

Research Article

Effects of TAPP Combined with Biological Mesh on Reproductive Function in Male Inguinal Hernia Patients of Reproductive Age: A Single-Center Retrospective Study

Li-Xiao Zhang,¹ Jia-Qi Kang,² Zhi-Bin Ye,¹ Li-Fei Zhang,¹ Hong-Yu Zhao,¹ Jiang-Nan Ge,³ and Wei Liang¹ 

¹Department of Gastrointestinal Surgery, Hebei General Hospital, Hebei 050051, China

²Department of Colorectal Surgery, Tianjin Union Medical Center, Tianjin 300121, China

³Department of Reproductive Genetics, Hebei General Hospital, Hebei 050051, China

Correspondence should be addressed to Wei Liang; liangw2023@163.com

Received 18 April 2023; Revised 4 October 2023; Accepted 6 October 2023; Published 31 October 2023

Academic Editor: Takashi Yazawa

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Objective. To explore the effect of laparoscopic trans-abdominal preperitoneal hernia repair (TAPP) combined with biological mesh on the reproductive function of male inguinal hernia patients during the reproductive period. **Methods.** Sixty male inguinal hernia patients during the reproductive period admitted to our department from October 2015 to October 2021 were selected for retrospective analysis. All patients were treated with TAPP combined with biological mesh by the same team. Bilateral testicular volume, testicular temperature, testicular blood perfusion, peripheral serum testosterone concentration, and semen analysis were examined before surgery, 3 months after surgery, 6 months after surgery, and 12 months after surgery. **Results.** The preoperative testicular volume, temperature, and blood perfusion were compared between the healthy side and the affected side; the testicular volume, temperature, blood perfusion of the affected side, peripheral blood testosterone concentration, and semen analysis were compared among the four time points, which were before operation, 3 months after operation, 6 months after operation, and 12 months after operation. All *p* values were >0.05 . **Conclusions.** The presence of inguinal hernia had no significant effect on the volume and blood perfusion of male testis. In addition, TAPP combined with biological mesh has no negative effect on postoperative reproductive function of male inguinal hernia patients of childbearing age, which manifested as a safe and feasible surgical method.

1. Introduction

Inguinal hernia is a common and frequently occurring disease in general surgery, and the incidence of male is significantly higher than that of female [1]. Surgery is the only way to cure inguinal hernia. Laparoscopic trans-abdominal preperitoneal hernia repair (TAPP) has high safety, fast postoperative recovery, and mature technology, is easy for clinicians to master, and has been widely used in the clinical practice [2]. At present, most scholars believe that the injury of the spermatic cord and the adhesion between the patch and the spermatic cord tissue can lead to local inflammatory reactions, which in turn affect the male reproductive function after inguinal hernia repair [3]; however, many studies are limited to animal experiments or only individual cases report. This

project is a retrospective study of 60 male inguinal hernia patients in our department, to explore whether TAPP combined with bio-mesh has any effect on the reproductive function of male inguinal hernia patients in a reproductive period.

2. Materials and Methods

2.1. Materials. Sixty male patients with primary unilateral inguinal hernia in the reproductive period admitted to our department from October 2015 to October 2021 were selected, including 14 cases (23.33%) of left inguinal hernia and 46 cases (76.67%) of right inguinal hernia. The average age was 26.93 ± 6.28 years. The course of disease ranged from 1 to 240 months, with an average of 50.56 ± 67.89 months. Inclusion criteria: American Society of Anesthesiologists (ASA)



FIGURE 1: Biodesign biological patch (10 cm × 15 cm) produced by COOK, USA.

Grade 1–2; no anticoagulant and anti-inflammatory therapy was received within 1 month before surgery; normal reproductive system development. All patients underwent TAPP surgery under general anesthesia by the same team of physicians using Biodesign biological mesh (10 cm × 15 cm) produced by COOK USA (Figure 1).

2.2. Variables. Bilateral testicular volume, testicular temperature, testicular blood perfusion, peripheral serum testosterone concentration, and semen analysis were examined before surgery, 3 months after surgery, 6 months after surgery, and 12 months after surgery.

