

# MRI Evaluation of Neuromas in Oncological Amputees

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## Introduction

Tumors in the extremities often require amputation for oncologic cure.<sup>1</sup> Symptomatic neuroma following amputation are a primary cause of neuropathic pain. MRI features of symptomatic neuromas have been described previously, and radiographic geometrical features did not show difference between symptomatic and non-symptomatic neuromas.<sup>2,3</sup> However, it remains unknown **to what extent time affects neuroma growth and whether morphology influences pain intensity**. Therefore, we aim to **assess whether time influences neuroma size and shape, and their association with pain intensity in oncological amputees**.

## Methods

Oncological patients who underwent extremity amputation were included, MRIs were assessed post-amputation and prior to potential neuroma surgery. **Pain of the residual limb, expressed on a Numeric Rating Scale (NRS, 0-10) within 3 months of the MRI assessment, and presence of neuropathic symptoms, were recorded from chart review.**

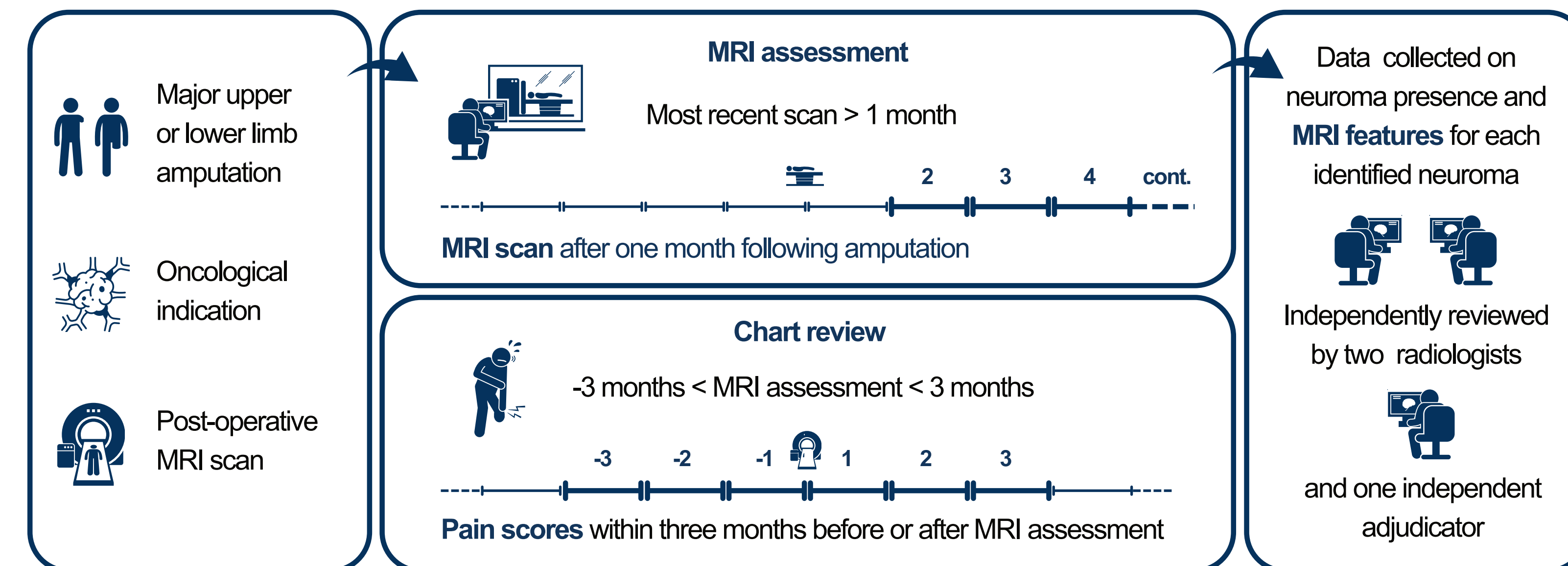


Figure 1 – Methodology of MRI assessments

Neuromas were **classified as symptomatic neuroma, or non-symptomatic neuroma**, based on description of pain with neuropathic symptoms. **Two musculoskeletal radiologists** independently assessed the MR images and collected MRI features per neuroma. Discrepancy was solved by a third musculoskeletal radiologist serving as independent adjudicator. **Neuroma size was expressed as the neuroma-to-nerve-ratio (NNR)**.

