Effects of Transabdominal Preperitoneal (TAPP) repair combined with biological mesh on reproductive function in male inguinal hernia patients of reproductive age: A single-center retrospective study

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Abstract

Objective

To investigate the impact of Transabdominal Preperitoneal (TAPP) repair combined with biological mesh on the reproductive function of male inguinal hernia patients during their reproductive period, we conducted a retrospective analysis.

Methods

Sixty male inguinal hernia patients admitted to our department from October 2015 to October 2021 were included in the study. All patients underwent TAPP combined with biological mesh performed by the same surgical team. Prior to surgery, as well as at 3, 6, and 12 months post-surgery, bilateral testicular volume, testicular temperature, testicular blood perfusion, peripheral serum testosterone concentration, and semen analysis were assessed.

Results

The preoperative testicular volume, temperature, and blood perfusion were compared between the healthy side and the affected side. Additionally, the testicular volume, temperature, blood perfusion of the affected side, peripheral blood testosterone concentration, and semen analysis were compared at four different time points: before operation, 3 months after operation, 6 months after operation, and 12 months after operation. It is worth noting that all P values were found to be greater than 0.05.

Conclusions

Transabdominal Preperitoneal repair combined with biological mesh has no significant effect on the reproductive function of reproductive male patients with inguinal hernia.

1. Introduction

Inguinal hernia is a common disease in general surgery, with a higher incidence in males compared to females[1]. Surgical intervention is the only effective treatment for inguinal hernia. Laparoscopic trans-abdominal preperitoneal hernia repair (TAPP) is a well-established and widely used technique, known for its safety, quick recovery, and ease of mastery by clinicians[2]. Currently, most researchers believe that local inflammatory reactions resulting from injury to the spermatic cord and adhesion between the patch and spermatic cord tissue can impact male reproductive function after inguinal hernia repair[3]. However, many studies on this topic are limited to animal experiments or individual case reports. This study is a retrospective analysis of 60 male patients with inguinal hernia in our department. The aim is to investigate whether the combination of TAPP and bio-mesh has any impact on the reproductive function of male patients in their reproductive period.

2. Materials and Methods

2.1 Materials.
A total of sixty male patients with primary unilateral inguinal hernia in the reproductive period were admitted to our department from October 2015 to October 2021. Among them, 14 cases (23.33%) had left inguinal hernia and 46 cases (76.67%) had right inguinal hernia. The average age of the patients was \((26.93 \pm 6.28)\) years. The duration of the disease ranged from 1 to 240 months, with an average of \(50.56 \pm 67.89\) months. The inclusion criteria for the study were as follows: American Society of Anesthesiologists grade 1 to 2, no anticoagulant and anti-inflammatory therapy within 1 month before surgery, and normal reproductive system development. All patients underwent TAPP surgery under general anesthesia, performed by the same team of physicians. Biodesign biological mesh (10 cm×15 cm) produced by COOK company was used for the surgery (Fig. 1).

2.2 Variables.

Bilateral testicular volume, testicular temperature, testicular blood perfusion, peripheral serum testosterone concentration, and semen analysis were assessed at four different time points: before surgery, 3 months after surgery, 6 months after surgery, and 12 months after surgery.

