

## **Painful neuromata following upper limb amputation**

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### **Abstract**

Painful neuromata occurring after upper limb amputation are a significant cause of stump pain and limit the success of prosthetic training and use.

There is little information in the literature regarding incidence, consequences or outcomes of painful neuromata subsequent to upper limb amputation. This article reports an analysis of thirty-two consecutive upper limb amputees. Of these 25% had moderate-to-severe stump pain and clinical signs suggestive of neuromata.

All patients with neuromata were limited in their ability to use a prosthesis prior to surgery and following failure of conservative measures, were referred for surgical opinion. Six patients have undergone surgical management. The results of surgery, with respect to pain and prosthetic usage, are discussed.

### **Introduction**

Pain following upper limb amputation may for the patient concerned be a major problem, causing significant distress and hindering rehabilitation, a prosthetic training programme and subsequent prosthetic use. The pain experienced may be due to a painful phantom or secondary to local stump problems. Phantom pain is defined as persistent painful feeling of the presence of the body-part even after the part has been excised, whereas stump pain may be considered as pain arising from the remaining body-part. Jenson *et al.* (1983) reported the incidence of phantom and stump pain eight days after amputation, as 72% and 57%, respectively. By six months the incidence had decreased to 67% and 22%.

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The cause of stump pain are many and varied. They include — poor prosthetic fit; neuromata; joint problems (e.g. arthritis); sympathetic pain (e.g. reflex sympathetic dystrophy); referred pain; ischaemic pain; abnormal stump tissue (e.g. heterotrophic ossification or adherent scar) and skin problems such as dermatitis or ulceration (Davis, 1993). Formation of a neuroma following transection of a nerve is a normal occurrence (Omer, 1981). The neuroma may occasionally cause spontaneous pain, but usually unless it is trapped in scar tissue or located in a vulnerable position in the stump, it does not cause any significant problems. However, it is well-known that for some patients, neuromata are a major concern causing ongoing pain and inability to use a prosthesis successfully.

The diagnosis of neuroma is made clinically in most cases. The pain is usually localised and described as sharp, shooting or electric shock-like. It may be elicited by light tapping over the area (Tinel's sign) and may be felt to be transmitted proximally or distally along the transected nerve.

The initial management of painful neuromata is usually conservative with surgical intervention reserved for intractable cases. Conservative treatment consists of pharmacological management, e.g. anti-convulsants or antidepressants, local injection with steroid and desensitisation techniques including local percussion, massage, ultrasound or TENS.

Many surgical techniques have been attempted in the management of neuromata. They all involve attempts to either inhibit axonal growth or to reposition the neuroma or residual nerve away from the noxious stimuli. Inhibition of axonal growth has been attempted through such techniques as chemical treatment, ligation, cauterization, capping the nerve with

an inert material as well as nerve-to-nerve repair grafting techniques. Repositioning may involve excision and retraction, implantation into soft tissue, muscle, bone or vascular structures or en bloc translocation away from the stimulus (Whipple, 1988).

Barbera and Albert-Pamplo (1993), reported twenty-two cases of neuromata in lower limb amputees, who were treated with the technique of centrocenral anastomosis. This involves the end-to-end connection of paired fascicular groups of the proximal stump of the severed nerve across interposed autologous nerve grafts. The aim was to prevent neuroma formation by allowing the nerve fibres to regenerate in a physiological environment (the autologous nerve graft). All of these patients had been unable to use a prosthesis prior to surgery and conservative measures had failed in all cases. At one year follow-up the typical neuroma pain had disappeared in all cases, but there was residual diffuse pain in four patients. Wood and Mudge (1987) treated five patients with intractable neuroma pain by resecting the neuroma and anastomosing the nerve to another nerve and burying it under the muscles of the forearm. Patients reported a 80-90% reduction in pain. Martini and Fromm (1989) treated sixty-eight painful neuromas in thirty-six patients by shortening single nerve fascicles, pulling the epineurium forward to cover them and sealing with tissue glue. At an average follow-up of seventeen months, all but three of the patients were improved or pain-free. Whilst the literature details extensively the surgical management of painful neuromata, there is little information regarding either the incidence in upper limb amputation or the influence of surgery on the ability to use the prosthesis.

