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Understanding the surgical pitfalls in total mesorectal excision: Investigating the histology of the perirectal fascia and the pelvic autonomic nerves

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Abstract

Aim: Excellent understanding of fasciae and nerves surrounding the rectum is necessary for total mesorectal excision (TME). However, fasciae anterolateral to the rectum and surrounding the low rectum are still poorly understood. We studied the perirectal fascia enfolding the extraperitoneally located part of the rectum in *en-bloc* cadaveric specimens and the University Medical Center Utrecht (UMCU) pelvic dataset, and describe implications for TME.

Methods: Four donated human adult cadaveric specimens (two males, two females) were obtained through the Leeds GIFT Research Tissue Programme. Paraffin-embedded blocks were produced and serially sectioned at 50 and 250 μm intervals. Whole mount sections were stained with haematoxylin & eosin, Masson's trichrome and Millers' elastin. Additionally, the UMCU pelvic dataset including digitalised cryosections of a female pelvis in three axes was studied.

Results: The mid and lower rectum were surrounded by a multi-layered perirectal fascia, of which the mesorectal fascia (MRF) and parietal fascia bordered the 'holy plane'. There was no extra constant fascia forming a potential surgical plane. Nerves ran laterally to the MRF. More caudally, the mesorectal fat strongly reduced and the MRF approached the rectal muscularis propria. The MRF had a variable appearance in terms of thickness and completeness, most prominently at the anterolateral lower rectum.

Conclusion: Dissection onto the MRF allows nerve preservation in TME. Rectal surgeons are challenged in doing so as the MRF varies in thickness and shows gaps, most prominently at the anterolateral lower rectum. At this site, the risk of entering the mesorectum is great and may result in an incomplete specimen.

Keywords: Total mesorectal excision; Perirectal fascia; Mesorectal fascia; Autonomic nerves; Rectal cancer

Introduction

Since the late 1990s, total mesorectal excision (TME) has been the golden standard for the surgical treatment of rectal cancer. Dissection in the 'holy plane' between the visceral and parietal fascia enables complete *en-bloc* removal of the diseased rectum, surrounding mesorectum with an *intact* mesorectal fascia (MRF) and preservation of the autonomic nerves.[1,2] It has been shown that suboptimal TME leads to a higher risk of tumour involvement of the circumferential resection margin (CRM) affecting the oncological outcome,[3,4] and iatrogenic damage of the

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nerves resulting in an impaired functional outcome.[5–7] Therefore, excellent anatomical knowledge of the rectum and surrounding structures is essential to perform an optimal TME.

Rectal cancer surgeons mobilize the posterior, lateral and anterior rectum by dissection in an anatomical space, which is bordered by the visceral and parietal fascia. Although there is agreement that the mesorectum is enveloped by the visceral fascia (also known as the MRF or fascia propria recti), concepts of the relationship between the hypogastric nerves and fasciae posterolateral to the rectum differ. Kinugasa et al.[8] clearly illustrated the various descriptions, of which the presence of an extra leaf of the visceral fascia has gained most support throughout recent years. Some argue that the hypogastric nerves are located anterior to this "posterior layer of the visceral fascia",[9] some believe that they are captured within this "urogenital fascia"[10] or even within the MRF,[11] whereas others advocate that they run posterior to this "pre-hypogastric nerve fascia".[8] To make the confusion greater, some support the idea that specific identification of the autonomic nerves is not essential during TME as dissection on the MRF would spare the nerves automatically.[12] This is based on the assumption that the MRF is a continuous structure, but one could question if this is really the case.

However, main focus has always been on elucidating the anatomy of fasciae and nerves located at the posterolateral rectum so to avoid incomplete mesorectal excisions while dissecting posterolaterally. The fasciae and nerves located at the anterolateral rectum and surrounding the lower rectum have not been described in such detail. As incomplete excisions are still encountered[13] and tumour involvement of the CRM is most frequently reported in anterior tumours[14] or advanced low rectal tumours,[15,16] there is a need to elucidate the anatomy of fasciae and nerves at these sites. We studied the perirectal fasciae along the length of the extraperitoneally located part of the rectum in whole mount microscopic sections of *en-bloc* cadaveric pelvic exenteration specimens and concentrate on the MRF and its relation to the autonomic nerves, specifically at the anterolateral rectum and the lower rectum. Additionally, the University Medical Center Utrecht (UMCU) pelvic dataset was studied including digitalized transverse cryosections of the whole female pelvis.

