

# Coaptation of Cutaneous Nerves for Intractable Stump Pain and Phantom Limb Pain after Upper Limb Amputation

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## ABSTRACT

**Background:** Various surgical treatments have been advocated for stump pain and phantom limb pain after limb amputation but the most effective is unknown. We report a case of intractable stump pain and phantom limb pain of the upper limb, which was successfully treated by end-to-end coaptation of the cutaneous nerves after multimodal treatment failures.

**Case description:** A 39-year-old man was referred to our department with a history of severe stump neuroma-related pain and phantom limb pain of his right upper limb. He had undergone multiple treatments over 26 years including medication, nerve blocks, and repeated surgeries. None had been successful for relief of pain. The clinical assessment showed a point of marked tenderness around the medial stump of the upper arm. Ultrasound-guided peripheral infiltration of local anaesthetic around the medial stump produced significant relief of his pain. Exploration around the medial limb stump revealed two stump neuromas of the medial cutaneous nerves of the forearm. Both stump neuromas were resected, and their stumps were coapted to each other. After 4 years, he was completely relieved of his pain and without any sensory deficit.

**Conclusion:** Successful nerve coaptations for painful stump neuromas of the upper limb are reported rarely. This case suggests this method can be helpful. The patient burden was minimal because it involved the resection and coaptation of the two neuromas. This method should be encouraged for cases of intractable stump-related pain in the upper limb.

**Keywords:** Cutaneous nerve, End-to-end coaptation, Phantom limb pain, Stump neuroma, Stump pain.

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## BACKGROUND

Multimodal treatments for neuroma-related stump pain and phantom limb pain after limb amputations have been reported. In recent years, nonsurgical treatments such as neuropathic pain medications, nerve blocks,<sup>1</sup> or radiofrequency ablation<sup>2,3</sup> have been selected as the initial treatment. However, those treatments may not successfully relieve pain<sup>4</sup> and some patients require surgical intervention. There are various kinds of surgeries for neuroma-related stump pain: simple ligation,<sup>5</sup> capping the nerve stump,<sup>6</sup> centrocentral nerve coaptation,<sup>7-10</sup> and implantation of the nerve stump into the surrounding vascularized tissue.<sup>11-24</sup> However, the failure rate of surgical intervention of up to 65% has been reported.<sup>21-24</sup> Among various surgical treatments, we assume that nerve-to-nerve coaptation creates an ideal physiologic state and can prevent recurrence of the neuroma because the stump of the nerve would be sealed by the healthy epineurium and can recover in a normal environment.

We report a case of successful surgical treatment of intractable neuroma-related stump pain and phantom limb pain after upper limb amputation by resecting the two stump neuromas of medial cutaneous nerves of the forearm followed by end-to-end nerve coaptation. This surgery has been applied rarely in the upper limb. Surgical details and outcomes of this method are presented.

## CASE DESCRIPTION

A 39-year-old man with a history of severe stump pain and phantom limb pain of his right upper limb for over 26 years was referred to our department. He had undergone a right below-elbow amputation when he was 13 years old because of severe avulsion injury of his forearm. Six years later, he developed phantom limb pain and stump

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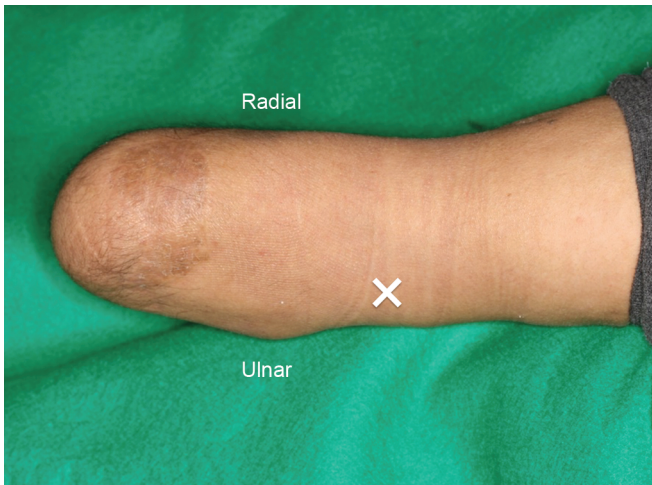
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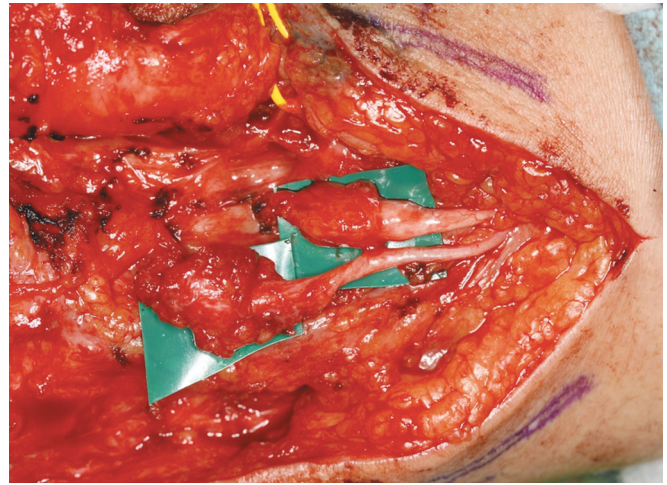
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pain. The pain was diagnosed as neuroma-related pain and he underwent excision of the stump neuromas of the radial, ulnar, and median nerve three times. Despite repeated surgeries, the pain was only relieved partially and temporarily and became more intense after the surgeries. After the last surgery, the pain was treated by nerve blocks but the effect transient.

