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The anatomical relationship of the superficial radial nerve and the lateral antebrachial cutaneous nerve: A possible factor in persistent neuropathic pain☆

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Summary The superficial branch of the radial nerve (SBRN) is known for developing neuropathic pain syndromes after trauma. These pain syndromes can be hard to treat due to the involvement of other nerves in the forearm. When a nerve is cut, the Schwann cells, and also other cells in the distal segment of the transected nerve, produce the nerve growth factor (NGF) in the entire distal segment. If two nerves overlap anatomically, similar to the lateral antebrachial cutaneous nerve (LACN) and SBRN, the increase in secretion of NGF, which is mediated by the injured nerve, results in binding to the high-affinity NGF receptor, tyrosine kinase A (TrkA). This in turn leads to possible sprouting and morphological changes of uninjured fibers, which ultimately causes neuropathic pain. The aim of this study was to map the level of overlap between the SBRN and LACN.

Twenty arms (five left and 15 right) were thoroughly dissected. Using a new analysis tool called CASAM (Computer Assisted Surgical Anatomy Mapping), the course of the SBRN and LACN could be compared visually. The distance between both nerves was measured at 5-mm increments, and the number of times they intersected was documented.

In 81% of measurements, the distance between the nerves was >10 mm, and in 49% the distance was even <5 mm. In 95% of the dissected arms, the SBRN and LACN intersected. On average, they intersected 2.25 times.

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The close (anatomical) relationship between the LACN and the SBRN can be seen as a factor in the explanation of persistent neuropathic pain in patients with traumatic or iatrogenic lesion of the SBRN or the LACN.

Introduction

In 1984, Dellon and Mackinnon[1] stated that surgery on the radial side of the wrist is notorious for the development of neuropathic pain. Their explanation was that in 80% of cases the cause of this complication was stretching or compression of the superficial branch of the radial nerve (SBRN).

Mackinnon and Dellon[2] also presumed that the persisting symptoms in some patients might be caused by the fact that the course of the lateral antebrachial cutaneous nerve (LACN) for a large part overlaps with the course of the SBRN. Thus, when the SBRN is lacerated, the LACN almost certainly also is cut. Therefore, they postulated that in these patients the pain was caused by the LACN and not the SBRN.

By performing a diagnostic nerve block to the LACN using a local anesthetic (1% lignocaine), pain can be temporarily reduced in some patients.[3] This shows that there is at least a relation between pain caused by lesion of the radial superficial nerve (SBRN) and the LACN. However, it remains unclear at which level the actual problem is localized: the distal segment, the dorsal root ganglion (DRG), or even central parts of the nervous system.[4]

It has been postulated that the nerve growth factor (NGF) plays a role in neuropathic pain,[5–8] although the exact mechanisms remain elusive.[9,10] When a nerve is transected, Schwann cells, but also other cells, in the entire distal segment of this transected nerve produce NGF.[11,12] This production is initiated by axonal degeneration and Schwann cell upregulation, also known as Wallerian degeneration. If the branches of two nerves overlap anatomically (e.g., in the case of the LACN and SBRN), the produced NGF in the distal part of one nerve stimulates the other nerve, causing pain. Therefore, our interest is to demonstrate the areas of overlap between the LACN and SRBN more precisely. This is hard to describe by standard anatomical techniques and, therefore, a system called Computer Assisted Surgical Anatomy Mapping (CASAM) was used. CASAM is a system created in the Erasmus MC Anatomy laboratory[13,14] that can create an average of all used dissections (i.e., a virtual "average arm") and subsequently create a visual representation of the "average" course of the SBRN and the LACN (see the CASAM section below).

The goals of the study were twofold: to describe the variation in the anatomy of the LACN and the SBRN, and to quantify the amount of overlap between the LACN and the SBRN by creating a visual model using CASAM.

Materials and methods

Twenty arms (nine male and 11 female; mean age 79.35 years (range 61–90); 15 right and five left) were embalmed with a solution containing 4% formalin preceded by flushing the specimen with Anubifix™. All dissections were performed using a 2.5× magnifying loupe.

To ensure comparable exposures, the dissection and imaging method were standardized.[14] Incisions were made from 5 cm below the caput humeri up to 5 cm above the elbow exposing the biceps. At the ends of the incision lines, two perpendicular incisions were made, creating two skin flaps that could be removed laterally and medially. Once the biceps brachi muscle was exposed, the fascia surrounding the muscle was incised and via blunt preparation the biceps was released from the underlying muscle tissue. Right behind the biceps, the musculocutaneous nerve, being the origin of the LACN, could be identified and the biceps was cut at the insertion and removed proximally. The LACN was dissected along its course distally down to the metacarpal region. Along the way, the nerve was marked using colored pins. Once the distal one-third of the arm was reached, the brachioradialis (BR) muscle was identified and bluntly dissected from the underlying tissue, while keeping the LACN intact.

In step 2, the SBRN was identified deep to the BR muscle. Once identified, the nerve was followed to the insertion of the BR where it continued to run a more superficial course. This spot was also marked with a colored pin. The SBRN was also dissected distally down to the metacarpal joint level.

To quantify our findings, necessary to operate CASAM, the following measurements were taken:

1) The distance between both the epicondyles and the point where the SBRN emerges
2) The distance to both epicondyles and the first branch of the SBRN (the same procedure was performed with regard to the LACN)
3) The distance between both epicondyles and the location of crossings between the SBRN and LACN

Furthermore, along the course of both nerves, every 5 mm, the smallest distance between the SBRN and the LACN was measured using digital calipers (IP67 waterproof digital caliper, Hogetex, Varsseveld, the Netherlands).

Every arm was photographed with a digital camera (Nikon D 60 with Sigma 50 mm 1:2,8 DG MACRO lens). The camera was placed perpendicular to the specimen at a distance of 100 cm on a tripod. The pictures were loaded