2.3 Operation.

(1) Prior to the procedure, the patient was given general anesthesia and positioned with the head lowered and feet elevated at an angle of \(15\)–\(30\) degrees. (2) Trocars were placed by making a 1.0cm arc-shaped incision on the upper edge of the navel and inserting a 1.0cm trocar to establish CO2 artificial pneumoperitoneum. With the assistance of a laparoscope, operation holes were created at the level of the umbilicus lateral to the rectus abdominis on both sides, with a size of 0.5cm on the left side and 1.0cm on the right side. (3) The peritoneum was incised from the medial umbilical wall to the superior iliac spine, approximately 2.5cm above the hernia ring (while avoiding going beyond the medial umbilical ligament). (4) Exposure of the preperitoneal space: In the case of a direct hernia, the hernia sac can be removed directly. If the diameter of the hernia ring is greater than 3cm, the hernia sac is pulled back and sutured on the pubic comb. For an indirect hernia, the hernia sac is completely stripped and closed or transected at an appropriate position. If the hernia sac is closely connected, it can be transected at the neck of the hernia sac. The myopic foramen is fully exposed. (5) Placement of mesh: A Biodesign mesh measuring 10 cm × 15 cm is placed in the separated preperitoneal space to cover the myopic foramen. The mesh is fixed punctately with medical chemical glue. (6) Closure of peritoneum: The incision peritoneum is sutured with a 3 – 0 absorbable suture (GL122 3 – 0). (Fig. 2).

2.4 Statistical analysis.

SPSS 26.0 statistical software was used for data analysis, and the patient data were following a normal distribution. For the measurement data, \(x \pm s\) was used. Paired t-test was used for pairwise comparison, and one-way ANOVA was used for multiple-group comparison. \(P<0.05\) means the difference is statistically significant.

3. Results

All 60 patients successfully completed the TAPP operation and follow-up. During the operation, the hernia ring defect was found to be \(2.5 \pm 0.8\)cm. Additionally, there were 5 patients who had contralateral hidden hernias, which were not treated at the same time. Fortunately, no complications such as vas deferens injury or inferior epigastric artery injury occurred. After the operation, 4 cases of low fever were observed, but they subsided spontaneously without any special treatment. There were also 3 cases of groin pain and 2 cases of high fever, all
of which were confirmed to be due to the presence of seroma. However, after ultrasound-guided puncture and aspiration, all symptoms were relieved.

The collected data was analyzed using SPSS 26.0 software. We compared the preoperative testicular volume, temperature, and blood perfusion between the healthy side and the affected side (Table 1). Additionally, we compared the testicular volume, temperature, and blood perfusion of the affected side, peripheral blood testosterone concentration, and semen analysis at four different time points: before operation, 3 months after operation, 6 months after operation, and 12 months after operation (Table 2). It is worth noting that all P values were found to be greater than 0.05.

### Table 1
Comparison of the healthy side and the affected side before surgery

<table>
<thead>
<tr>
<th>Variable</th>
<th>the healthy side</th>
<th>the affected side</th>
<th>Statistics</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>testicular volume (cm³)</td>
<td>10.81 ± 1.08</td>
<td>10.79 ± 1.05</td>
<td>0.75</td>
<td>0.46</td>
</tr>
<tr>
<td>testicular temperature (°C)</td>
<td>36.08 ± 0.26</td>
<td>36.11 ± 0.34</td>
<td>-0.82</td>
<td>0.41</td>
</tr>
<tr>
<td>spermatic vein diameter (mm)</td>
<td>1.98 ± 0.15</td>
<td>1.99 ± 0.14</td>
<td>-0.34</td>
<td>0.75</td>
</tr>
<tr>
<td>the maximum blood flow of spermatic artery (cm/s)</td>
<td>13.18 ± 1.45</td>
<td>13.09 ± 1.35</td>
<td>1.67</td>
<td>0.10</td>
</tr>
<tr>
<td>spermatic artery resistance coefficient</td>
<td>0.76 ± 0.05</td>
<td>0.76 ± 0.04</td>
<td>0.63</td>
<td>0.52</td>
</tr>
</tbody>
</table>
Table 2
Comparison of relevant indicators at four-time points (preoperative, 3 months postoperative, 6 months postoperative, and 12 months postoperative).