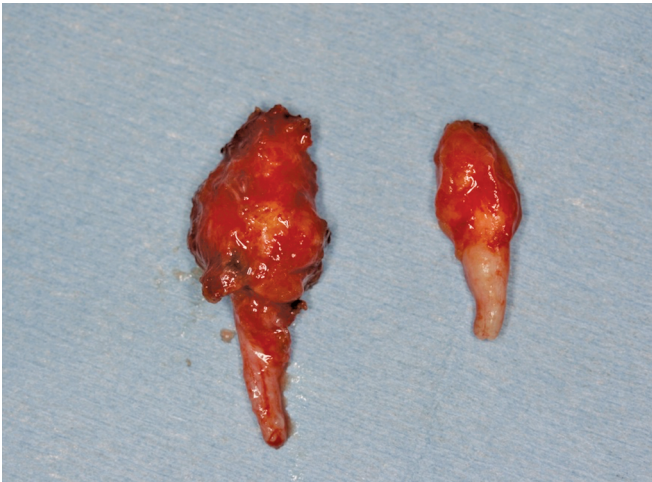
At first assessment in our unit, he presented with increased and intolerable phantom pain and stump pain. He described the pain as stabbing with an intensity of 9/10 on the visual analogue scale. The pain lasted for a few minutes and reoccurred at 30-60 minute intervals. It was accentuated when pressure was applied to the medial side of the limb stump (Fig. 1) and the Tinel's sign was confirmed by pressing on the point. He experienced phantom pain and sensations on his small and ring fingers. Oral administration of pregabalin, opioids, and non-steroidal anti-inflammatory drugs



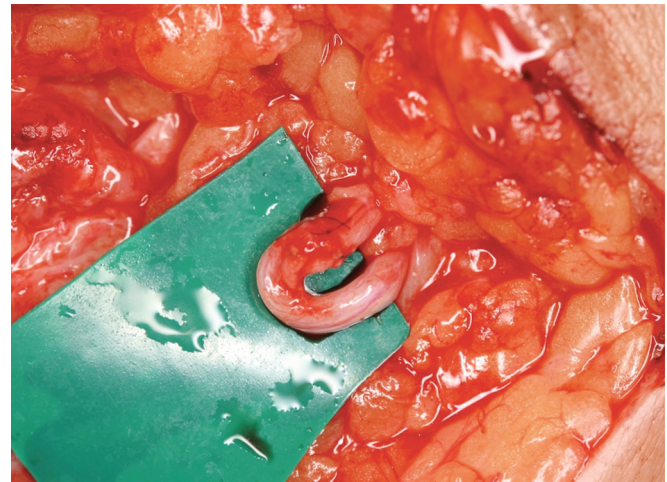
**Fig. 1:** Appearance of the right upper extremity and the point of severe stabbing pain (marked as a white cross)



**Fig. 2:** Stump neuromas of the medial cutaneous nerve of the forearm with severe scarring



**Fig. 3:** Resected stump neuromas of the medial cutaneous nerve of forearm



**Fig 4:** End-to-end coaptation after resection of the stump neuromas

and a stellate ganglion block injection were ineffective. He could no longer use his upper limb prosthesis because of this severe stump pain.

An ultrasound examination showed that the stump of the ulnar nerve was around the point of pressure-induced pain. Infiltration of local anaesthetic of 1% lidocaine around the ulnar nerve stump with ultrasound guidance produced significant pain relief. This suggested that the pain was possibly related to the problem around the stump of the ulnar nerve.

Surgical exploration around the medial side of the upper limb was performed. Two large stump neuromas originating from the medial cutaneous nerve of the forearm were found (Fig. 2). The tight scar tissue had formed around the stump neuromas making dissection very difficult. The nerve stump of the ulnar nerve was found close to the stump neuromas of the medial cutaneous nerve of the forearm but had not developed into a stump neuroma. The nerve stumps of median and radial nerves were also explored but none had developed neuromas and all were free of scarring. Neuromas that had developed in the stumps of the medial cutaneous nerves of the forearm were considered to be the main cause of his pain and both resected (Fig. 3). After confirming that

the cut ends of the medial cutaneous nerves were healthy and with clear fascicles and no scar tissue, the ends were coapted together in an end-to-end fashion using #9-0 nylon without any tension (Fig. 4).

