

Clinical effect of minimally invasive surgery for inguinal cryptorchidism

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Research article

Keywords: Minimally invasive surgery, Transscrotal incision, Inguinal incision, Laparoscopy, Orchidopexy

Posted Date: October 29th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-31371/v2>

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Version of Record: A version of this preprint was published on January 6th, 2021. See the published version at <https://doi.org/10.1186/s12893-020-01010-4>.

Abstract

Background: The purpose of this study was to investigate the clinical effect of minimally invasive surgery for inguinal cryptorchidism.

Methods: The patients were divided into the minimally invasive surgery group (n=100) and the traditional surgery group (n=58). In the minimally invasive surgery group, patients with low inguinal cryptorchidism (n=54) underwent surgery with a transscrotal incision, and patients with high inguinal cryptorchidism (n=46) underwent laparoscopic surgery.

Results: For low inguinal cryptorchidism, the operative duration in the minimally invasive surgery group was significantly shorter than that in the traditional surgery group ($P<0.05$). For high inguinal cryptorchidism, there was no difference in the operative duration, the postoperative hospital stay duration or hospital costs between the two groups ($P>0.05$). Additionally, there were no cases of testicular atrophy, testicular retraction, inguinal hernia or hydrocele in either group. There was no significant difference in the incidence of poor wound healing between the two groups ($P>0.05$). Although there was no significant difference in the incidence of scrotal hematoma between the two groups ($P>0.05$), the incidence in the minimally invasive surgery group was higher than that in the traditional surgery group.

Conclusions: Minimally invasive surgery including a transscrotal incision for low inguinal cryptorchidism and laparoscopic surgery for high inguinal cryptorchidism is as safe and effective as traditional surgery, and could also provide a good cosmetic effect for children.

Background

Cryptorchidism is one of the most common genital malformations of the urinary system of children. There is no other generally agreed treatment for cryptorchidism than surgery.^[1-2] After Annandale successfully performed orchidopexy in 1879^[3], testicular descent and fixation through an inguinal incision became the classic method for the treatment of inguinal cryptorchidism and suprascrotal cryptorchidism; however, this operation leaves obvious surgical scars in the groin, which affects a patient's appearance.

With continuous surgical improvements, minimally invasive surgery has become a developmental trend. Various minimally invasive procedures are used to treat inguinal cryptorchidism to meet patients' aesthetic requirements. Laparoscopic testicular descent and fixation has been the gold standard for the treatment of abdominal cryptorchidism and can also be used in the treatment of groin cryptorchidism to achieve an aesthetic effect^[4-10]. The treatment of suprascrotal cryptorchidism with testicular descent and fixation via a single scrotal incision has reached a basic consensus and can also be used for the treatment of groin-type cryptorchidism to improve the appearance of the incision^[11-14]. This article retrospectively analysed the clinical data and summarized the clinical experience of patients treated with minimally invasive surgery for inguinal cryptorchidism.

Methods

Patients

We retrospectively analysed the clinical data of 158 patients with inguinal cryptorchidism at our hospital from January 2017 to January 2018. According to the surgical method, the patients were divided into two groups: the minimally invasive surgery group (n=100) and the traditional surgery group (n=58). In the minimally invasive surgery group, patients with low inguinal cryptorchidism (n=54) underwent surgery with a transscrotal incision, and patients with high inguinal cryptorchidism (n=46) underwent laparoscopic surgery.

The follow-up times were one week, three months, six months and one year after the operation. The children underwent follow-up examinations of the symptoms and signs via outpatient visits. Scrotal colour Doppler ultrasonography was performed six months and one year after the operation. The clinical data collected included age, weight, size of cryptorchidism, position of cryptorchidism, operative duration, postoperative hospital stay duration, hospitalization costs and postoperative complications.

Children with inguinal cryptorchidism were included in the study. Children with recurrent inguinal cryptorchidism after surgery and/or whose parents declined participation in this study were excluded.