2.3. Operation. (1) Preparation: general anesthesia, with the head lowered and feet elevated at 15–30°. (2) Placement of trocars: a 1.0 cm arc-shaped incision was made on the upper edge of the navel, and a 1.0 cm trocar was placed to establish CO₂ artificial pneumoperitoneum. Under the supervision of a laparoscope, place operation holes at the level of the umbilicus lateral to the rectus abdominis on both sides (0.5 cm on the left side and 1.0 cm on the right side). (3) Incision of the peritoneum: incision of the peritoneum from the medial umbilical wall to the superior iliac spine at a position of 2.5 cm above the hernia ring (no more than the medial umbilical ligament). (4) Exposure of preperitoneal space: for direct hernia, the hernia sac can be removed directly; if the diameter of the hernia ring was >3 cm, the hernia sac was pulled back and sutured on the pubic comb. For indirect hernia, the hernia sac was 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 was fully exposed. (5) Placement of mesh: a Biodesign mesh (10 cm × 15 cm) was placed in the separated preperitoneal space to cover the myopic foramen. The mesh was fixed punctately with medical chemical glue. (6) Closure of peritoneum: the incision peritoneum was sutured with a 3-0 absorbable suture (GL122 3-0) (Figure 2).

2.4. Statistical Analysis. SPSS 26.0 (IBM, Chicago, USA) 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 completed the TAPP operation and follow-up. Intraoperative conditions: the hernia ring defect was found to be 2.5 ± 0.8 cm, and there were five patients with contralateral hidden hernias (not treated at the same time), and no complications such as the vas deferens injury or inferior epigastric artery injury occurred. Postoperative conditions: four cases of low fever, without special treatment, subsided spontaneously; three cases of groin pain, two cases of high fever, all confirmed the presence of seroma, after ultrasound-guided puncture and aspiration, the symptoms were all relieved.

We used SPSS 26.0 software to analyze the collected data and found that: the preoperative testicular volume, temperature, and blood perfusion were compared between the healthy side and the affected side (Table 1); the testicular volume, temperature, and blood perfusion of the affected side, peripheral blood testosterone concentration, and semen analysis were compared among the four time points, which were before operation, 3 months after operation, 6 months after operation, and 12 months after operation (Table 2); all *p* values were >0.05.

4. Discussion

Patients with inguinal hernia typically do not experience significant discomfort. However, there is a potential risk of incarceration and strangulation of the hernia sac. Additionally, in cases where the hernia sac is large and the duration of the condition is prolonged, it can result in local adhesion of the spermatic cord and varicocele at the site of the hernia sac. This can adversely affect the blood supply to the vas deferens and testes, ultimately leading to a decline in male reproductive function. However, the impact of the presence of a hernia on testicular perfusion is still a subject of debate and has not been thoroughly studied. Studies by Beddy et al. [4] and EI-Awady et al. [5] have shown that the resistive index on the side of a unilateral hernia is significantly higher than that on the normal side. On the other hand, Neto et al. [6] and Ramadan et al. [7] did not observe any statistically significant elevation in resistive indexes. In this study, we conducted a comparison of testicular temperature, volume, and blood perfusion before surgery on both the inguinal hernia side and the healthy side. Our findings indicate that there is no significant difference between the two sides. Thus, this study does not provide evidence supporting the notion that inguinal hernias have an impact on testicular blood perfusion.

Laparoscopic repair has become the standard of care for patients with inguinal hernia [8]. After the patch is placed in the body, it triggers an acute inflammatory response in the short term, which later develops into a chronic fibroproliferative response. This response leads to the formation of scar tissue, strengthening the abdominal wall, and preventing hernia recurrence [9]. While the recurrence rate was a major