The aim of this study was to find the incidence of painful neuromata in upper limb amputees, the rate of referral for surgical management and the effect of the neuromata and subsequent surgery on pain levels and prosthetic usage.

#### Methods

The study involved the analysis of the medical records of thirty-two consecutive patients with upper limb amputation, who underwent rehabilitation at the Royal South Sydney and Prince Henry Hospitals between 1991 and 1995, to identify those who had

painful neuromata. All patients had been managed by the same rehabilitation specialist (one of the authors) at the time of their initial rehabilitation programme and those with neuromata diagnosed by clinical examination. The records of all thirty-two patients were reviewed to obtain details of demographics, severity of pain and rate of referral for surgical opinion and those patients with painful neuromata further surveyed using a questionnaire.

The questionnaire focused on the occurrence of stump pain — before, immediately after surgery (within the first month), at the time of follow-up and on the degree to which a prosthesis could be used before and following neuroma surgery. Pain levels were measured using a visual analogue scale, as was the patient's overall satisfaction with the results of the surgical procedure.

Prince Henry Hospital is the main tertiary referral centre for upper limb amputation in the State of New South Wales and as such manages patients from all over the State. For this reason not all patients were available for personal interview, but where possible this was done. In other cases a telephone interview was conducted. The surgical technique used and the number of neuromas treated in each patient was obtained by reviewing the surgical record.

#### Results

Thirty-two patients underwent a rehabilitation and prosthetic programme for upper limb amputation during the study period. Demographic details of the group are displayed in Table 1 and Figure 1 shows the age distribution of the group.

Table 1. Demographic details of upper limb amputees treated at RSSH and PHH between 1991 and 1995

Mean age	35 (range 15-78)	
Sex	29 male/3 female	
Level of amputation		
	trans-radial	11
	trans-humeral	16
	partial hand	5
<b>TOTAL:</b>		<b>32</b>
Cause of amputation		
	trauma	27
	carcinoma	4
	infection	1
<b>TOTAL:</b>		<b>32</b>

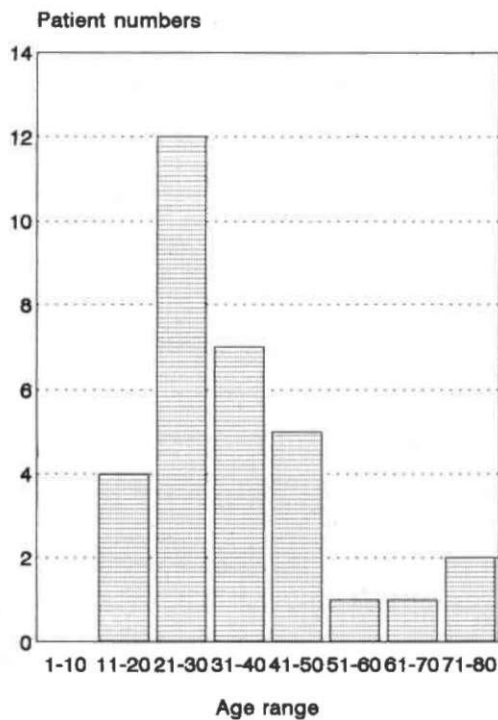


Fig. 1. Age distribution of upper limbs amputees

#### Pain

Of the thirty-two patients — twenty reported some degree of stump pain, seven reported mild pain, seven moderate and six severe pain. Twenty-five patients reported a painful phantom, with six mild, eleven moderate and eight severe. Eight patients (25%) had clinical signs suggestive of neuromata and all of these reported moderate to severe stump pain. All the eight patients identified with painful neuromata were contacted and the questionnaire administered either in person or by telephone. The demographic details of those eight patients are shown in Table 2.