Transverse scrotal incision for testicular descent and fixation

After the induction of anaesthesia, the patient was placed in the supine position with the waist slightly raised using a cushion. The surgical area was routinely disinfected and draped. A transverse incision was made in the middle part of the scrotum. The skin and subcutaneous tissue were cut layer by layer. The external ring was fully exposed using a small retractor pulled upward through the incision after bluntly separating the space between the external oblique and Scarpa fascia. The aponeurosis of the external abdominal oblique muscle was cut 0.5 cm to 1.0 cm through the external ring, and the middle and lower segments of the groin were thus fully exposed. After pushing the testicle to the area near the outer ring and clamping and cutting the processus vaginalis, the testicle was visible. The tissue between the spermatic cord and processus vaginalis was bluntly and sharply separated until the testicle could descend to the bottom of the scrotum without tension. The processus vaginalis was transected at a high location, and the outer ring orifice was reconstructed by suturing the aponeurosis of the external abdominal oblique muscle to ensure the integrity of the inguinal canal. The testicle was sutured in an interrupted manner to the dartos fascia of the scrotum with no torsion. We then closed the scrotal incision using 5-0 absorbable interrupted sutures.

Transinguinal testicular descent and fixation

After the induction of anaesthesia, the patient was placed in the supine position with the waist slightly raised using a cushion. An inguinal dermatoglyphic incision was made on the affected side. The inguinal skin, superficial subcutaneous fascia, deep fascia and abdominal oblique aponeurosis were successively incised. The inguinal canal was opened, and the testis was brought into the field. The spermatic cord was

freed more fully at a higher position until the testicle could be fixed at the bottom of the scrotum without tension. Then, the proximal end of the processus vaginalis was transected at a high location. A tunnel was bluntly separated along the direction of the outer ring to the bottom of the scrotum. The testicle was sutured in an interrupted manner to the dartos fascia of the scrotum with no torsion. We sutured the aponeurosis of the external abdominal oblique muscle to ensure the integrity of the inguinal canal. Finally, we closed the inguinal incision and bottom of the scrotum layer by layer.

Laparoscopic testicular descent and fixation

After the induction of general anaesthesia, while in a supine position, pneumoperitoneum (8-10 mmHg) was established using a closed technique with a Veress needle. A 5-mm trocar was placed in the umbilical area, and 3- or 5-mm trocars were placed bilaterally on the midclavicular line, slightly infraumbilical. A laparoscope was introduced into the abdominal cavity allowing the internal inguinal ring area to be observed and anatomic structures to be identified. The peritoneum of the internal ring was incised to transect the patent processus vaginalis lateral to the spermatic vessels and medial and distal to the vas deferens, enabling the vas deferens and testicular vessels to be separated. The peritoneum was removed at the anterior surface of the spermatic vessels, and the distal triangle of the peritoneum between the vessels and the vas deferens was spared to enhance collateral circulation. To achieve tension-free placement of the testis within the dependent position of the scrotum, extensive retroperitoneal dissection was needed in some cases. Next, the testis was pulled into the abdominal cavity. The anterior tunica vaginalis was incised distally, and the gubernaculum was identified, grasped, and divided after determining the distal extent of the vas deferens. A 5-mm trocar was inserted from the scrotum to under the inferior epigastric vessels through the outer ring. A laparoscopic clamp was introduced through the scrotal cannula and used to grasp the gubernaculum. The testis and cannula were delivered with a gentle twisting motion. After the testis was transferred into the scrotum, the spermatic vessels and vas deferens were visualized at the inguinal ring to rule out iatrogenic torsion of the vessels. When the length of the spermatic cord was sufficient to achieve tension-free placement of the testis within the scrotum, the lateral endoabdominal bands did not need to be divided; therefore, the impact on the blood supply to the testis was reduced. No attempt was made to close the peritoneal defect in the inguinal area unless the internal ring incision was very large. In bilateral cases, the same procedures were performed on the contralateral testis. The testis was fixed in the scrotum through the fibrous tissue at the junction of the testis and the gubernaculum.

Statistical analysis

Continuous data are presented as the mean \pm standard deviation and range. Clinical parameters between the two groups were compared with the independent samples t-test. The χ^2 or Fisher test was used to categorize variables. A *p* value of <0.05 was defined a statistically significant.

Results

The preoperative clinical data of all patients are shown in Table 1. There was no significant difference in age, weight, or size or laterality of cryptorchidism.

All patients in the minimally invasive surgery group underwent successful surgery, and there were no cases of conversion to conventional surgery. For patients with low inguinal cryptorchidism, the operative duration in the minimally invasive surgery group was significantly shorter than that in the traditional surgery group ($P<0.05$). For patients with high inguinal cryptorchidism, there was no difference between the two groups in the operative duration ($P>0.05$). Additionally, there was no significant difference in the postoperative hospital stay duration or hospital costs between the two groups ($P>0.05$) (Table 1).

