	4 cm	4.5 cm	5 cm
Mean(SD)	14(17)	32(40)	35(49)	57(64)	56(53)	54(59)	59(66)

Table 2—Allodynia thresholds (newtons) 1 and 3 months after open or endoscopic carpal tunnel release

		Control	1 month		3 months	
			Open	Endoscopic	Open	Endoscopic
Thenar eminence	Mean(SD)	39(2.2)	21(8.4)	29(14.3)	22(10.3)	37(9.1)
Hypothenar eminence	Mean(SD)	38(3.7)	20(7.6)	31(13.5)	22(10.0)	36(10.1)

point on the thenar eminence and one on the hypothenar eminence were chosen, 2 cm distal to the distal wrist crease and 2 cm on either side of the palmar scar, or for the endoscopically treated patients, an imaginary line from the third web space to the distal wrist crease. With an increasing pressure starting from 0 the patient was instructed to indicate when the pain reached a value of 5 on a scale from 0 to 10, with 10 being unbearable. This was done three times on each test point and the mean value of the these measurements was used for further evaluation. The clinical results were compared statistically with a software computer package (InStat® 2.02A, GraphPad Software, USA) using Welch's alternate t-test which does not assume that the two populations have equal SDs. It results in a higher P-value and a wider confidence interval than the normal t-test. A significance level at $P \leqslant 0.005$ was adopted.

RESULTS

The maximal pressure generated in the carpal tunnel by the endoscope reached 162 mmHg, with a mean of 59 mmHg (Table 1). In comparison, the mean was 122 mmHg (Table 1) for full extension with one recording reaching 424 mmHg and the mean pressure generated by maximal flexion was 60 mmHg (Table 1). The mean pressure generated from radial deviation was 49 mmHg and ulnar deviation gave a mean of 33 mmHg (Table 1).

Of the 100 patients who had surgery, four patients who had endoscopic release did not want to attend the last follow-up, and although telephone contact revealed that they had no discomfort from the hand, they were excluded from the study. At the 1 month follow-up all patients were free from night pain and at 3 months all patients were free from clinical signs of median nerve entrapment. No patient in either group sustained a nerve injury.

Measurements of pain-generating pressure are shown in Table 2. P-values after statistical comparisons can be seen in Table 3.

DISCUSSION

The measurements revealed that the introduction of the endoscope in the carpal canal gave rise to a pressure increase of a mean of 59 mmHg. In the clinical situation, this would last for less than 5 minutes. Intravital microscopy has made it possible to analyse the intraneural blood flow during compression of peripheral nerves and has revealed that external pressure of the nerve in the range of 20 to 30 mmHg causes retardation of venous blood flow in the epineurium, and pressures of 60 to 80 mmHg cause a complete standstill in the compressed nerve segment (Ogato and Naito, 1986). It is therefore possible that the Agee® endoscope may cause a disruption in the circulation of the nerve during the procedure, but obviously it has no such effect if a 'bloodless field' is used. However, in order to cause a conduction block in the nerve, an interstitial pressure of at least 130 mmHg must be present. As some of our measurements showed values up to 162 mmHg, it could be argued that a conduction block might occur. However, for this to happen such a pressure would have to be maintained for several hours and the short period during the endoscopic release is far less than the pressures normally produced by an inflated tourniquet (Dahlin et al, 1989).

Table 3—P values of differences in alloydnia thresholds 1 and 3 months after open or endoscopic carpal tunnel release (thenar/hypothenar)

	1 month	3 months
Open vs control	0.0001/0.0001	0.0001/0.0001
Endoscopic vs control	0.0001/0.0019	NS
Open vs endoscopic	0.0037/0.0001	0.0001/0.0001

Compression of 200 to 400 mmHg can cause an epineural vessel injury and endoneural oedema; however, such changes are only seen if the compression lasts for more than 15 minutes (Rydevik and Lundborg, 1977). Pronounced changes in the structure of the myelinated fibres after short compression periods are only seen after pressures of 1000 mmHg (Ochoa et al, 1972), which was never recorded in this study.

Previous studies have revealed a high and prolonged incidence of postoperative touch allodynia over the thenar and hypothenar eminences for more than 3 months after open carpal tunnel decompression (Brown et al, 1993; Das and Brown, 1976; Povlsen and Tegnell, 1996). In this study we found that at 1 month after operations none of the patients in either group complained of unprovoked pain in the scar of the palm or wrist and none of the patients had loss of sensation or other signs of peripheral nerve injury. This indicates that no nerves were unintentionally injured with either method. The lack of complications in our endoscopic group in comparison with previous reports (Brown et al, 1993; Erdman, 1994; Kelly et al, 1994) may be due to the fact that our patients were all treated by the method described by Agee (Agee et al, 1995) and the other reports used the method described by Chow (1990). This suggests that there is a difference between the incidence of complications of the double and single-portal methods as these techniques are distinctly different. The method described by Chow requires a prolonged maximal extension of the wrist which in our cadaver model generated very high pressures in the carpal tunnel even before introduction of the endoscope. It is therefore possible that some of the complications following release with the Chow method which have been reported as incomplete nerve divisions could have been iatrogenic crush injuries.

At 1 month, significant postoperative touch allodynia was found in both groups after surgery compared with controls (Tables 2 and 3). Threshold measurements showed that the allodynia was significantly less in the endoscopic group compared with the open group (Tables 2 and 3). It is possible that the measurements of allodynia could have been reduced if we had used early early mobilization as advocated by Cook et al (1995). Three months after endoscopic surgery the threshold measurements were no longer significantly different from the control group (Tables 2 and 3). As the touch allodynia initially developed in both median and ulnar nerve innervated regions, and even in some endoscopic cases, we do not believe that the development of the allodynia was solely related to the incision of the skin. It may be a combined effect of reversible changes in the central processing of low threshold mechanoreceptive input both from the carpal ligament and the palmar skin (Torebjörk et al, 1992; Wahren, 1991).

The key finding in the present study is that single-portal endoscopic division of the carpal ligament, when used by surgeons with previous experience in arthros-copy and on carefully selected patients, can significantly reduce the development of postoperative touch allodynia and the pain thresholds return to normal significantly sooner than after an open decompression. The Agee endoscopic release may therefore be of particular advantage to patients with heavy loading of the palms, such as heavy labourers and chronic users of crutches, who would be seriously disadvantaged if postoperative touch allodynia should develop. The Agee® endoscope is unlikely to cause disruption of the nerve function due to increased carpal pressure during the release.

Acknowledgements

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