#### Onset of stump pain

The time between amputation and the onset of the stump pain characteristic of neuromata is shown in Figure 2. The average time was 11.6 weeks with a range of one to thirty-six weeks.

#### Referral for surgical opinion

All eight patients had undergone conservative management techniques to control the neuroma pain including pharmacological treatment, desensitisation and in some cases, local

Table 2. Demographic details of upper limb amputees with painful neuromata

Mean age	31 (range 21-56)	
Sex	all male	
Occupation (prior to amputation)	butcher	2
	farmer	2
	process worker	2
	miner	1
	teacher	1
<b>TOTAL:</b>		<b>8</b>
Level of amputation	trans-humeral	4
	trans-radial	3
	partial hand	1
<b>TOTAL:</b>		<b>8</b>
Cause of amputation	all traumatic	

injection. All were subsequently referred for surgical opinion. Several different surgeons were involved during the period of the study.

#### Time to follow-up

The average time from amputation to follow-up was 11.5 months with a range from one month to forty-five months. At the time of

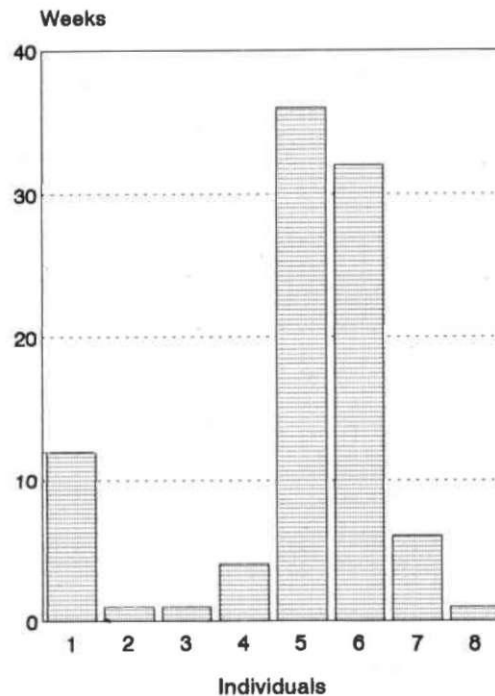


Fig. 2. Time onset of pain

follow-up six of the eight patients had undergone surgical procedures and two were awaiting surgery.

#### *Surgical intervention*

The average time from amputation to surgical intervention was eleven months with a range of three to twenty-two months. A variety of surgical procedures was employed. In two cases, the neuromata were divided and the nerve buried in soft tissue as proximally as possible. In one case after excision, the nerve was buried in the wrist and proximal metacarpals, then in a further instance the terminal nerve was implanted into a vein. In one other case the neuroma was simply excised.

#### *Number of neuromata*

A total of nine neuromata were surgically treated in the six patients. The painful neuroma occurred on the ulnar nerve in three cases, on the median in five cases and on the radial in one case. Three patients had neuromata treated on two nerves.

#### *Pain in patients with neuromata*

In the amputees with neuromata, pain levels were further investigated using a visual analogue scale. Patients were asked to identify the degree of pain experienced on a scale of zero to ten where zero was no pain and ten was the worst pain they could imagine. There were asked the same question regarding the pain — before surgery, immediately after surgery (within one month) and at the time of follow-up. For one patient the time of follow-up was within one month of neuroma surgery. Stump and phantom pain were investigated separately.

Results revealed that the average Visual Analogue Scale (VAS) score for phantom pain was 5.8 and for stump pain 7.4 prior to surgery. The average reduction in pain immediately post-operatively was 0.6 for phantom pain and 4.6 for stump pain. At the time of follow-up, the reduction was 0.6 and 1.5 respectively. As would be expected, the results indicate that there was little effect of neuroma surgery on

phantom pain. There was a reduction in the severity of stump pain immediately, but this was not maintained by the time of follow-up and there was large variability in response to surgery. Several patients had large reductions in pain levels which were maintained at the time of follow-up. However, several reported little, if any, reduction and one patient had a good result immediately but, by the time of follow-up, pain had returned to pre-surgery levels.