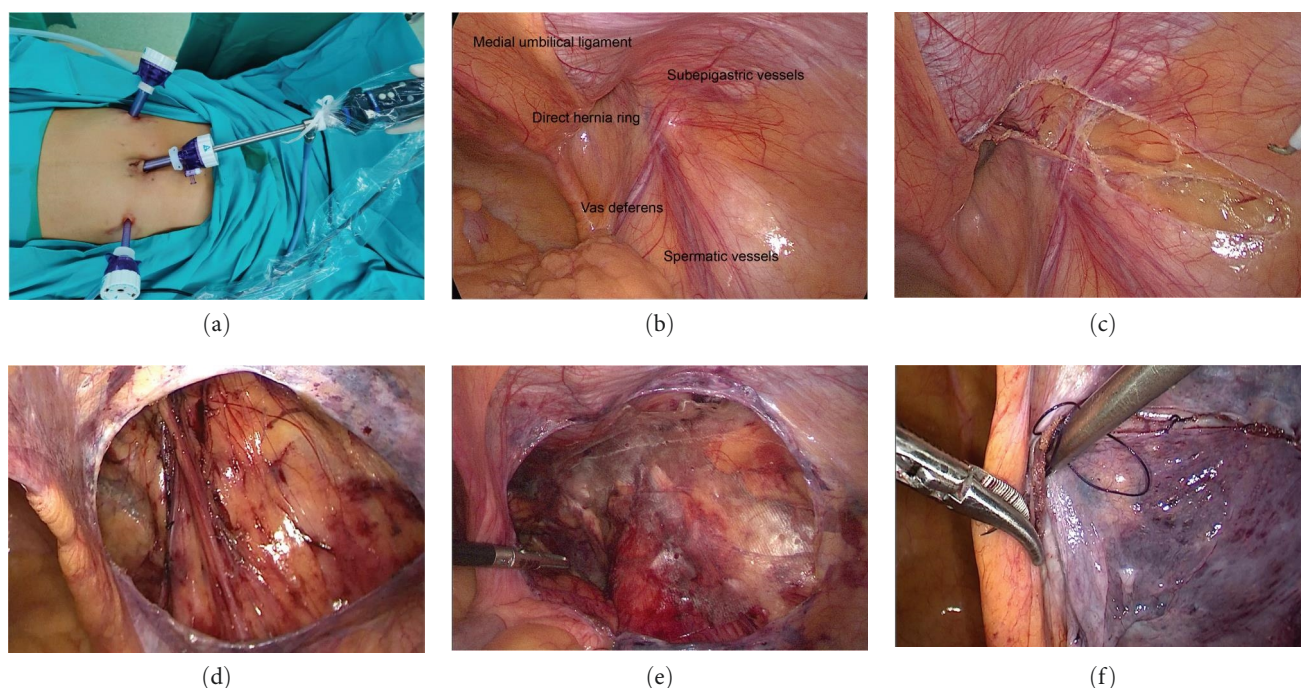


FIGURE 2: Operation: (a) body position and placement of trocars, (b) exploration of the groin area, (c) incision of the peritoneum, (d) exposure of preperitoneal space, (e) placement of mesh, and (f) closure of the peritoneum.

TABLE 1: Comparison of the healthy side and the affected side before surgery.

Variable	The healthy side	The affected side	Statistics	P value
Testicular volume (cm ³)	10.81 ± 1.08	10.79 ± 1.05	0.75	0.46
Testicular temperature (°C)	36.08 ± 0.26	36.11 ± 0.34	-0.82	0.41
Spermatic vein diameter (mm)	1.98 ± 0.15	1.99 ± 0.14	-0.34	0.75
The maximum blood flow of spermatic artery (cm/s)	13.18 ± 1.45	13.09 ± 1.35	1.67	0.10
Spermatic artery resistance coefficient	0.76 ± 0.05	0.76 ± 0.04	0.63	0.52

TABLE 2: Comparison of relevant indicators at four-time points (preoperative, 3 months postoperative, 6 months postoperative, and 12 months postoperative).