<table>
<thead>
<tr>
<th>Variable</th>
<th>preoperative</th>
<th>3 months postoperative</th>
<th>6 months postoperative</th>
<th>12 months postoperative</th>
<th>Statistics</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>testicular volume (cm³)</td>
<td>10.81 ± 1.08</td>
<td>10.72 ± 1.09</td>
<td>10.71 ± 1.02</td>
<td>10.79 ± 1.05</td>
<td>0.121</td>
<td>0.95</td>
</tr>
<tr>
<td>testicular temperature (°C)</td>
<td>36.02 ± 0.26</td>
<td>36.14 ± 0.32</td>
<td>36.17 ± 0.35</td>
<td>36.19 ± 0.28</td>
<td>1.47</td>
<td>0.22</td>
</tr>
<tr>
<td>spermatic vein diameter (mm)</td>
<td>1.98 ± 0.15</td>
<td>2.02 ± 0.14</td>
<td>2.01 ± 0.16</td>
<td>2.01 ± 0.16</td>
<td>0.64</td>
<td>0.59</td>
</tr>
<tr>
<td>the maximum blood flow of spermatic artery (cm/s)</td>
<td>13.18 ± 1.45</td>
<td>13.33 ± 1.35</td>
<td>13.35 ± 1.34</td>
<td>13.35 ± 1.40</td>
<td>0.21</td>
<td>0.89</td>
</tr>
<tr>
<td>spermatic artery resistance coefficient</td>
<td>0.76 ± 0.05</td>
<td>0.76 ± 0.05</td>
<td>0.76 ± 0.04</td>
<td>0.76 ± 0.05</td>
<td>0.80</td>
<td>0.97</td>
</tr>
<tr>
<td>testosterone concentration (ng/mL)</td>
<td>3.98 ± 0.84</td>
<td>3.98 ± 0.82</td>
<td>3.97 ± 0.80</td>
<td>4.00 ± 0.86</td>
<td>0.14</td>
<td>0.99</td>
</tr>
<tr>
<td>acrosomal enzyme (u/L)</td>
<td>30.71 ± 5.78</td>
<td>30.41 ± 5.83</td>
<td>30.73 ± 5.68</td>
<td>30.65 ± 5.48</td>
<td>0.04</td>
<td>0.99</td>
</tr>
<tr>
<td>Fructose (mmol/L)</td>
<td>12.53 ± 1.76</td>
<td>12.53 ± 1.70</td>
<td>12.46 ± 1.68</td>
<td>12.47 ± 1.70</td>
<td>0.03</td>
<td>0.99</td>
</tr>
<tr>
<td>Semen volume (mL)</td>
<td>4.18 ± 1.73</td>
<td>3.76 ± 1.65</td>
<td>4.01 ± 1.70</td>
<td>4.14 ± 1.70</td>
<td>0.74</td>
<td>0.53</td>
</tr>
<tr>
<td>Semen concentration (M/mL)</td>
<td>67.54 ± 42.12</td>
<td>63.33 ± 40.47</td>
<td>66.12 ± 41.81</td>
<td>67.34 ± 42.21</td>
<td>0.13</td>
<td>0.94</td>
</tr>
<tr>
<td>sperm motility (a + b)</td>
<td>45.86 ± 21.59</td>
<td>41.78 ± 20.34</td>
<td>44.62 ± 21.23</td>
<td>44.71 ± 21.82</td>
<td>0.40</td>
<td>0.76</td>
</tr>
</tbody>
</table>

4. Discussion

Patients with inguinal hernia typically do not experience significant discomfort, but there is a risk of the hernia sac becoming incarcerated and strangulated. Additionally, in cases where the hernia sac is large and the history of the condition is prolonged, it can lead to local adhesion of the spermatic cord and varicocele at the site of the hernia sac. This can potentially affect the blood supply to the vas deferens and testes, resulting in a decline in male reproductive function. Surgical intervention is the only effective treatment for adult inguinal hernias. Therefore, surgical treatment is recommended for male patients with inguinal hernias during their reproductive period. The prevailing belief[3] is that the decrease in male reproductive function following inguinal hernia surgery is attributed to intraoperative spermatic cord injury and the local immune inflammatory response caused by adhesion between the patch and the spermatic cord.

