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Why do inguinal hernia patients have pain? Histology points to compression neuropathy

Robert Wright, MD [a, *], Donald E. Born, MD, PhD [b], Natasha D'Souza [c], Larissa Hurd [c], Rachel Gill [d], Daniel Wright [e]

[a] Cascade Hernia Institute, Puyallup, WA, USA
[b] Department of Pathology, Stanford University, School of Medicine, Stanford, CA, USA
[c] Pacific Northwest University of Health Sciences, Yakima, WA, USA
[d] Creighton University, Omaha, NE, USA
[e] University of Denver, Denver, CO USA

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ABSTRACT

Purpose: The purpose of this study is to describe the known soft tissue neuro-histology factors associated with compression neuropathy in relation to the incidence of preoperative pain in primary inguinal hernia. Enlargement of the ilioinguinal nerve occurs in 63% of patients with primary inguinal hernia; compression neuropathy has similar gross features.

Methods: Patients completed pain questionnaires pertaining to preoperative pain and the quality of pain experienced. During routine inguinal hernia repair, nerve segments were sampled for histologic evaluation.

Results: Twenty-two thickened nerve segments (63% of total) with proximal and distal specimens were resected for examination and comparison. We quantified various histologic indicators including nerve diameter, fascicle count, myxoid content within the epineurium, perineurium and endoneurium. Increased preoperative patient pain scores correlate with increased nerve diameter, increased fascicle count and increased myxoid material both within the perineurium and endoneurium.

Conclusion: These findings support the concept that preoperative hernia pain is associated with compression neuropathy.

1. Introduction

Measurable enlargement of the ilioinguinal nerve at the external inguinal ring has been described in primary inguinal hernia in as many as 63% of patients.[1,2] This is consistent with compression neuropathy where increased nerve size and pain are associated with nerve constriction sites, particularly modeled by carpal tunnel syndrome.[3–6] Further histologic parameters associated with ilioinguinal nerves have not previously been described.

Compression neuropathy, or what is often considered the equivalent—entrapment neuropathy—occurs at a number of fascial constriction sites and is associated with characteristic histologic connective tissue changes including edema and thickening of the epineurium, perineurium, and endoneurium.[7–12] It is thought that compression of the nerve at these constriction sites results in impairment of venous and then arterial blood supply that transits through the epineurium.[7,13] This results in breakdown of the "blood/nerve barrier" in the perineurium. Consequently, the endoneurial and sub-endoneurial spaces become flooded with edema described as a "mini compartment syndrome" within the fascicle causing nerve damage.[13] Myxoid, under light microscopy consists of non-cellular blue staining polysaccharides surrounded by normal neural elements, variably described as edema or fibrosis by compression neuropathy researchers.[7–10]

The histology of the ilioinguinal nerve associated with primary inguinal hernia has not been described with attention to the features known to occur in compression neuropathy found in humans. This study examines the hypothesis that soft tissue neuro-histological findings of compression neuropathy will be demonstrated in nerves removed during primary inguinal hernia.

* Corresponding author.
E-mail addresses: bob@meridiansurgerycenterwa.com (R. Wright), donborn@stanford.edu (D.E. Born), ndsouza@pnwu.edu (N. D'Souza), lhurd413@gmail.com (L. Hurd), RachelGill@creighton.edu (R. Gill), Daniel.wright210@gmail.com (D. Wright).

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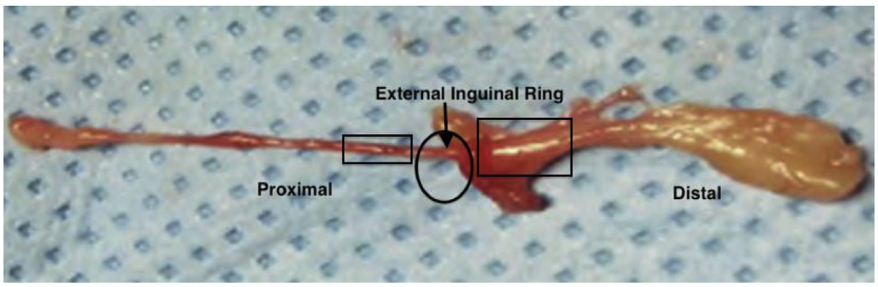

Fig. 1. Gross findings of *involved* nerve depicting segments sampled.