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

focus in previous studies, the standardization of surgical techniques has significantly reduced the recurrence rate [10]. Current research now emphasizes other adverse outcomes, such as the impact on testicular functions. The impact of inguinal hernia repair on male fertility has been a topic of discussion for decades [11]. Maciel et al. [12] 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. They also observed disordered mucosa and low motility of sperm in the lumen. In another study, Shin et al. [13] reported 14 cases of azoospermia after hernia repair with polypropylene mesh. Surgical exploration confirmed vas deferens occlusion on the operated side in all cases. This study was performed in eight surgical centers in the United States between 1988 and 2002. Yamaguchi et al. [14] reported a case of 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. Animal research has provided evidence of a strong association between mesh repairs for inguinal hernia and the potential for damage to the structures of the spermatic cord and testicle [15, 16]. Clinical reports have also indicated instances of infertility or testicular atrophy following inguinal hernia repair [13, 14, 17, 18]. However, the majority of clinical studies have not discovered a significant decline in male reproductive function after inguinal hernia patch repair, particularly over the long term. Stula et al. [19] conducted a comparison between TAPP and open repair, where they observed a noteworthy increase in the levels of anti-sperm antibodies (ASA) and the calculated mean resistive index (RI) of intratesticular vessels and capsular vessels after 3 months. Nevertheless, these changes were not statistically significant after 6 months postsurgery. In 2017, Kordzadeh et al. [20] conducted a systematic review and pooled analysis of male infertility following inguinal hernia repair. The study included 10 studies with a total of 35,740 patients. The findings indicated that sperm motility could be affected immediately after any type and/or technique of inguinal hernia repair, but this effect was limited to the postoperative period of ≤ 48 hr. Similar results have been observed in other studies evaluating the effect of laparoscopic inguinal hernia surgery on testicular perfusion. These studies have shown that testicular blood perfusion returns to normal several months after inguinal hernia surgery and is comparable to the levels prior to surgery [4, 21–23]. In this study, the testicular blood perfusion indexes, including spermatic vein diameter, the maximum blood flow of spermatic artery, and spermatic artery resistance coefficient, were compared at 3, 6, and 12 months after surgery with those before surgery. No significant differences were found, indicating that TAPP combined with biological patches did not have a significant impact on testicular blood perfusion in patients with inguinal hernias at these three time points after surgery. The temperature and volume of the inguinal hernia side testis were also compared at 3, 6, and 12 months after surgery with those before surgery, and no relevant differences were observed. Therefore, TAPP combined with biological patches did not lead to testicular

atrophy in patients with inguinal hernias at these three time points after surgery.

Fertility is a crucial concern for patients, particularly those in their reproductive age, and holds significant medical and legal implications. In prospective [24] and retrospective [25] trials, it has been observed that mesh repair of inguinal hernia does not hurt male fertility. Silber et al. [26] conducted a study on 333 patients with groin hernias and found that men who had undergone inguinal hernia repair either during childhood or later did not have lower sperm quality compared to men who had not undergone groin surgery. Since fertility cannot be directly measured, this study indirectly assessed fertility in inguinal hernia patients by analyzing peripheral blood testosterone concentration and semen parameters such as acrosomal enzyme, fructose, semen volume, and semen concentration. The researchers conducted a comparative study by analyzing these factors 3, 6, and 12 months after surgery and comparing them with the pre-operative values. No significant differences were observed, indicating that TAPP combined with biological patches did not lead to a decline in fertility among inguinal hernia patients during these postoperative time points.

The study aimed to investigate whether rates of infertility in patients with inguinal hernia repair differed from those in the general population. A national registry study [27] was conducted in Denmark, collecting data on 32,621 male patients aged 18–55 who underwent one or more inguinal hernia repairs between 1998 and 2012. The study compared these patients with 97,805 controls and recorded the number of children each participant fathered as the primary outcome. The findings revealed that the number of children fathered by patients who underwent inguinal hernia repair using the Lichtenstein technique or laparoscopic surgery was not lower than expected. Therefore, this study suggests that male fertility is not negatively affected by inguinal hernia repair using either Lichtenstein or laparoscopic methods.

The sample size of our study ($n = 60$) is relatively small and does not have sufficient statistical power. However, the findings of our study align with the majority of the existing literature worldwide.

This study has certain limitations that should be considered. First, it is important to note that it is a single-center retrospective study, which may limit the generalizability of the findings. Additionally, the sample size used in this study is relatively small. Finally, the study had a relatively short follow-up period. Therefore, future research should aim to collaborate with multiple centers to conduct studies with a larger sample size and longer follow-up time, allowing for more robust and comprehensive results.

5. Conclusion

The presence of inguinal hernia had no significant effect on the volume and blood perfusion of male testis. In addition, TAPP combined with biological mesh has no negative effect on postoperative reproductive function of male inguinal hernia patients of childbearing age, which manifested as a safe and feasible surgical method.

