Variant muscular covering of the sacral hiatus

Miguel Bautista Royo Salvador, Marco Vinicio Fiallos Rivera, Horia Calin Salca

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We describe a variant muscular layer covering the superficial layer of the posterior sacrococcygeal membrane over the sacral hiatus, with longitudinally oriented muscular fibers, that in our opinion belongs to the multifidus muscle. We had the privilege to discover it in twelve patients while performing an open surgical approach of the sacral hiatus, which gives a prevalence of 11.11% among all cases treated with this intervention. Knowledge of this anatomical variant is important because it may render difficult any caudal approach to the sacral canal and might explain some failures of caudal epidural blocks. Significantly, our report is based on direct surgical visualization of an area until now described only indirectly, by magnetic resonance imaging, ultrasonography or cadaver sacral bone examination..

Key Words: *Muscle; Sacrococcygeal membrane; Sacral hiatus; Ultrasonography*

INTRODUCTION

The posterior or dorsal sacrococcygeal membrane or ligament unites the dorsal surfaces of sacrum and coccyx and has two layers: a deep portion, lying over the floor of the sacral hiatus and continuing into the sacral canal and above, as the posterior longitudinal ligament; a superficial portion, covering the sacral hiatus as it stretches from its superolateral borders towards the dorsal surface of the tailbone, like a diminute caudalmost ligamentum flavum as we know it in other vertebral segments.

During surgical unroofing of the distal sacral canal, as we perform it on a routine basis since 2003 [1], one mandatory step is the opening of the superficial layer of the posterior sacrococcygeal membrane, followed by the visualization of the adipose tissue that fills the sacral canal; in most instances this is quite straightforward, despite some bleeding from fascial vessels, easy to control with bipolar coagulation. Nevertheless, in a few patients, we had the surprise to discover this anatomical variant consisting of a muscular layer covered by a thin fascia, applied over the sacral hiatus and obstructing the visualization and opening of its roof.

CASE REPORT

We report on 12 patients with surgical approaches of the sacral canal as we routinely perform at the Hospital CIMA of Barcelona, Spain, operated between the 24th of April, 2014, and the 14th of March, 2019. They were selected by a retrospective search of our surgical registry because of the intraoperative finding of a variant muscular covering of the sacral hiatus. In all cases, the responsible caregivers or the patients themselves, depending on age, had previously signed a consentment form concerning the use of clinical data by the Institut Chiari & Siringomielia & Escoliosis de Barcelona, in accordance with actual legal requirements. All eight patients that were operated throughout 2017 were consecutive cases presenting this anatomical variant, interspersed within an uninterrupted series of 72 sacral canal approaches performed between the 13th of July and the 14th of December, 2017, which gives a quite significant figure of prevalence of 11.11% among our surgical cases during that period.

All patients underwent a thorough preoperative evaluation including magnetic resonance and radiographic survey of the lumbosacral spine and last but not least, surgery was initiated in most cases after visualization of the area with portable ultrasonography [2]. Despite all that, there were no obvious clues on imaging which might have warned us of the later intraoperative findings. Nevertheless, retrospectively, we could identify magnetic resonance and ultrasonographic features suggestive of the variant (Figures 1 and 2). None of the patients had spina bifida of the sacrum evident on magnetic resonance imaging or radiographs - therefore, we assume that the location and extent of the sacral hiatus were within normal range.

As these patients belonged to a very diverse international population and had their preoperative studies performed

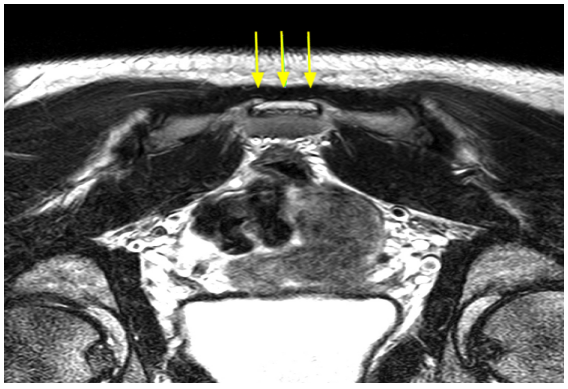

Figure 1) Case No. 5: *The axial T2-weighted magnetic resonance imaging at the level of the sacral hiatus shows a muscular covering of its opening (arrows). The patient's back is up as in the surgical prone position.*