Methods

Adult cadaveric specimens

Four human adult *en-bloc* cadaveric specimens were obtained from consented donors trough the University of Leeds GIFT Research Tissue Programme (www.gift.leeds.ac.uk). Ethical approval was granted by the Northern and Yorkshire Regional Ethics Committee, Jarrow, UK (unique reference number 11/H0903/6). The donor bodies belonged to two females aged 64 and 74 years and two males aged 68 and 89 years. The donors did not suffer from any pathology in the pelvis. The specimens were retrieved during tissue donation autopsy undertaken at St. James's University Hospital in Leeds, in the prone jack-knife position according to the technique described by Hölm et al.[17] The specimens were essentially *en-bloc* pelvic exenteration specimens and comprised the anal canal and rectum up to the rectosigmoid junction, mesorectum within an intact MRF, all surrounding extraperitoneal connective tissues, obturator internus muscle, levator ani muscle, bladder and vagina or prostate.[18] Specimens were fixed in 8% formaldehyde solution for seven days prior to transverse sectioning at one centimetre. After this, the slices were photographed and dissected to fit in Super Mega Cassettes measuring 74.8 × 52.5 × 16.5 mm (CellPath; Powys; UK). The tissues underwent an extended tissue processing cycle in a Leica ASP200 tissue processor as follows: 1 hour (h) in 70% ethanol, 2 h in 80% ethanol, 2 h in 90% ethanol, 3 h in 95% ethanol, 12 h in 100% ethanol (repeated three times), 12 h in xylene, 24 h in xylene (repeated twice), 24 h in paraffin. All tissues were embedded in paraffin mega blocks.

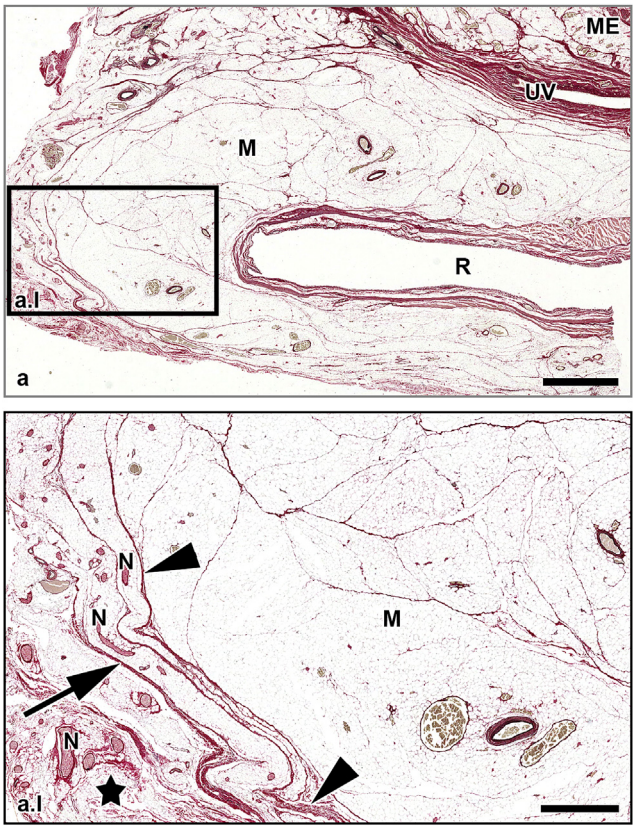

Figure 1. This shows the organization of fasciae posterolateral to the mid rectum (R). The parietal fascia is indicated by the arrow and covers the presacral space (star) in which the pelvic splanchnic nerves (N) are seen. The arrowheads shows the mesorectal fascia, which consists of multiple laminae. Note that the autonomic nerves (N) run both anterior and posterior to these laminae. UV: upper vagina; M: mesorectum; ME: Miller's elastin. Scale bar in window a: 6 mm, window a.I: 2 mm.

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