Analysis with Ultrasound of Different Surgical Meshes for Abdominal Hernia Repair: Experimental Study

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Abstract

Objective: To evaluate the ultrasound dampening effect of the different types of meshes abdominal surgery after implantation in Wistar rats.

Method: We used two Wistar rats, assessed positions and different types of meshes. The animals were anesthetized prior to surgery to open the abdominal cavity for placement of the prosthesis. Divided into three stages, 1) analysis of the abdominal cavity with ultrasound and no mesh 2) onlay position (mesh placed anterior the abdominal muscles) 3) underlay (intraperitoneal) for the posterior muscular. The meshes were used polypropylene (PP), polyester (PE), polypropylene/poliglecaprone (PU), polytetrafluoroethylene condensate (MO), polyester/collagen (PC) and polypropylene/polydioxanone/oxidized regenerated cellulose (PRO). The animals were euthanized after the procedure.

Results: There was no need to exclude the animals. The initial assessment showed no areas of difficulty or ease that would harm the exam. In all analyzes there was no problem identifying the the skin and subcutaneous tissue. There was a statistically significant difference in the attenuation of the meshes in both the onlay position p<0.001. Underlay position there was a small improvement in the graduation, with PE median (min-max) of 3 (2-5), PP, PU with 2 (1-5) and PC 2 (2-5) followed by PRO mesh with 1 (2-5) and MO with 0 (0-5) with statistical significance at p=0.001. However there was no comparison to the same mesh in two positions on the all meshes.

Conclusion: All types of meshes used in this study was independent of the position of the sound degree attenuation in ultrasound examination. The polyester mesh got to take a lower degree of attenuation compared with other meshes of the study. Is needed a new test to check the attenuation in the long term.

Keywords:
Incisional-hernia; Mesh; Adhesions; Polypropylene; Polyester; Ultrasound; Attenuation

Introduction

Prostheses and biomaterials represent a major contribution in the repair of abdominal wall defects. Currently, its use is accepted and spread throughout the world, especially in difficult and recurrent in both conventional surgery and laparoscopic hernia repair in approach [1].

Currently there is a wide variety of biomaterials that can be used in the repair of hernias. The lack of consensus on the use of these meshes become necessary analyzes the advantages and disadvantages of each one specifically.
Methods

Delineation

The present study was conducted in the form of a longitudinal experimental, prospective study. Developed on the premises of the bioterium, Lutheran University of Brazil (ULBRA) through the use of the protocols used by the institution and approved by the ethics committee itself.

Sample

Was used for sample 2 Wistar rats (Rattus norvegicus albinus Rodentia mammalia). Adult with 30 weeks of life. The animals were housed in the same cage until the period of the examination, at a temperature between 22°C and 24°C, with supply of water and food ad libitum (ration Nuvital, Nuvilab, Colombo, PR, Brazil). The animals were randomly allocated by a simple draw.

Inclusion criteria

1) Wistar rat aged 30 weeks or weighing more than 450 grams
2) Do not have brothers
3) Have not undergone previous treatment

Exclusion criteria

1) Visible anatomical distortion before the ultrasound
2) Visible anatomical distortion during the ultrasound examination
3) Anatomic distortion viewed at necropsy

Sequence of procedure

Two animals that were on ultrasound met all the criteria above. Initially anesthetized prior to examination to identify the structures evaluated.

Times of measurement

1) Analysis of ultrasound abnormalities of the abdominal cavity; gone to the next step and score check sonographic scores negative.
2) Insert each prior to the rectus abdominis mesh below the subcutaneous tissue and attempt to visualize the proposed structures, being replaced until the sixth mesh to be seen by switching the animals and masked analysis of the radiologist;
3) Evaluation and visualization in the intraperitoneal position with ultrasound for examination of abdominal structures.

Procedures

For the procedures, the animals were anesthetized with an intramuscular injection of Xylazine (0.1 ml of 2% solution diluted in 0.2 ml of 0.9% saline) at a dose 5 mg/kg and an intramuscular injection of ketamine (0.35 ml of 50 mg/ml solution) at a dose of 50 mg/kg, as directed by the responsible veterinary bioterium.