Department of Medical, Institut Chiari & Siringomielia & Escoliosis de Barcelona, Paseo de Manuel Girona 16, 08034 Barcelona, Spain

Correspondence: *Dr. Miguel Bautista Royo Salvador, Department of Medical, Institut Chiari & Siringomielia & Escoliosis de Barcelona, Paseo de Manuel Girona 16, 08034 Barcelona, Spain. Telephone +34 932800836; e-mail: mroyo@institutchiaribcn.com*

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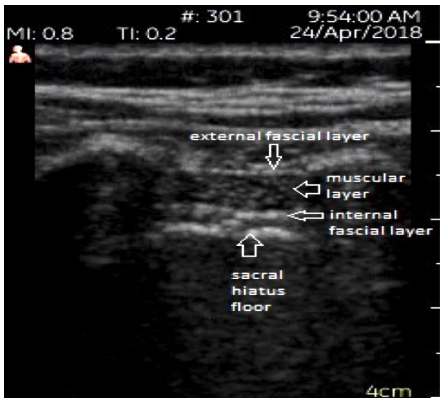

Figure 2) Case No. 10: *The transversal ultrasonographic picture demonstrates three hyperechoic horizontal layers at the level of the sacral hiatus, instead of two as in normal cases, corresponding to the external and internal fascial layers and the deepest to the floor of the sacral hiatus. The thickest and uppermost hypoechoic layer represents the variant muscle itself.*

worldwide, we received magnetic resonance imaging series from a varied range of devices that we scrutinized in DICOM format with the programme OsiriX version 5.8.2 (Pixmeo SARL, Bernex, Switzerland). Ultrasonography was routinely performed preoperatively by one of the authors (HCS) with a portable Vscan device with Dual Probe (GE Healthcare, Chicago, IL, USA).

After identification of the sacral hiatus by palpation and ultrasonography in the patient in prone position, we performed a midline sacral incision and separation of the subcutaneous adipose tissue, then we defined the outer surface of the superficial posterior sacrococcygeal membrane with curettes and dissectors, followed by the opening of this membrane with immediate visualization of the adipose tissue contained within the sacral canal.

Nevertheless, in these 12 cases, while opening what we supposed to be the superficial posterior sacrococcygeal membrane (Figure 3), in fact a superficial muscular fascia in these instances, we had the surprise to visualize, instead of the yellow, shiny and protruding fat tissue normally found underneath, a layer of muscular tissue with longitudinal fibers i.e. following a cranio-caudal direction. It was impossible to make assumptions about its origin proximally as the dissector inserted beneath the outer muscular fascia in a proximal direction could not encounter any obstacle over a distance of at least 2-3 cm; because of these features, we interpreted this finding as representing a caudal prolongation of the multifidus muscle [3]. Caudally, in most of the cases if not all, the muscular fibers ended shortly thereafter and the two fascial layers coalesced in one on the dorsal aspect of the sacro-coccygeal junction. In one of the cases, a piece of the anomalous tissue was sent to pathological examination, which confirmed it as being muscular tissue with slight signs of atrophy.

In all cases, there was a more or less developed midline fibrous septum separating the interposed muscle into two paramedian muscular fascicles (Figure 4).

Underneath the muscle, a thin deep fascia, corresponding topographically to the superficial posterior sacrococcygeal membrane, united the free borders of the sacral hiatus forming its roof and enclosing the various anatomical structures embedded within the adipose tissue of the sacral canal (Figure 5). Important from a

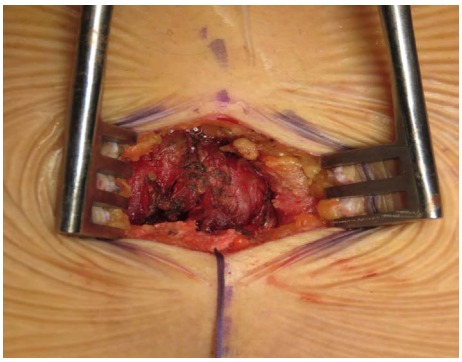

Figure 3) Case No. 5: *The superficial fascial layer has been opened and marked with a suture, with visualization of variant muscle fibers after coagulating small bleeders on their surface. The marking suture holding the fascia points caudally.*

