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Technical Note

Three-dimensional virtual reconstruction as a tool for preoperative planning of complex anal fistulas[☆]

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ABSTRACT

The making of three-dimensional virtual models is a promising technology in preoperative planning, but that is not used in the treatment of anal fistulas. The objective of this work is to describe the development and initial experience of the construction of a virtual three-dimensional model of the pelvic anatomy of a patient, allowing the exact identification of the relationships between the fistulous tracts of complex anal fistulas and the other pelvic structures. An MRI was performed on this patient, and the images were exported to the Vitrea fx Workstation[®] software. A radiologist did the analysis and segmentation of the images that were then sent to a three-dimensional image processor (Meshlab v. 1.3.3 – ISTI – CNR Research Center, Pisa University, Italy). The final 3D color image was analyzed by the surgeon and used to guide the catheterization of the fistulous pathways, the internal orifice and to assist in the identification of adjacent structures. The final three-dimensional model presented a high correlation with the intraoperative findings and facilitated the surgical planning.

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Reconstrução virtual tridimensional como ferramenta de planejamento pré-operatório de fistulas anais complexas

R E S U M O

Palavras-chave:

Fístula retal

Imagem tridimensional

Procedimentos cirúrgicos do sistema digestório

A criação de modelos virtuais tridimensionais é uma tecnologia promissora no planejamento pré-operatório, entretanto não é utilizada no tratamento de fistulas anais. O objetivo desse trabalho é descrever o desenvolvimento e a experiência inicial da construção de um modelo virtual tridimensional da anatomia pélvica de um paciente, que permite a identificação exata das relações entre os tratos fistulosos de fistulas anais complexas e as demais estruturas pélvicas. O paciente realizou uma ressonância magnética e as imagens foram exportadas para o programa Vitrea fX software Workstation[®]. Um radiologista realizou a análise e segmentação das imagens que, em seguida, foram enviadas para um processador de imagens tridimensionais (Meshlab v. 1.3.3 – ISTI – CNR research center, Pisa University, Italy[®]). A imagem 3D colorida final foi analisada pelo cirurgião e utilizada para guiar a cateterização dos trajetos fistulosos e orifício interno e para auxiliar na identificação das estruturas adjacentes. O modelo tridimensional final apresentou alta correlação com os achados intraoperatorios e facilitou o planejamento cirúrgico.

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Introduction

An anal fistula is an abnormal pathway coated with granulation tissue that connects the anal canal with the perianal skin. The objectives of its treatment are the resolution of the inflammatory process, maintenance of continence, and prevention of future recurrences.¹ Currently, the main techniques used for the treatment of complex anal fistulas are simple fistulotomy, application of fibrin glue, application of an endorectal advancement flap, video-assisted surgery, and ligation of the intersphincteric tract of the fistula.²

A good knowledge of the anatomical relationships of the anorectal fistula with the adjacent pelvic structures is essential for an adequate surgical management, which makes it possible to decrease the chance of recurrence. Magnetic resonance imaging is currently the method of choice for preoperative evaluation because it can demonstrate areas of abscess and secondary extensions of the fistula.³

Imaging studies are essential in the preoperative planning process, but they may cause doubts in interpretation by the surgeon, especially in cases of complex fistulas. In recent years, the conception of three-dimensional models has been gaining space as a promising alternative in the preoperative planning of surgeries, but this is an option yet little explored in the treatment of anal fistulas.

Objective

The present study aims to describe the development and initial experience with the construction of a three-dimensional virtual model of the patient's specific pelvic anatomy, which allows the precise identification of pathways relationships of complex fistulae for preoperative planning and surgical counseling in a tertiary hospital in the northeast of Brazil.

Methods

Initially, an MRI was performed on a Magnetom Avanto 1.5 T device (Siemens Medical System; Erlangen, Germany), with our institution's usual protocol for perianal fistulas, which included T2-weighted sequences in the axial, coronal (with an angulation for the anal canal) and sagittal planes, as well as T1-weighted post-contrast sequences, STIR and diffusion sequences, with 3-mm thick slices. The images were exported to Vitrea fX Workstation[®] software (Vital Images Corporation – Toshiba Medical Images)[®]. An experienced radiologist analyzed and did the image segmentation. The aim of the segmentation was to identify the following anatomical aspects: anal canal, levator ani musculature (external anal sphincter), internal anal sphincter muscles, fistulous paths (including internal and external orifices' positioning).

After segmentation, the images were sent in a CAD-compatible format (.STL) to a 3D image processing software (Meshlab v. 1.3.3 – ISTI – CNR Research Center, Pisa University, Italy). Colors were attributed to the different anatomical structures, in order to facilitate identification. The fistulous paths were marked in purple, levator ani muscles in red, and the rectum in blue. The final three-dimensional colored model allowed the control of rotation, zoom use, and the selection of any 3D object, individually or grouped. The software was tested in the preoperative period and applied during the surgery, in the trans-operative stage, for orientation of the surgeon both in the catheterization of the fistulous paths and the internal orifice and in the identification of the adjacent structures.

Results

Man, 52 years old, with a history of pain and anorectal secretion lasting two years. In the proctological examination,

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