There were no cases of testicular atrophy, testicular retraction, inguinal hernia or hydrocele between the two in either group. There was no significant difference in the incidence of poor wound healing between the two groups ($P>0.05$). Although there was no significant difference in the incidence of scrotal hematoma between the two groups, the incidence in the minimally invasive surgery group was higher than that in the traditional surgery group (9% vs 3.4%). In the minimally invasive surgery group, scrotal hematoma occurred mostly in patients who underwent surgery with a transverse scrotal incision for testicular descent and fixation, of which there were 8 cases in total (Table 2).

All patients were followed up for more than 12 months, with a median follow-up time of 14 months. One year after the operation, the size of the affected testicle was 1.30 ± 0.26 cm in the minimally invasive surgery group and 1.26 ± 0.31 cm in the traditional surgery group, indicating improvement compared with before the operation; however, there was no significant difference between the two groups ($P=0.921$).

Discussion

The incidence of cryptorchidism is higher in the neonatal period than in later stages of development, but the incidence of cryptorchid remains 1% at approximately 1 years of age^[1,15]. Cryptorchidism can affect reproductive function, cause decreased fertility or even infertility, and increase the probability of testicular tumours. Cryptorchidism is also a predisposing factor for testicular torsion. Therefore, early active treatment is needed^[16-17]. The testes of children with cryptorchidism may continue to descend after birth, but the chance of self-descent after 6 months is obviously reduced. Therefore, children require evaluation for the possibility of medical intervention after 6 months^[18-20].

For inguinal cryptorchidism, the current surgical methods are mainly laparoscopic surgery, transinguinal incision surgery and transscrotal incision surgery. The traditional operation adopts the transinguinal approach and involves an oblique incision, transverse incision, or double scrotal incision to find the testis; then, the spermatic cord is freed, the sheath process is transected or ligated, the spermatic cord and vas deferens are fully released, and the testis is fixed in the middle or lower part of the scrotum without tension. This surgical procedure provides clear exposure and is technically mature and effective; however, this surgery leaves obvious scars in the inguinal area after the operation that will affect the aesthetic appearance. With the increasing demands of children and their families regarding the aesthetics after

surgery, paediatric surgeons need to consider achieving not only an effective surgery but also an aesthetically pleasing and scarless result.

The length of the inguinal canal increases most between the ages of 1 and 3. The length of the inguinal canal in a 1-, 2- and 3-year-old child is 1.4 cm, 1.9 cm, and 2.7 cm, respectively, and most children with cryptorchidism have a shorter inguinal canal than other children^[21]. Therefore, performing surgery through a scrotal incision can expose the external ring of the inguinal canal and allow high transection or ligation of the sheath process and complete transection of the extraspermatic fascia and intraspermatic fascia to ensure sufficient release of the spermatic cord. Then, the testis can be placed in the scrotum without tension. The operation requires only a single scrotal incision that does not destroy the inguinal structure as in the traditional operation. The operation is simple and leads to less trauma and postoperative pain, and the incision is located in the scrotal fold. Essentially no scar is left after the operation, and the cosmetic effect is good. In this study, we performed this procedure in children with low inguinal cryptorchidism, and the operative duration of this method was significantly shorter than that of the traditional surgery ($P<0.05$). The scrotal incision is low and small and provides a relatively small field of view. The difficulty of the operation lies in fully releasing the spermatic cord vessels and achieving high ligation or transection of the sheath process. In patients with a high testicular position or older age, the operation is more difficult^[22]. Therefore, we chose to apply this operation in cases of low inguinal cryptorchidism. In such cases, if the spermatic cord vessels could not be fully released and the sheath process could not be ligated or transected, the outer ring mouth could be cut at 0.5-1.0 cm to fully release the spermatic cord and ligate or transect the sheath process. In this group, the side of the outer ring mouth was cut in 5 cases, and good results were achieved. Therefore, although testicular descent and fixation through a scrotal incision has the advantages of a short operative duration and good cosmetic effect, its indications should be well understood prior to the operation.

For patients with high inguinal cryptorchidism, laparoscopic testicular descent and fixation was used. This surgical procedure involves no inguinal incision and no inguinal canal incision and thus results in a good cosmetic effect. Additionally, the scope of the laparoscopic exploration is large and clear, allowing determination of the presence and location of the testis (especially in high cryptorchidism) and full freeing of the spermatic vessels to the inferior pole of the kidney. The surgery can be carried out under direct vision, thus reducing damage to the testicular blood supply and ensuring tension-free testicular descent into the scrotum. Although laparoscopic surgery carries the risk of complications, such as intestinal injury, bladder injury and subcutaneous emphysema caused by CO₂ pneumoperitoneum, these complications have a low incidence and can be avoided if care is taken during the operation^[23-24].