#### *Prosthetic use*

Patients were asked to indicate the degree to which they were able to use their prosthesis prior to and following surgery. Constant use, was defined as use for six hours a day, five days a week. Occasional use, as anything less than this.

Results indicated that six of the patients were never able to use the prosthesis prior to surgery, whilst two were occasional users. Following neuroma surgery, two of the non-users remained non-users. One of these was due to continuing severe stump pain and the other due to an increase in phantom pain. This patient had excellent reduction in stump pain post-surgery. One patient, who had good reduction in pain, was able to use the prosthesis occasionally following surgery. Another patient stated that the prosthesis was used constantly immediately after surgery, but unfortunately the pain returned by the time of follow-up and prosthetic use again became impossible.

The patient with the partial hand amputation had two prostheses. The first, a cosmetic glove, was used constantly prior to surgery despite considerable pain and with much improved comfort following the surgery. A functional orthotic device was used occasionally prior to surgery and more often following surgery. One patient did not have the opportunity to re-use prosthesis at the time of follow-up.

#### *Outcome*

As a measure of overall outcome, patients were asked to indicate their satisfaction with the surgical procedure, using a visual analogue

Table 3. VAS scores for patient satisfaction with outcome following surgical intervention for painful neuromata in upper limb amputees

Patient	1	2	3	4	5	6	7	8	Av.
VAS score	1	5	10	5	–	8.5	8	–	6.25

scale. The average VAS score was 6.25, but again there was wide fluctuation in individual results (Table 3).

### Discussion

Whilst painful neuromata are known to occur and to influence prosthetic usage following upper limb amputation, this study revealed a higher than expected incidence. Eight of thirty-two patients (25%) were found to have clinical signs indicative of neuroma and all of the patients described moderate-to-severe stump pain. The demographic features of this group of patients was an accurate reflection of upper limb amputees in general. They tended to be younger males in "at risk" occupations, in whom trauma was the cause of the amputation.

The onset of the pain in this group of patients was highly variable with not all patients experiencing pain immediately after amputation. Several did not experience the characteristic pain until months later. The reason for this is unclear. However, it can be hypothesised that in these cases it is not until the neuroma becomes large, scar tissue contracts or other soft tissue/bony structures intervene, that enough pressure or irritation is caused around the neuroma to induce pain. It is also likely that the pressure caused with the first attempts at wearing a prosthesis, may be the trigger which activates an otherwise non-painful neuroma.

The relatively long period between amputation and surgical intervention — eleven months, is not unexpected as in many cases pain occurring soon after amputation resolves spontaneously or with pharmacological and/or conservative management. Surgery is usually reserved for cases of ongoing pain, which has been unresponsive to these measures. In particular it is used when the pain interferes with the rehabilitation programme, prosthetic usage or lifestyle in general. However, as was the case for several patients in this study, an argument can be made for earlier surgery where the diagnosis of a neuroma is clear-cut with pain being severe and disabling, in an attempt to avoid ongoing difficulties.

All patients were eventually referred for surgical opinion and in all cases an attempt at surgical remediation felt to be appropriate. Six patients had undergone a variety of procedures. The variety of surgical procedures employed by

different surgeons in this study would seem to confirm review of the current literature which indicates that no one technique has been proven to be more successful than any other. The studies by Barbera and Albert-Pamplo (1993), Martini and Fromm (1989), Wood and Mudge (1987) all showed significant reduction in pain. It is not possible, from this study, to make any meaningful comments on the success of any particular surgical techniques, but further investigation of one particular procedure or a comparison of procedures, performed by the same surgeon, would be informative.