Data Availability

The data supporting the findings of this study are available from the corresponding author, Wei Liang, upon reasonable request.

Disclosure

The original manuscript of the study is presented as preprint at the Research Square [28].

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Li-Xiao Zhang and Jia-Qi Kang contributed equally to this work.

References

- [1] C. Kangwen and W. Guihe, "Efficacy of laparoscopic percutaneous extraperitoneal closure for unilateral inguinal hernia in children and significance of simple exploration maneuver for contralateral patent processus vaginalis: a retrospective study," *The American Surgeon*, vol. 84, no. 5, pp. 732–738, 2018.
- [2] U. Scheuermann, S. Niebisch, O. Lyros, B. Jansen-Winkel, and I. Gockel, "Transabdominal preperitoneal (TAPP) versus Lichtenstein operation for primary inguinal hernia repair—a systematic review and meta-analysis of randomized controlled trials," *BMC Surgery*, vol. 17, no. 1, Article ID 55, 2017.
- [3] B. Restrepo and W. Cardona-Maya, "Antisperm antibodies and fertility association," *Actas Urológicas Españolas (English Edition)*, vol. 37, no. 9, pp. 571–578, 2013.
- [4] P. Beddy, P. F. Ridgway, T. Geoghegan et al., "Inguinal hernia repair protects testicular function: a prospective study of open and laparoscopic herniorrhaphy," *Journal of the American College of Surgeons*, vol. 203, no. 1, pp. 17–23, 2006.
- [5] S. E. El-Awady and A. A.-M. Elkholy, "Beneficial effect of inguinal hernioplasty on testicular perfusion and sexual function," *Hernia*, vol. 13, no. 3, pp. 251–258, 2009.
- [6] E. V. de Lima Neto, A. Goldenberg, and M. J. Jucá, "Prospective study on the effects of a polypropylene prosthesis on testicular volume and arterial flow in patients undergoing surgical correction for inguinal hernia," *Acta Cirurgica Brasileira*, vol. 22, no. 4, pp. 266–271, 2007.
- [7] S. U. Ramadan, D. Gokharman, I. Tuncbilek et al., "Does the presence of a mesh have an effect on the testicular blood flow after surgical repair of indirect inguinal hernia?" *Journal of Clinical Ultrasound*, vol. 37, no. 2, pp. 78–81, 2009.
- [8] M. Gass, V. M. Banz, L. Rosella, M. Adamina, D. Candinas, and U. Güller, "TAPP or TEP? Population-based analysis of prospective data on 4,552 patients undergoing endoscopic inguinal hernia repair," *World Journal of Surgery*, vol. 36, no. 12, pp. 2782–2786, 2012.
- [9] R. G. Uzzo, G. E. Lemack, K. P. Morrissey, and M. Goldstein, "The effects of mesh bioprosthesis on the spermatic cord structures: a preliminary report in a canine model," *Journal of Urology*, vol. 161, no. 4, pp. 1344–1349, 1999.
- [10] L. Neumayer, A. Giobbie-Hurder, O. Jonasson et al., "Open mesh versus laparoscopic mesh repair of inguinal hernia," *New England Journal of Medicine*, vol. 350, no. 18, pp. 1819–1827, 2004.
- [11] H. Tekatli, N. Schouten, T. van Dalen, I. Burgmans, and N. Smakman, "Mechanism, assessment, and incidence of male infertility after inguinal hernia surgery: a review of the preclinical and clinical literature," *The American Journal of Surgery*, vol. 204, no. 4, pp. 503–509, 2012.
- [12] L. C. Maciel, S. Glina, P. C. R. Palma, N. F. C. Costa, and N. R. Netto, "Histopathological alterations of the vas deferens in rats exposed to polypropylene mesh," *BJU International*, vol. 100, no. 1, pp. 187–190, 2007.