Furthermore these findings will be correlated with preoperative visual analog scale and Carolina Comfort Scale [tm] pain scores to improve understanding of preoperative inguinal hernia pain.[14,15]

2. Methods and materials

Patients undergoing primary inguinal hernia repair using open Lichtenstein technique in a private practice setting were prospectively enrolled for the study. The study design was reviewed, approved, and monitored by a hospital institutional review board. These patients were assigned study identification numbers and underwent preoperative history and physical examination, and completed routine preoperative pain questionnaires including the Carolinas Comfort Scale [tm] (CCS), three additional visual analog scale (VAS) questions, and a question regarding the quality of their pain (burning, stabbing, or pressure). CCS is a visual analog graphic scaled response (Likert Scale) survey where patients rate common hernia-related symptoms during 8 activities of varying intensity: laying down, bending over, sitting up, activities of daily living, coughing or deep breathing, walking, stairs, and exercise.[14,15] VAS questions were formatted similarly—asking maximum pain level, pain most of the time, and pain while at rest.

During Lichtenstein repair, routine neurectomy of the ilioinguinal nerve was carried out. This involved excision of the entire visible segment of the ilioinguinal nerve from its lateral penetration site through the internal oblique muscle to a point beyond the external inguinal ring. Nerves were excised and grossly inspected by the surgeon. Nerves with no gross evidence of enlargement at the external ring, or neuroperforatum were designated as *uninvolved*. Ilioinguinal nerves that exhibited any enlargement at and beyond the external inguinal ring were labeled *involved*. We compared the proximal segment of *uninvolved* nerves to the proximal (not enlarged) segment of *involved* nerves. Within the *involved* nerves, we also compared the proximal (not enlarged) segment to the distal (enlarged) segment.

For both *involved* and *uninvolved* nerves a 1 cm segment of nerve proximal to the external inguinal ring was sampled and sent for processing under protocol. The grossly thickened segments of *involved* nerves were resected and also sent for processing to be compared with the proximal segment of the same nerve (Fig. 1). Study identification numbers were assigned to each nerve segment. Longitudinal and cross-sectional slides of nerve segments were stained with H & E technique. Each slide was then forwarded to a single neuropathologist with study numbers to assure blinded methodology. The neuropathologist examined all nerves and tabulated data.

From the H & E sections a cross sectional count of fascicles and Renaut bodies was tabulated. Additionally, the relative area of myxoid staining was graded subjectively from 0 to 3 with 0 assigned for no myxoid staining and 3 being the greatest amount of myxoid staining (Fig. 2). The epineurium likewise was graded in its relative area on a five-point scale. In a prior study we reported, the presence of onion bulbs or other specific pathology as well as measurements of nerve diameter in millimeters.[1]

We compared the proximal *uninvolved* nerves to the proximal *involved* nerves. Within the *involved* nerves, we also compared the proximal segment to the distal segment. Preoperative CCS pain scores were then correlated with fascicle count, the *overall diameters* and *nerve-specific diameters*, and other histological findings. Group means between nerve categories were compared using independent samples *t*-test for independent measures while the means for segments within a nerve type were compared using paired t-tests for same-nerve comparisons. The statistical significance of the correlation coefficients for pain was tested using a Pearson correlation test. Multivariate analysis further evaluated diameter and fascicle correlation to pain scores.

3. Results

Thirty-five patients were prospectively enrolled and underwent open inguinal hernia by Lichtenstein technique. All patients completed preoperative Carolina Comfort Scale pain questionnaires, three additional VAS questions, and pain quality surveys. Four patients were found not to have an ilioinguinal nerve (11%). Of the patients who had an ilioinguinal nerve, all were resected; eight were found to have uniform nerve diameter (*uninvolved* nerves), thus 23 patients had size disparity of the ilioinguinal nerve and 23 nerve paired segments were generated for subsequent evaluation

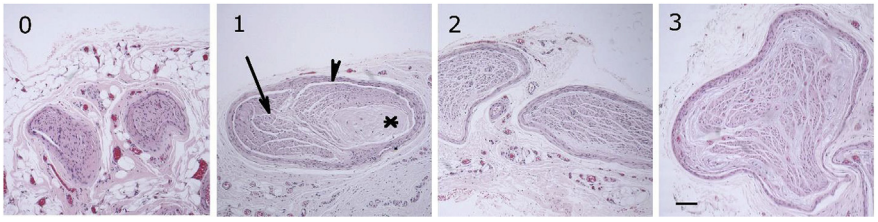

Fig. 2. Images from representative hematoxylin and eosin stained nerve sections along with the scores of myxoid material (0 = absent and 1–3 for incremental amounts). The faint staining myxoid material was scored in endoneurium (arrow) and sub-perineurium (arrow head). A Renaut body is seen at the asterisk. Scale bar indicates 100 μm for all panels.