High inguinal cryptorchidism can easily occur with patent processus vaginalis. Due to the difficulty of high ligation, hydrocele or inguinal hernia as complications after surgery are common concerns. A study by Ceccanti S et al. reported that high ligation of the processus vaginalis was not performed for a high-traversing processus vaginalis and that this procedure did not increase the risk of an indirect inguinal hernia or hydrocoele^[25]. Handa R et al. demonstrated that the absence of ligatures or sutures in the inner

ring orifice during laparoscopic testicular descent and fixation also did not increase in the risk of an indirect hernia or hydrocoele^[26]. At our centre, we also did not perform high ligation of the processus vaginalis in cases of a high-traversing processus vaginalis, and there were no cases of hydrocoele or inguinal hernia as complications in this study.

The incidence and severity of postoperative complications are important indicators for judging the safety of surgical procedures. Scrotal hematoma was a common postoperative complication that occurred mostly in children who underwent surgery with a transverse scrotal incision for testicular descent and fixation in this study. The main process of creating the scrotal incision is concentrated in the scrotum, which causes greater damage to the scrotal tissue and therefore increases the risk of scrotal hematoma after surgery. Therefore, the operation should be performed gently. Attention should be paid to haemostasis and minimizing pressurize on the scrotum after surgery to reduce the occurrence of scrotal hematoma. There were no cases of testicular atrophy, testicular retraction, inguinal hernia or hydrocoele in either group during the perioperative period or at the 1 year follow-up after the operation, and the size of the affected testis improved to varying degrees. There was no significant difference between the two groups, which indicated that the minimally invasive surgery and traditional surgery had good and similar clinical effects.

This single-centre retrospective study had a small sample size and short follow-up time. Multi-centre, large-sample, medium- and long-term follow-up studies need to be completed to determine the clinical outcomes of these procedures more objectively.

Conclusion

Minimally invasive surgery including surgery with a transscrotal incision for low inguinal cryptorchidism and laparoscopic surgery for high inguinal cryptorchidism is as safe and effective as traditional surgery and provides good cosmetic effects.

Declarations

Acknowledgements

We gratefully acknowledge the contribution of the participating doctors: Yi-fan Fang, Bing Zhang, Yuan-bin He, Ming-kun Liu, Jian-cai Chen, Jian-xi Bai, and Wen-chen Xu.

Author contributions

WYJ and ZZM conceptualized and designed the study. CL and CX wrote the manuscript and collected the data. ZCM performed data analysis and assisted with proofreading. ZQ revised the manuscript. The authors have read and approved the final manuscript.

Funding

None.

Availability of data and materials

The datasets of the current study are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

This study was approved by the ethics committee of our hospital and strictly adhered to the tenets of the Declaration of Helsinki (code of Ethical approval for scientific research project:2019 Ethical Scientific Research Approval No. 2004).In addition,all patients were minors,and they signed an informed consent form before the study.

Consent for publication

Written informed consent was obtained from the patients' guardians for publication of clinical data.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1. Comparison of preoperative, intraoperative and postoperative data between the two groups

Item	Minimally invasive surgery group	Traditional surgery group	P value
Number	100	58	
Age(year)	1.64±1.37	1.87±1.65	0.562
Weight(kg)	11.56±2.34	13.59±2.53	0.642
Size of cryptorchidism[cm]	0.78±0.22	0.76±0.26	0.886
Unilateral/Bilateral	78/22	43/15	
Cryptorchidism position			
Low inguinal testes	54	32	0.887
High inguinal testes	46	26	
Patent processus vaginalis	20	9	0.483
Operative time[min]			
Low inguinal testes	26.34±6.12	38.73±8.84	0.033
High inguinal testes	51.83±11.65	49.69±10.36	0.658
Postoperative hospital stay time[d]	1.38±0.61	1.45±0.63	0.921
Hospital costs (1000RMB)	7.22±1.51	6.94±1.45	0.662

The hospital costs refers to all expenses during hospitalization

Table 2. Comparison of postoperative complications between the two groups

Item	Minimally invasive surgery group	Traditional surgery group	P value
Number	100	58	
Testicular atrophy	0	0	
Testicular retraction	0	0	
Inguinal hernia	0	0	
Hydrocele	0	0	
Poor wound healing	5 (5.0%)	4 (6.8%)	0.620
Scrotal haematoma	9 (9.0%)	2 (3.4%)	0.186