FREEZE-THAWED MUSCLE GRAFTING FOR PAINFUL CUTANEOUS NEUROMAS

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We used freeze-thawed muscle grafts to restore continuity to the affected nerve in 22 painful cutaneous neuromas. In 11 of the 15 neuromas in the upper limb, pain was partially or completely relieved; in six of these there was some recovery of distal sensation. Partial pain relief was achieved in only two of the seven neuromas in the lower limb. The difference is attributed to the longer grafts required in the lower limb.

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Painful neuromas are incapacitating, often substantially limiting function in an otherwise normal limb. Many methods of non-operative and operative treatment have been proposed (Whipple and Unsell 1988) but none is consistently successful (Sunderland 1991). Freeze-thawed muscle grafts (FTMG) have been found to allow axonal regeneration across defects in the rat sciatic nerve, the sheep femoral nerve (Glasby et al 1986; Glasby 1990) and the human digital nerve (Norris et al 1988).

We report the results of restoration of nerve continuity by FTMG as a method of relieving the pain of cutaneous neuromas.

PATIENTS AND METHODS

FTMG were used in 20 patients for 22 neuromas, 15 in the upper limb and 7 in the lower limb (Table I). There were 11 men and 9 women with a mean age of 41 years (20 to 83). All the nerves had been transected in open wounds. Surgical incisions were responsible in eight cases, four of them injuries to the superficial radial nerve. The interval from injury to operation ranged from 2 months to 9 years (mean 2 years). Three patients had undergone one previous surgical procedure for neuroma and one patient had had three procedures. The length of the FTMG ranged from 1 to 6 cm in the upper limb (mean 2.9) and 0.5 to 17 cm in the lower limb (mean 6.25). The patients were followed for 6 to 25 months after operation (mean 12).

Before operation all had complained of severe pain which interfered with work or normal daily activities. Those with upper-limb neuromas had severe loss of hand function even if the neuroma was not in the hand. Several had not responded to other methods of treatment including transcutaneous nerve stimulation and guanethidine blockade carried out in the Rehabilitation Unit of the Royal National Orthopaedic Hospital.

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Neurona</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper limb</td>
<td></td>
</tr>
<tr>
<td>Digital</td>
<td>8 (4 in 2 patients)</td>
</tr>
<tr>
<td>Superficial radial</td>
<td>5</td>
</tr>
<tr>
<td>Ulnar (sensory division)</td>
<td>1</td>
</tr>
<tr>
<td>Median (partial)</td>
<td>1</td>
</tr>
<tr>
<td>Lower limb</td>
<td></td>
</tr>
<tr>
<td>Medial plantar</td>
<td>2</td>
</tr>
<tr>
<td>Saphenous</td>
<td>2</td>
</tr>
<tr>
<td>Deep peroneal</td>
<td>1</td>
</tr>
<tr>
<td>Superficial peroneal</td>
<td>1</td>
</tr>
<tr>
<td>Sural</td>
<td>1</td>
</tr>
</tbody>
</table>

All patients experienced exquisite tenderness over the neuroma and 18 described constant and severe hyperaesthesia in the cutaneous territory of the injured nerve. The area of lost cutaneous sensation was mapped and any postoperative improvement was recorded.

All the operations were performed under general anaesthesia and a tourniquet. Exposure was adequate to display not only the suspected nerve but other possible sources of pain (neuromas were found within the lateral cutaneous nerve of the forearm in two patients with superficial radial neuromas). The neuroma was resected until a recognisable bundle pattern could be seen at the proximal level of section. If no distal stump could be found the case was not suitable for FTMG.

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Preparation of the muscle was by the technique of Glasby et al (1986). The block of muscle must be taken parallel to the fibres; this is possible in unipennate muscles such as palmaris longus and flexor carpi radialis in the upper limb and in gastrocnemius in the lower limb. The muscle graft measured at least 2.5 times the length of the nerve defect. It was wrapped in aluminium foil and immersed in liquid nitrogen until effervescence had ceased (30 to 45 sec). The package was then placed in sterile water at room temperature for at least three minutes. The graft always contracted to about half its fresh length and fragmentation was a frequent problem in grafts more than 3 cm long. It was cut to size, allowing 20% excess in length and diameter, and sutured into position (Fig. 1). Fibrin glue (Tisseel, Tissue Col Company, Immuno, Vienna, Austria) was dropped on to the suture line to form a surrounding cuff. Appropriate plaster-of-Paris splints were used to protect the repair for a minimum of three weeks. Early movement of the part was encouraged from the outset and a vigorous course of exercises and desensitisation was begun after removal of the splints.

RESULTS
Details are given in Table II. The relief of pain was better in the upper limb than in the lower limb. Relief of hyperaesthesia was also greater in the upper limb. Six of the 15 upper limbs with single neuromas regained protective sensation in the area of the repaired nerves.

DISCUSSION
A neuroma is a collection of regenerating axons and their supporting cells which are unable to reform their distal connections. In man, the formation of a neuroma is an inevitable response by the living neurone to axotomy and it cannot be prevented. Some sensory nerves are notoriously prone to form painful neuromas, particularly the superficial radial nerve, the medial cutaneous nerve of the forearm and the terminal branches of the sural nerves.

Early changes occur within the central nervous system including extension of the receptor fields of sensory neurones, spontaneous activity within the dorsal-root ganglion and substantia gelatinosa, and increased sensitivity of the axonal sprouts to catecholamine transmitters (Thomas and Ochoa 1993). Once established, these central changes are unlikely to respond to distal manipulation of the injured nerve. Many of these neuromas are iatrogenic and the techniques of treatment are so unsatisfactory that prevention is much better than cure.

Non-operative methods attempt to desensitise the painful neuroma by repeated nerve stimulation or percussion (Granville 1838). Long (1977) reported improvement in 33% of patients treated by transcutaneous nerve stimulation and Smith and Gomez (1970) described some relief in 70% of patients treated by multiple local injections of steroids. The patients referred to us who had had the latter treatment had found it indescribably painful.

Of the numerous operations described, simple excision of the neuroma usually fails (Laborde, Kalisman and Tsai 1982). Operations to relocate the injured nerve away from weight-bearing skin are more successful. Herndon, Eaton and Littler (1976) reported relief of pain in 63% of patients in whom a palmar cutaneous neuroma had been transposed. Dellon and McKinnon (1986) described the
well-known technique of excision of the neuroma and implantation of the proximal nerve into muscle; 81% of their 60 patients had a good or excellent outcome but the results were much worse for the palmar digital nerves. Of their patients with superficial radial neuroma, 88% improved after burying of the cut nerve into brachioradialis. Goldstein and Sturim (1985) reported success in 91% of palmar sensory neuromas implanted into bone. We have used all of these techniques except the last and have not been impressed by the results.

The method we describe restores continuity of the nerve and in six of 15 upper-limb neuromas, there was some restoration of sensation. Recovery was not achieved in the lower limb, probably because longer grafts had to be used. Graft length has a significant effect on the outcome of repair with muscle grafts as it does on that with nerve grafts, and with FTMG the maximum useful length is shorter. There is much circumstantial evidence to suggest that 5 cm is the maximum safe length to use in mixed nerves.

The authors chose not to respond to the request for a conflict of interest statement.

REFERENCES