Following the placement of the patch in the body, it triggers an acute inflammatory response initially, which later progresses into a chronic fibroproliferative response. This response leads to the development of scar tissue, which strengthens the abdominal wall and reduces the risk of hernia recurrence[4]. However, due to the close proximity of the patch to the spermatic cord, this chronic inflammatory reaction can cause the vas deferens to stick to the surrounding tissues, leading to blockage and other complications. Consequently, male reproductive function may
be affected. Maciel et al.[5] conducted a study using a rat model and found that the lumen of the vas deferens in contact with the patch became thinner and dilated. The mucosa also showed signs of disorder, and the motility of sperm in the lumen decreased. In a separate study, Shin et al.[6] reported 14 cases of azoospermia after hernia repair with polypropylene mesh in 2005. Surgical exploration confirmed that all of these cases had vas deferens occlusion on the operated side. Another case reported by Yamaguchi et al.[7] described infertility diagnosed 5 years after bilateral inguinal hernia repair with polypropylene mesh. Examination revealed slight enlargement of the right vas deferens and epididymis, and semen analysis showed a significant increase in sperm concentration within 5 months. However, the animal experiments and clinical reports mentioned above primarily involve the use of artificial synthetic material patches, mostly made of polypropylene. It is important to note that the tissue repair mechanism of biological mesh differs significantly from that of artificial synthetic material mesh[8, 9]. The biological mesh guides the tissue to undergo ‘intrinsic tissue regeneration’ after implantation. It consists of a frame structure of extracellular matrix that facilitates fibroblast ingrowth and collagen deposition. The intact extracellular matrix and revascularization enable the conversion of such repair materials into autologous tissue for repairing tissue defects. In this study, the biological mesh used is Biodesign, produced by COOK company in the United States. It is worth mentioning that Biodesign is a non-crosslinked biological material. This material exhibits characteristics such as carrying biological signals, tolerance to infection, complete tissue shaping, and long-lasting strength of regenerated tissue. It can effectively facilitate the long-term repair of tissues by promoting the natural regeneration of healthy tissues within the human body. This approach avoids the need for foreign bodies and prevents the formation of scars, thereby maximizing the structural and functional restoration of tissues in their original location[10].

In addition to the mesh factor, the surgical procedure itself also plays a significant role in the impact of inguinal hernia repair on male reproductive function. Leung et al.[11] conducted a follow-up study on 173 patients with unilateral inguinal hernia, ranging from 6 to 123 months, and observed that one patient experienced 50% testicular atrophy on the surgical side, while 10 patients exhibited 25% atrophy compared to the healthy side. Other studies have indicated that local immune inflammation resulting from intraoperative spermatic cord injury or patch adhesion to the spermatic cord tissue can cause damage to the blood-testis barrier and the release of anti-sperm antibodies (ASA) into the bloodstream. This, in turn, can lead to a decrease in sperm count and motility. Stula et al.[12] reported that 10% of patients diagnosed with infertility after inguinal hernia surgery had elevated serum ASA levels. They found that ASA levels were higher after traditional inguinal hernia patch repair compared to laparoscopic inguinal hernia repair, especially when the spermatic cord was overdrawn or injured during the operation. Singh et al.[13] concluded that laparoscopic surgery has less impact on reproductive function and is more protective of reproductive function compared to open surgery. Depending on the surgical method, laparoscopic inguinal hernia repair can be divided into TAPP, total extraperitoneal hemiorrhaphy (TEP), and laparoscopic intraperitoneal onlay mesh. TAPP and TEP are the most commonly used methods[14]. TEP is a surgical procedure that avoids entering the abdominal cavity, reducing the risk of abdominal organ injury and adhesion. However, it is a challenging operation that requires highly skilled surgeons and a long learning curve. It is most suitable for patients with a short medical history and small hernia sacs[15]. On the other hand, TAPP is performed within the abdominal cavity, and the patch is placed after creating a free preperitoneal space. While there is a risk of abdominal infection and adhesion, TAPP is easier to master, has broader indications, and shows good results for giant hernias and irreducible hernias. This operation is considered safe, with fast postoperative recovery, and its technology is well-established and easily mastered by clinicians[2].
In conclusion, our study found that standardized TAPP surgery combined with bio-mesh, resulting in a small foreign body reaction, has minimal impact on reproductive function. Therefore, it can be safely performed on male inguinal hernia patients during their reproductive period. We conducted this study on sixty reproductive-age male patients with inguinal hernia who underwent TAPP combined with biological mesh surgery at our center. The research revealed no significant differences in the temperature, volume, and blood perfusion of the affected testis, peripheral blood testosterone concentration, and semen biochemistry before surgery, as well as at 3 months, 6 months, and 12 months after surgery. These findings further support the aforementioned conclusions.