- [13] D. Shin, L. I. Lipshultz, M. Goldstein et al., "Herniorrhaphy with polypropylene mesh causing inguinal vasal obstruction: a preventable cause of obstructive azoospermia," *Annals of Surgery*, vol. 241, no. 4, pp. 553–558, 2005.
- [14] K. Yamaguchi, T. Ishikawa, Y. Nakano, Y. Kondo, M. Shiotani, and M. Fujisawa, "Rapidly progressing, late-onset obstructive azoospermia linked to herniorrhaphy with mesh," *Fertility and Sterility*, vol. 90, no. 5, pp. 2018.e5–2018.e7, 2008.
- [15] K. Agnihotri, S. Awasthi, H. Chandra, U. Singh, and S. Thakur, "Validation of WHO QOL-BREF instrument in Indian adolescents," *The Indian Journal of Pediatrics*, vol. 77, no. 4, pp. 381–386, 2010.
- [16] E. Myers, K. M. Browne, D. O. Kavanagh, and M. Hurley, "Laparoscopic (TEP) versus Lichtenstein inguinal hernia repair: a comparison of quality-of-life outcomes," *World Journal of Surgery*, vol. 34, no. 12, pp. 3059–3064, 2010.
- [17] G. Akbulut, M. Serteser, A. Yücel et al., "Can laparoscopic hernia repair alter function and volume of testis? Randomized clinical trial," *Surgical Laparoscopy, Endoscopy & Percutaneous Techniques*, vol. 13, no. 6, pp. 377–381, 2003.
- [18] Z. T. Homonnai, N. Fainman, G. F. Paz, and M. P. David, "Testicular function after herniotomy herniotomy and fertility," *Andrologia*, vol. 12, no. 2, pp. 115–120, 1980.
- [19] I. Štula, N. Družijanić, A. Sapunar, Z. Perko, N. Bošnjak, and D. Kraljević, "Antisperm antibodies and testicular blood flow after inguinal hernia mesh repair," *Surgical Endoscopy and Other Interventional Techniques*, vol. 28, no. 12, pp. 3413–3420, 2014.
- [20] A. Kordzadeh, M. O. Liu, and N. V. Jayanthi, "Male infertility following inguinal hernia repair: a systematic review and pooled analysis," *Hernia*, vol. 21, no. 1, pp. 1–7, 2017.
- [21] A. S. Celik, N. Memmi, F. Celebi et al., "Impact of slit and nonslit mesh technique on testicular perfusion and volume in the early and late postoperative period of the totally extraperitoneal preperitoneal technique in patients with inguinal hernia," *The American Journal of Surgery*, vol. 198, no. 2, pp. 287–291, 2009.
- [22] S. Ersin, U. Aydin, O. Makay et al., "Is testicular perfusion influenced during laparoscopic inguinal hernia surgery?" *Surgical Endoscopy and Other Interventional Techniques*, vol. 20, no. 4, pp. 685–689, 2006.
- [23] N. Koksall, E. Altinli, A. Sumer et al., "Impact of herniorrhaphy technique on testicular perfusion: results of a prospective study," *Surgical Laparoscopy, Endoscopy & Percutaneous Techniques*, vol. 20, no. 3, pp. 186–189, 2010.
- [24] M. Hallén, G. Sandblom, P. Nordin, U. Gunnarsson, U. Kvist, and J. Westerdahl, "Male infertility after mesh hernia repair: a prospective study," *Surgery*, vol. 149, no. 2, pp. 179–184, 2011.
- [25] M. Hallén, J. Westerdahl, P. Nordin, U. Gunnarsson, and G. Sandblom, "Mesh hernia repair and male infertility: a retrospective register study," *Surgery*, vol. 151, no. 1, pp. 94–98, 2012.
- [26] S. Silber, V. M. Becker, R. Seufert, and O. J. Muensterer, "Fertility in males after childhood, adolescent, and adult

- inguinal operations,” *Journal of Pediatric Surgery*, vol. 54, no. 1, pp. 177–183, 2019.
- [27] A. P. Kohl, K. Andresen, and J. Rosenberg, “Male fertility after inguinal hernia mesh repair: a national register study,” *Annals of Surgery*, vol. 268, no. 2, pp. 374–378, 2018.
- [28] L. Zhang, J. Kang, L. Zhang, Z. Ye, H. Zhao, and W. Liang, “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,” 10 August 2023, PREPRINT (Version 1) available at Research Square, 2023.