After anesthetic induction, the animals were placed in the supine position correctly and members with the help of cords were fixed. Shaving the anterior abdominal wall, and then antiseptic with an alcoholic solution of 2% chlorhexidine was performed [2-21].

Ultrasound examination was performed by an experienced radiologist masked to the types of meshes and positioning the mesh (before or after the abdominal wall muscles). The ultrasound device used in the analysis was a model Medison SA-5500 Sonoace CO.LTDA (digital), Korea. The frequency of 7.5 MHz transducer (probe) to capture linear images and recorded using camera Sony DSC 1154 (Tokyo, Japan).

After antisepsis, lateral skin incision was made was made larger area to leave a smooth surface for ultrasound analysis. After, there was a dissection of the subcutaneous and placement of meshes one by one leaving exposed only the area of comparative interest.

In the third steps, the median 4 cm incision was made to access the peritoneal cavity and insertion of the mesh under the rectus abdominis and new ultrasound analysis. The incision was closed in plans with suture mononylon 4.0 continuous. After the end of the procedure the animal was euthanized closed with carbon monoxide with one-way valve system camera. After euthanasia, review of abnormality of the abdominal cavity was performed. The degree of visualization was identified according to the tables of the degree of ultrasound visualization [22,23] (Table 1).

<table>
<thead>
<tr>
<th>Degree</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>Normal</td>
</tr>
<tr>
<td>4</td>
<td>Minimal restriction</td>
</tr>
<tr>
<td>3</td>
<td>Partly distinguishes</td>
</tr>
<tr>
<td>2</td>
<td>Distinguished, but with restrictions</td>
</tr>
<tr>
<td>1</td>
<td>Unable to distinguish the structures</td>
</tr>
<tr>
<td>0</td>
<td>Not displayed structures (acoustic shadow)</td>
</tr>
</tbody>
</table>

Table 1: Description of the degree of visualization by ultrasound attenuation

Variables

The study evaluated the following variables: the normal presence and distribution of the structures in the abdominal cavity and wall. Were evaluated by scores from (Table 1) the structures skin, subcutaneous tissue, muscles of the anterior wall, liver, spleen, kidney, bowel and bladder, with or without the presence of prosthesis in two different positions. The position described as onlay was placed anterior to the abdominal wall prosthesis and underlay placed intraperitoneally (on the posterior of the abdominal wall).

Data analysis

Continuous variables were described by median, minimum and maximum. The categorical variables were described in association. The test used was the Wilcoxon and Friedman verifies the association between variables. In all tests the significance level of 5% was used. Analyses were performed using SPSS (Statistical Package for Social Science) version 17.0.

Ethical aspects

This work was submitted to the Lutheran University of Brazil Ethics Committee, passed in accordance with the protocols required by this committee for experiments to be conducted on animals.
Financial aspects

The survey was conducted only with resources from researchers without support from external sponsors or companies having no conflicts of interest in this study.

Results

All animals offered for analysis met the criteria for the study. At the initial examination was not found anatomical changes. The thickness of the skin and subcutaneous tissue was 3 mm, with the same measure in relation to the muscles of the anterior abdominal wall, in the two animals (Figure 1).

In the evaluation of the prostheses placed in both the anterior abdominal wall muscles (onlay) and the position intraperitoneal (underlay) position was no loss of display quality in all devices used.

Figure 1: Lateral incision for insertion of the meshes in onlay position

Figure 2: Different types of meshes used: a) Polypropylene, b) Polypropylene-polyglecaprone, c) Polypropylene-polylactidoxanon/cellulose oxidized regenerated, d) Polyester/collagen and) polyester, f) condensed polytetrafluoroethylene (PTFEc)

The analysis of the meshes in the attenuation was no difference between the meshes in the same position with p<0.001 and p=0.001 for onlay to underlay (Figure 2 and Table 2). Graduation of the meshes relative to onlay placement (Figure 3) presented with PE mesh structures analyzed a median of 2 with a minimum of 2 and maximum of 5. Meshes PP, PU and PC had similar view with respect to a median of 2 and a minimum of 1 and maximum of 5. Then the PRO mesh with a median of 1, minimum 1 and maximum of 5, with the worst performance and effect of posterior acoustic shadowing the MO mesh with median 0, minimum 0, maximum 5).