Based on our findings, we recommend the use of biological mesh for TAPP surgery in male inguinal hernia patients of reproductive age, especially those experiencing discomfort that significantly impacts their quality of life. During the procedure, it is advised for the operator to carefully separate the peritoneum while preserving the outer spermatic fascia and cremaster muscle to the greatest extent possible. Additionally, caution should be exercised during the separation of the hernia sac to avoid any damage to the blood supply of the spermatic cord and testis. In cases where the hernia sac tightly adheres to the spermatic cord and vas deferens, it may be necessary to cut it at the neck of the hernia sac. (4) Seroma is the most common complication after biological mesh repair of an inguinal hernia[16]. In cases where patients experience symptoms such as local pain and high fever, good results can be achieved through ultrasound-guided puncture and aspiration. (5) In male patients of reproductive age with bilateral inguinal hernia, it is not recommended to perform bilateral tension-free hernia repair simultaneously. Instead, it is advisable to wait until one year after unilateral mesh hernia repair to assess the normal testicular function on one side before proceeding with the repair on the other side. (6) In the context of performing inguinal hernia repair on male patients of reproductive age, particularly those with contralateral testicular dysfunction, it is crucial to provide comprehensive information about the potential risks of surgery on reproductive function. In situations where there is vas deferens occlusion, restoring vas deferens recanalization becomes highly challenging due to fibrosis and scar formation in the surgical area. As a result, it is advisable to consider cryopreservation of sperm prior to undergoing primary hernia repair.

5. Conclusion

TAPP combined with biological mesh has no significant effect on the reproductive function of reproductive male patients with inguinal hernia.

Abbreviations

TAPP  
Transabdominal preperitoneal
TEP  
Total extraperitoneal herniorrhaphy
USA  
United States
ASA  
anti-sperm antibodies.

Declarations

Acknowledgments
We want to thank our patients for consenting to the publication of the article.

**Authors' contributions**

Li-Xiao Zhang: patient recruitment, data collection and analysis, manuscript writing. Jia-Qi Kang: statistical analysis. Li-Fei Zhang: data collection, statistical analysis. Zhi-bin Ye and Hong-Yu Zhao: data collection and analysis, manuscript writing. Wei Liang: reviewed the manuscript, the primary surgeon of the research. All authors read and approved the final manuscript.

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None.

**Availability of data and materials**

All data related to the outcome are included in the manuscript.

**Ethics approval and consent to participate**

The study was approved by the Ethics Committee of Hebei General Hospital. As a new surgical procedure, all patients who underwent TAPP combined with biological mesh were given the written informed consent to the surgical procedure. All methods were performed in accordance with the ethical standards of the institutional ethics committee and Helsinki Declaration.

**Consent for publication**

Written informed consent was obtained from the patient for the publication of this case report and accompanying images.

**Competing interests**

All authors declare that they have no competing interests.

**References**


**Figures**
Figure 1

Biodesign biological patch (10 cm×15 cm) produced by COOK, USA.
Figure 2

Operation: A body position and placement of trocars; B exploration of the groin area; C incision of the peritoneum; D Exposure of preperitoneal space; E placement of mesh; F closure of the peritoneum.