After surgery, the patient's stump pain and phantom pain diminished dramatically. Four years after the surgery, the patient has only occasional episodes of stump or phantom pain with symptoms only when it rained, describing the intensity of pain as 3/10 on the visual analogue scale and with a duration of only a few minutes. There was no longer a need for oral analgesics or nerve blocks and the patient has been using his upper limb prosthesis without problems.

## DISCUSSION

Stump neuroma-related pain occurs in 13–32% of patients after limb amputation.<sup>25–28</sup> The incidence of phantom limb pain is reportedly higher, up to 80% after amputation.<sup>29,30</sup> Amputation stump pain should be distinguished from phantom limb pain but this is difficult to do sometimes.<sup>31</sup> There is growing consensus that the two types of pain are caused by a problem of not only the peripheral nerve but also the central nervous system and they are intimately related to each other. The exact aetiology of neuroma-related stump pain and

phantom limb pain is still poorly understood and their treatments are controversial.

Various surgical interventions for neuroma-related pain and phantom limb pain have been described, which differ in the way the stump of the responsible nerve is managed. In most cases, the stump neuroma is resected and the cut end of the nerve is coapted to the well-vascularized tissues. The methods of coaptation of the nerve stump vary: to the same nerve (end-to-side or end-to-end anastomosis after nerve split),<sup>7,32</sup> to a concomitant nerve,<sup>8–10,31,33</sup> to muscle,<sup>4,12,14,18,21,22,24</sup> vein,<sup>13,16,22</sup> fat,<sup>19,20</sup> or to bone.<sup>11,15,17</sup> The implantation of the stump into the muscle is the most commonly selected procedure in clinical practice.<sup>4</sup> However, the results of muscle implantation are variable and the success rate ranges from 35 to 90%.<sup>21–24,34</sup> In addition, it is reported that muscle implantation does not prevent neuroma formation but results in the formation of a “non-classical neuroma”; this has no interaction with the muscle fibres and contains small regenerating units of immature nerve fibres in a connective tissue-poor environment.<sup>21</sup> Thus, the nerve stump implanted into the muscle is in a nonphysiologic state and harmful scarring, irritation and inflammation, and, we suspect, neuroma recurrence may occur.

In reconstructive plastic surgery, there is a principle that “one should reconstruct like tissues if at all possible.”<sup>32</sup> Ideally, the nerve stump should be coapted to the nerve. In contrast to muscle implantation, the nerve stump can be sealed by the regenerated epineurium in nerve-to-nerve coaptation and thus returned to a physiologic state. The epineurium is considered to work as a shock absorber and protects the axons from damage.<sup>34</sup> Thus, the risk of recurrence of neuroma would probably be reduced as much as possible after the nerve stump is sealed by the epineurium. So far, success rates of  $\geq 90\%$  for nerve coaptations performed for amputation stump-related pain have been reported, which is higher than that for muscle implantation.<sup>9,31,33</sup>

End-to-end nerve coaptation was first applied for painful digital neuromas of the hand by Gorkisch, known as the “Gorkisch pinch,” in 1984.<sup>10</sup> Nowadays, it is mostly performed for major nerves after lower limb major amputation, such as sciatic, tibial, and peroneal nerves.<sup>9</sup> As mentioned by Elliot,<sup>35</sup> this method has not been applied to many upper limb cases. Furthermore, this procedure has rarely been performed for cutaneous nerves of the forearm.

Our patient complained of phantom limb pain in his small and ring fingers and so the ulnar nerve was suspected to be the responsible nerve preoperatively. However, surgery revealed no stump neuroma of the ulnar nerve. Only two medial cutaneous nerves of the forearm showed neuroma formation with severe scarring of the surrounding tissue. Although infiltration of local anaesthesia around the stump of the ulnar nerve was effective, this anaesthetic may have been infiltrated around the medial cutaneous nerves of the forearm because of the close proximity of the ulnar nerve and the medial cutaneous nerves in the forearm. The resections of neuromas and coaptation of these cutaneous nerves were effective in relieving both the stump pain and phantom pain. By managing the abnormal peripheral nerves by nerve-to-nerve coaptation, and perhaps before structural changes took place in the central nervous system, success was achieved in a difficult problem.

In recent years, nonsurgical treatments are favoured over surgery for stump pain and phantom limb pain. However, there are still some cases in which pain is refractory to multimodal conservative treatment. Although surgical intervention was

required in this patient, there was no sensory nerve deficit after the operation because only two stump neuromas of the cutaneous nerves were handled.

A successful outcome of cutaneous nerve coaptation in the upper limb with long-term follow-up is rare. Although our experience is limited to a single case, it serves to remind surgeons that this method is a useful option as it is simple and minimally invasive. Further accumulation of data on patients managed using this technique should be encouraged to evaluate its overall effectiveness.

## CONCLUSION

A case of intractable neuroma-related pain of the upper limb was successfully treated by resecting stump neuromas and end-to-end nerve coaptation. Although this method was rarely adapted in the upper limb, its use should be encouraged for cases of intractable neuroma-related pain.

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## COMPLIANCE WITH ETHICAL STANDARDS

### Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

### Informed Consent

Informed consent was obtained from all the individual participant included in the study.

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