Table 2: Distribution of median score in the ultrasound analysis of the meshes and the position in relation to the muscles of the anterior wall (md=median, min=minimum and max=maximum)

<table>
<thead>
<tr>
<th>Type of Meshes</th>
<th>Onlay</th>
<th>Underlay</th>
<th>Value-p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP polypropylene</td>
<td>2 (1 – 5)</td>
<td>2 (1 – 5)</td>
<td>0,257</td>
</tr>
<tr>
<td>PE Polyester</td>
<td>2 (2 – 5)</td>
<td>3 (2 – 5)</td>
<td>0,102</td>
</tr>
<tr>
<td>UP PP/polyglecaprone</td>
<td>2 (1 – 5)</td>
<td>2 (1 – 5)</td>
<td>0,102</td>
</tr>
<tr>
<td>MO PTFEc</td>
<td>0 (0 – 5)</td>
<td>0 (0 – 5)</td>
<td>0,317</td>
</tr>
<tr>
<td>PRO PP/cellulose</td>
<td>1 (1 – 5)</td>
<td>1 (2 – 5)</td>
<td>0,059</td>
</tr>
<tr>
<td>PC Polyester/collagen</td>
<td>2 (1 – 5)</td>
<td>2 (2 – 5)</td>
<td>0,102</td>
</tr>
<tr>
<td>Value-p**</td>
<td>&lt;0,001</td>
<td>0,001</td>
<td></td>
</tr>
</tbody>
</table>

* test of Wilcoxon ** test of Friedman

Underlay in position (Figure 4) remained the same relationship of onlay and there was a small improvement in the graduation, with PE median (min-max) of 3 (2-5), PP, PU with 2 (1-5) and PC 2 (2-5) followed by PRO mesh with 1 (2-5) and MO with 0 (0-5) with
statistical significance at p=0.001, using the Friedman test (Table 2 and Figure 5).

Figure 4: Degree of attenuation of the meshes in the underlay position. PP=polypropylene, UP=polypropylene/polyglecaprone, PRO=polypropylene/oxidized regenerated cellulose, PC=Polyester/collagen, PE=Polyester, MO=Polytetrafluoroethylene condensate.

Discussion

The use of only two animals was the optimization of laboratory animals and the possibility of comparison. There was no need to exclude the animals by anatomical defect and can be evaluated. The initial assessment showed no difficulty or mitigation areas that harmed the exam. In all the analysis were visualized seamlessly skin and subcutaneous tissue.

In concordance with previous studies, the animals of this study, which received independent implementation of the previous meshes in intraperitoneal position shows a loss of quality of the ultrasound image [23,24]. Whereas there was no significant statistical difference between the same mesh in different positions, showed a trend towards a higher degree when placed in position underlay (intraperitoneal), since the identification of muscle tissue can be fully evaluated at this position.

Following the trend of decreasing the obstructive effect of attenuation of the sound beam was no significant difference between the meshes used. The characteristics of the meshes being used single sided as PP, PE, PU and MO just had different behavior depending on their composition monofilament or multifilament, thicknesses and pore size. In this evaluation the mesh was less attenuation PE mesh, followed by PP and UP, and worst reviewed MO mesh for presenting the effect of posterior acoustic shadowing in both positions [25-29].

The analysis of meshes with double-sided (covering) there was a lower degree of attenuation using the PC mesh in relation to the PRO, but no statistical difference between them, however there was no spare acoustic MO [29] seen on mesh [30].

The limitation of the study is the use of only two animals and a single analysis.

Since the analysis after inflammatory process could influence the image and degree of attenuation of the ultrasound beam.

Figure 5: MO: mesh PTFEc in onlay position images on the left with posterior acoustic shadow (PAS) and right mesh without showing the kidney in normal position.

An evaluation to be considered is the time of review, requiring the comparative long-term inflammation caused by foreign body and also by absorption of the fabrics or fabrics with double sided coated.

Conclusion

All types of meshes used in this study and previous or intraperitoneal position there was a statistically significant greater attenuation of the sound beam on ultrasound examination. The polyester mesh got to take a lower degree of attenuation compared with other meshes of the study. Is needed a new test to verify attenuation in the long term.

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References