Introduction

- The pubovisceral muscle (PVM) is subject to increased risk for injury nearest its origin from the pubic bone during difficult vaginal births (Kearney et al., Obstet Gynecol 2004).
- The PVM origin can be classified as a fibrous enthesis because of the absence of Sharpey’s fibers perforating the bone (Mason’s triad).
- The amount of connective tissue and muscular tissue becomes equal at approximately 8 mm from the pubic bone origin.

Aims

- Determine what type of enthesis the PVM has.
- Examine the anatomical and histological characteristics of the PVM enthesis in the context of the stress-reduction mechanisms.

Methods

- Dissection:
  - Five female cadavers
  - Range: 51 – 98 years old (mean 77 years)
- Histochemical processing:
  - Staining: Hematoxylin and eosin, Masson’s trichrome, and Verhoeff-Van Gieson
- Fixation: 10% neutral buffered formalin
- Decalcification: 10% formic acid
- Dysthyalin: 70% ethanol
- Quantitative Image Processing:
  - Custom-designed software written in Matlab
  - Interactive selection on the image in the quadrangular form of the sampling bands
  - Sampling bands: Quadrangles, 2 mm intervals, 1 mm width, 6 ~ 7 locations
  - Color-based segmentation using the k-means clustering technique
  - Composition of the muscle and the connective tissue was computed
  - Longitudinal distribution of the muscle and the connective tissue in the sampling bands along the PVM from its origin. The unit area of the muscle matches that of the connective tissue at location 5 (8 mm away) from the pubic bone origin.

Results

- Gross morphology:
  - Short connective tissue (tens of μm to a few mm in length) region connects the PVM to the pubic bone periosteum
  - The PVM is bounded by the superficial fascia of the pelvic diaphragm on both its ventral and dorsal surfaces
  - Surrounding structures include the arcus tendineus fascia pelvis, the perineal body, and the obturator internus muscle
- Histological features:
  - The PVM enthesis was classified as a fibrous enthesis because of the absence of Sharpey’s fibers perforating the bone (Mason’s triad)
  - The constant thickness of the periosteum at the enthesis
  - The PVM origin can be classified as a fibrous enthesis because of the absence of Sharpey’s fibers perforating the bone (Mason’s triad)
- Elastic fibers
  - Rare, distributed at widely spaced intervals
- Elastic fibers
  - Approximately 8 mm apart from the origin
- Elastic fibers
  - A piece of connective tissue, b) Cylindrical fibers of the PVM (green and red, respectively).
- Elastic fibers
  - Approximately 8 mm from the pubic bone origin.
- Elastic fibers
  - The amount of connective tissue and muscular tissue becomes equal at approximately 8 mm from the pubic bone origin.

Discussion

- The PVM enthesis has not been classified before.
- The PVM tissue architecture becomes isomorphic to connective tissue, which resembles connective tissue at location 5 (8 mm away) from the pubic bone origin.

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Fig. 1 Dissection and Image Processing

(a) Parasaugal section through a cadaveric pelvis for orientation. The rectangular box shows an area on which histological analyses were performed.
(b) The PVM origin showing the sampling bands (dashed quadrangles) at 6 different locations, where color-based segmentation was conducted (Masson’s trichrome).

Fig. 2 Overview of the PVM Enthesis

(a) Two examples of entheses: The PVM emanates tangentially from the pubic bone (green) (Verhoeff-Van Gieson).
(b) Detailed view of the boxed region in (a). The collagenous tissue from the PVM blend in with the periosteum of the pubic bone, and can sometimes be seen to insert on irregularities on the surface of the pubic bone.

Fig. 3 Elastic Fibers

(a) Elastic fibers (black, arrowhead) and myofibroblasts (arrows) are sparsely distributed in a fibellar form (Verhoeff-Van Gieson).
(b) Detailed view of the boxed region in (a).

Fig. 4 Composition of Muscle and Connective Tissue

(a) Composition of muscle and connective tissue at location 5 (8 mm away) from the pubic bone origin.