All the patients with painful neuromata in this study reported moderate-to-severe pain in the stump prior to surgery with VAS scores ranging from 5 to 10. Whilst there was an overall reduction in the VAS score immediately post-operatively, this was not uniform. Several patients reported little change in pain levels. The good immediate response was maintained at the time of follow-up for several patients. At least two reported further increases in pain and one of these to pre-operative levels. In the instances where pain is unaffected or recurs, the patient should be carefully re-examined to exclude complicating or intervening causes of pain and at some point, a decision made to attempt a further surgical procedure.

Surgery for pain neuromata was found to have little influence on the occurrence of phantom pain in this group of patients, either immediately or at follow-up. Current theories of the aetiology of phantom pain are theories of either initiation or magnification. The first is thought to involve plasticity in the dorsal horn neurons, induced by damage to peripheral nerves, which causes the neurons to generate pain impulses that are directed rostrally (Dubner, 1991). The second is that, due to the loss of the body-part, there is lack of inhibition of peripheral inhibitory afferent input which leads to pain magnification (Melzac, 1971).

There is no doubt that, for the patients in this study, the pain produced by the neuromata severely limited prosthetic use prior to surgery. Six of the eight patients were unable to use their prosthesis at all, whilst two used them occasionally. All patients indicated that pain was the dominant reason for lack of prosthetic use. Post-operatively at least three patients used their prosthesis more frequently, although only one of these reached constant usage and in this

case, the pain subsequently recurred again causing difficulty with use. Two patients remained unable to use their prostheses at all, but in one of these cases it was not stump pain, but the emergence of severe phantom pain which was the cause.

This latter case illustrates the difficulty in analysis of prosthetic use following upper limb amputation. Studies have previously shown that the overall rate of usage is low and that prostheses are discarded or not used at all for a variety of reasons. Jones and Davidson (1995), in a recent review of forty-one upper limb amputees, found a rate of prosthetic use for more than eight hours per day by only 37% and occasional use by 18.5%. Common reasons for lack of prosthetic use include — insufficient cosmesis; the cumbersome nature of the prosthesis; the sweating and irritation produced by use; and reduction rather than improvement, in functional abilities.

The results of the outcome assessment reflected other results clearly, in that there was a spectrum that ranged from highly-satisfied to totally dissatisfied. All patients who reported a high level of satisfaction, had excellent reduction in pain following surgery. The most dissatisfied patient had no reduction in pain. Interestingly, only one of those who were highly satisfied, described constant prosthetic use following surgery and even the patient, who was unable to commence prosthetic use, due to intercurrent phantom pain, was highly satisfied with the diminution of the stump pain. This perhaps, emphasises that at least from the patients point-of-view, the endpoints of surgery for painful neuromata, are pain reduction primarily and only secondarily, prosthetic usage.

### Conclusion

This study has demonstrated a rate of 25% for painful neuromata following upper limb amputation. This rate was higher than expected and indicates that neuromata may be a more significant cause of disabling stump pain than has been previously thought.

All patients suffered from moderate-to-severe stump pain and most were completely unable to use their prosthesis prior to surgery. All patients were referred for surgical opinion and a variety of surgical procedures was performed.

Analysis of pain reduction and prosthetic use

was somewhat hampered by the differing surgeons and techniques involved, but overall there appeared to be a reduction of pain in the first month following surgery. However, there was some loss of this immediate reduction by the time of follow-up. As with pain reduction, analysis of prosthetic usage following surgery, revealed wide variability. This was dependent primarily, but not only, on reduced pain levels following surgery.

This study involves only a small number of upper limb amputees and further studies involving larger groups of patients, should be undertaken. The problem of the most appropriate surgical technique is difficult, but ideally one surgeon performing one type of procedure, or comparing it to an alternative, would allow more accurate assessment of pain reduction and subsequent prosthetic usage.

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