

MRI ANALYSIS OF EXTERNAL ANAL SPHINCTER SUBDIVISIONS: ARE THERE TWO, THREE, OR FOUR PARTS?

Hypothesis / aims of study

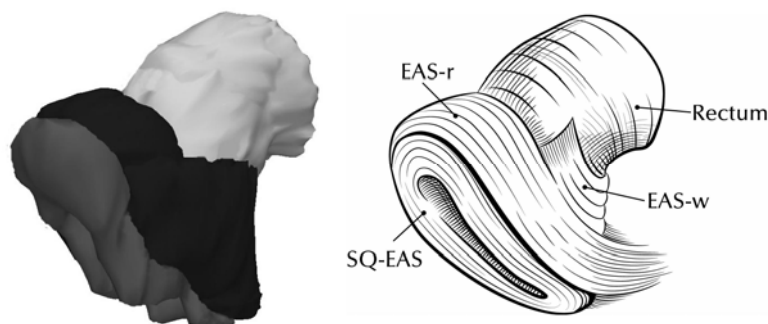
The external anal sphincter (EAS) has been described as having either two, three or four components by various authors. The purpose of this study was to use magnetic resonance images and 3-D modelling of living women to identify the number of visible components and characteristic features of the EAS.

Study design, materials and methods

MR images from 3 normal nulliparous women acquired in the supine position were selected based on the optimal visibility of the anal sphincter region from an ongoing study of pelvic anatomy. Individual components were traced in axial, coronal and sagittal planes to create 3-D models using the 3-D Slicer (version 2.1b1) program. Separate models from each plane were created from these outlines ("lofting"). These models were compared to verify that structures seen and modelled in one plane were also seen in other planes. These models were then "back-compared" against the original scans by having the model and scan in the same space to assure that features contained in the models corresponded to visible structures and were not lofting artifacts. The tracings of the structures and the 3-D models were reviewed independently by two senior examiners. The characteristic features of the anal sphincters segments defined by this process were catalogued. To determine how often these features are visible in other scans, the MR images of an additional 10 nulliparas with normal pelvic support were reviewed and the occurrence of features tallied.

Results

There are 3 distinct and consistently identifiable parts to the anal sphincter in MR images. The most caudal is the subcutaneous external anal sphincter (SQ-EAS) which is easily distinguished from the remaining external anal sphincter by the inter-sphincteric groove in all scan planes. Since the patients were prone with their legs together, the SQ-EAS has a flattened and elongated "ring" appearance. It contains fibers which are seen crossing ventrally in the axial scan plane and cross dorsally in the coronal scan plane. The ventral and dorsal crossing fibers were seen in 8/10 nulliparas. Cephalad to the SQ-EAS is another ring structure (EAS-r) which also crosses the ventral midline. Unlike the SQ-EAS that is purely circular, this portion sends dorsal fibers to the anococcygeal ligament. The ventral midline crossing fibers of the EAS-r were seen in all scans (10/10). The most cephalic structure is the "wing shaped" (EAS-w) and is distinguished from EAS-r by fibers that flare out laterally and which do not cross the midline ventrally. The EAS-w was seen in the axial plane of all MR images (10/10) reviewed. The lateral fibers of the EAS-w usually have a clear separation from the adjacent fibers of the puborectalis muscle (7/10). The internal anal sphincter has a thick, tubular appearance and was identified in both the axial and coronal planes of all scans (10/10).



3-D Slicer Model and Drawing: Note the oval rather than circular appearance of the sphincter occurs because scans are performed with the subjects' legs together.

Interpretation of results

Each of these components has visible characteristics that separate it from the others. These characteristics suggest different effects of contraction. The SQ-EAS is the only truly circular component and therefore functions mainly as a constrictor. The EAS-r, in addition to some circular fibers is also tethered to the coccyx. This suggests that in addition to constriction, it pulls the anal canal dorsally counter to the ventral action of the puborectalis muscles. The opposite directions of actions of these muscles also result in constriction of the anal canal. The EAS-w fibers are directed ventrally and laterally in a similar orientation to the puborectalis muscle, yet despite this similarity, they formed a distinct body of muscle visibly separate from the puborectalis, justifying their anatomical (although perhaps not functional) designation as part of the anal sphincters.

Concluding message

Three components of the external anal sphincter (not two or four) were identified using MRI structure identification and 3-D modelling. These components have characteristic features which can reliably be identified in MR scans of nulliparous women. The differences in the components' structure suggest different biomechanical functions. The ability to identify these components from MR images of living women allows clinicians to relate specific disruptions with clinical findings. Funded by NICHD P50 HD044406.

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