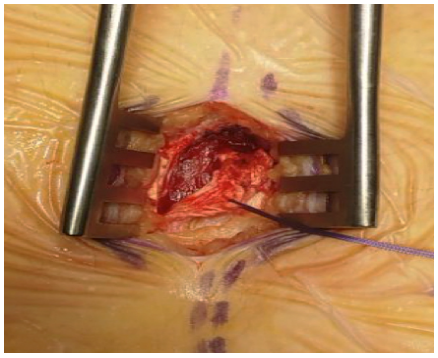

Figure 4) Case No. 4: *The marking suture elevates only the left half of the superficial fascia, restricted by a midline vertical septum interposed between the left and right muscular masses.*

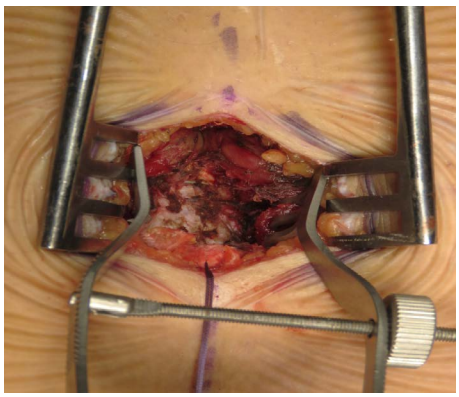

Figure 5) Case No. 5: *Exposure of the deep fascial layer, after separation of muscular fibres by the sides (with help of the smaller retractor) and coagulation of small bleeders. Opening this layer will provide final access to the sacral hiatus and its contents.*

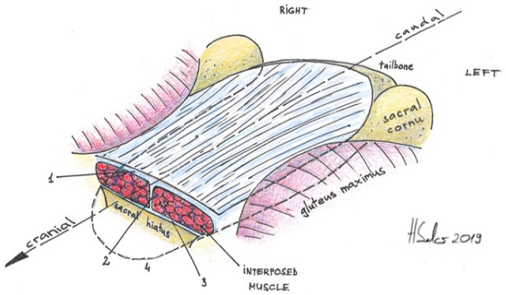

Figure 6) *Artist's schematic representation of the variant muscle from an oblique view: 1 - Superficial fascial layer; 2 - Midline septum; 3 - Deep fascial layer; 4 - Underlying sacral hiatus border (interrupted line).*

practical standpoint is the fact that often, the deep opening of the sacral hiatus, underneath the anomalous muscle, was much more narrow than the superficial one, making entrance into the hiatus somehow more awkward.

A schematic representation of our discovery can be seen in (Figure 6).

DISCUSSION

First of all, the anomaly that we describe may be an important and largely unsuspected hindrance in the successful performance of a caudal anesthetic block or a surgical approach to the sacral hiatus: if not acquainted with this possibility, even an experienced anesthetist or surgeon may have to abort the procedure or unduly prolong it while striving to find entry into the sacral canal, especially in cases where it is delicate and elusive to any intent of penetration.

We have no knowledge of any description of this anomaly so far in medical literature, at least in publications in English and Spanish language. Neither descriptions of caudal epidural block techniques, nor anatomy texts concerning the sacral bone and its coverings, nor do those dealing with the multifidus muscle seem aware of this possibility and its consequences [4-8]. This would not be surprising, given the difficulty to visualize the posterior sacrococcygeal membrane with any imaging modality. Nevertheless, our description includes some interesting magnetic resonance and ultrasonographic features which could help detect this anomaly, although they were difficult to find in this retrospective study using traditional imaging protocols. This could inspire future studies aiming to define its specific magnetic resonance and ultrasonic image characteristics and advance our knowledge as to its prevalence and the associated predictive factors that could help in its identification prior to any surgical or anesthetic procedure.

CONCLUSION

As to its developmental origin, we can hypothesize that it could result by a lack of synergy between the involution of the underlying sacral bone tip that gives rise to the formation of the sacral hiatus and the musculo-fascial planes that cover it and normally are due to follow a parallel process of regression until they coalesce into a unique fascia of variable thickness well known as the superficial layer of the posterior sacrococcygeal membrane.

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