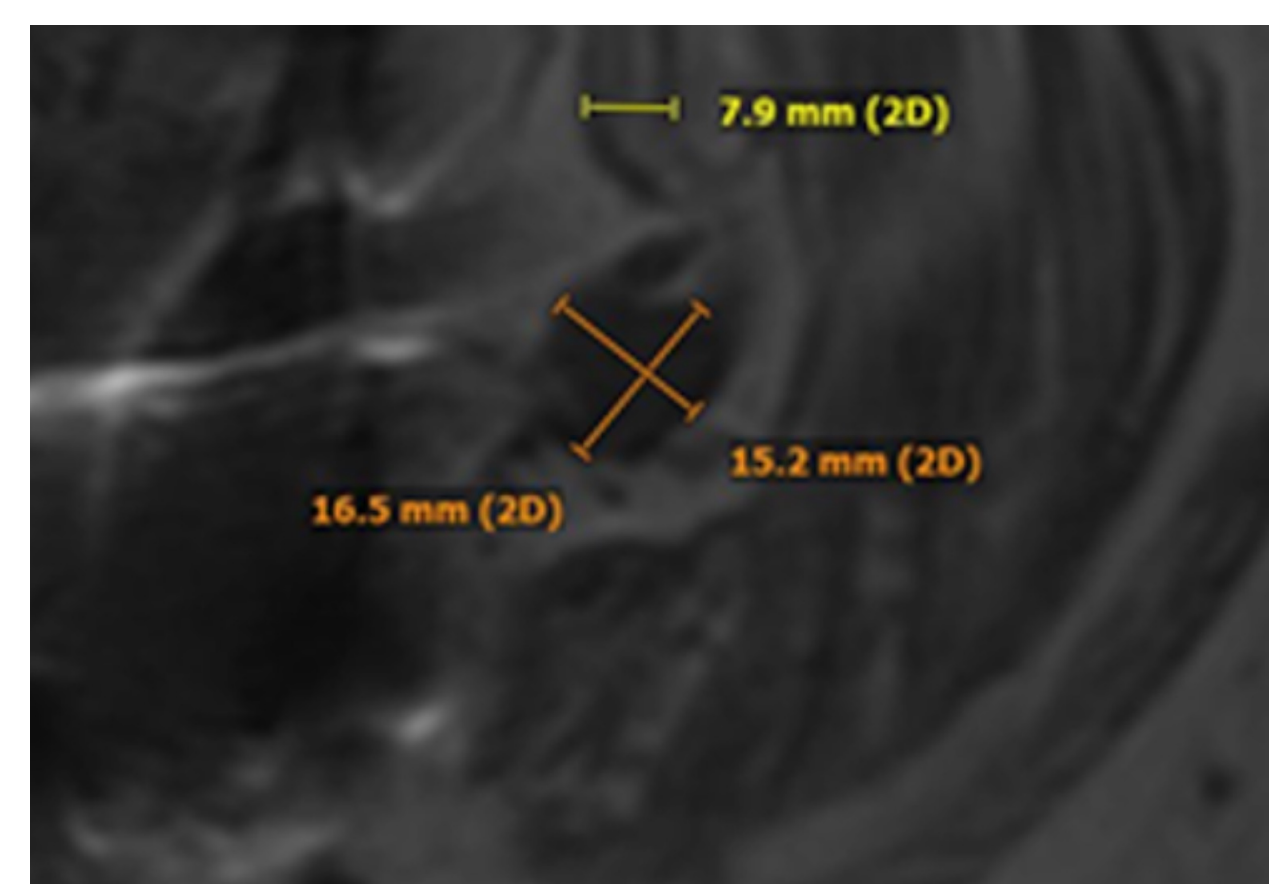


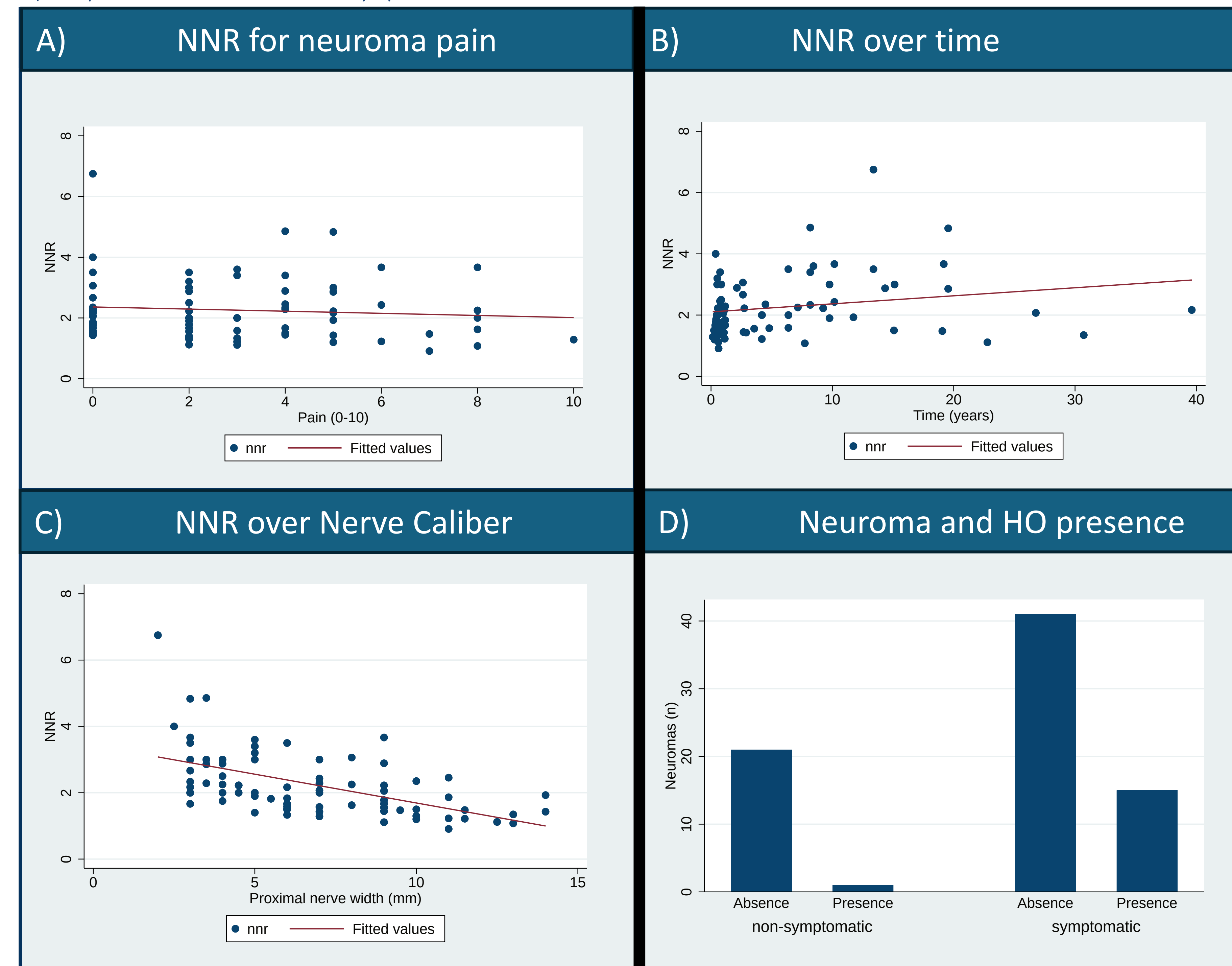
Figure 2 – NNR measurement of sciatic neuroma

## Results

**Sixty patients** were included in this study, of which 27 (45.0%) were female and 49 (81.7%) were lower extremity amputees. A total of **78 neuromas** were identified on MRI, of which **56 (71.8%) were deemed symptomatic** with a median pain score of 3.5 (IQR 2.0-5.0).

Image 1 – NNR and neuroma associations

- A) NNR did not correlate with pain intensity
- B) Larger NNR was associated with a longer time interval between amputation and MRI assessment
- C) Larger NNR was associated with a smaller proximal nerve caliber
- D) HO presence was associated with symptomatic neuromas



## Results

- The median NNR of all neuromas was 2.0 (IQR 1.5-2.9). **NNR was not significantly different for (non-) symptomatic neuromas ( $p=0.665$ ) and pain intensity ( $p=0.471$ ).**
- Symptomatic neuromas were associated with the **upper extremity distribution** ( $p=0.001$ ), **T2 heterogeneity** ( $p<0.001$ ) and presence of distal **heterotopic ossification** of the adjacent residual bone ( $p=0.029$ ).
- T2 heterogeneity** ( $p=0.003$ ), **perineural oedema** ( $p=0.031$ ), **enlarged fascicles** ( $p=0.042$ ) and presence of distal **heterotopic ossification** of the adjacent bone ( $p=0.024$ ) were associated with **more painful neuromas**.
- A larger NNR was associated with **longer time-to-neuroma excision interval** ( $p=0.011$ , Spearman's  $\rho=0.2850$ ), and a **smaller proximal nerve width** ( $p<0.001$ , Spearman's  $\rho=-0.5957$ ) for which **time did not demonstrate confounding**.

## Conclusion

Based on MRI assessment, smaller nerve caliber was associated with a larger NNR, and NNR increased over time. NNR did not significantly influence neuroma related pain. MRI features associated with symptomatic neuromas were T2 heterogeneity and the presence of HO and MRI features associated with neuroma pain intensity were T2 heterogeneity, perineural edema, enlarged fascicles and the presence of HO. These findings may aid in **physician awareness of neuromas in the oncological population and assist in the selection of patients for surgical neuroma treatment**. Understanding the relationship between MRI features and pain score can aid in pain management strategies for patients with neuromas. These results may help in more **refined patient stratification and selection for nerve surgical treatments focusing on neuroma treatment and the mitigation and prevention of neuropathic pain in the oncological population**.

## References

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