

Full Length Research Paper

A modified trocar puncturing method in laparoscopic high ligation of vaginal process in children

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In the present study, we introduced a modified trocar puncturing method and evaluated its clinical application in laparoscopic high ligation of vaginal process in children. A total of 62 communicating hydrocele children were treated by high ligation of vaginal process under laparoscopy. Among them, 32 children underwent laparoscopic high ligation of vaginal process with traditional trocar puncturing method (traditional group) and the remaining 30 children underwent trocar puncturing with a modified method (modified group). In the modified group, after a 5 mm trocar was inserted, other trocars with a puncturing needle pierced through skin, subcutaneous tissues, muscular layers and peritoneum and were further inserted in a certain direction and angle. The puncturing time, total operating time and complications were compared between both groups. All operations were successfully performed in both groups. The mean puncturing time (11 ± 2.7 min) in the traditional group was significantly longer than that (5.2 ± 1.0 min) in the modified group ($t = 11.07, P < 0.05$). The total operating time in the traditional group was significantly longer than that in the modified group (24 ± 4.0 min vs. 19 ± 3.1 min, $t = 5.48, P < 0.05$). No intra-abdominal organ injuries, postoperative scrotal hematoma or wound infections were found in both groups. There was no significant difference in postoperative administration of analgesics between two groups (3.8 ± 1.3 mg vs. 3.6 ± 1.2 mg, $t = 0.63, P > 0.05$). Mean length of stay in both groups was 2.3 ± 0.6 and 2.2 ± 0.5 days, respectively ($t = 0.71, P > 0.05$). Except that 2 patients lost follow-up, the remaining 60 patients were followed up for 3 - 12 months and no hydrocele recurrence, incisional hernia or testicular atrophy occurred. This modified trocar puncturing method can save puncturing time and total operating time, with improved safety of trocar puncturing theoretically in children. This method is worthy of application in more extensive clinical practice.

Key words: Hydrocele, laparoscopy, children, trocar puncturing.

INTRODUCTION

Communicating hydrocele is a common disease in children which is gradually absorbed and disappears at 1 year old in most children, but in children whom hydrocele does not completely disappear and are older than 1 year must be treated by surgical treatments to prevent hydrocele from inhibiting the development of testes or forming incarcerated hernia (Lau et al., 2007). Recently, with the rapid development of laparoscopic technology,

the advantages of laparoscopy including amplified operative field, clear display and distinguish of spermatic duct, blood vessels and surrounding organs, fewer perioperative complications, less surgical trauma and rapid recovery are recognized by more and more surgeons and thus laparoscopy is used in more and more extensive clinical fields (Yao et al., 2004; Bi et al., 2004). From January 2008 to September 2009, 62 children with communicating hydrocele were treated of laparoscopic high ligation of vaginal process with traditional or modified trocar puncturing method and satisfactory curative effects were obtained in these patients. Now, the clinical data of these patients are reported as follows.

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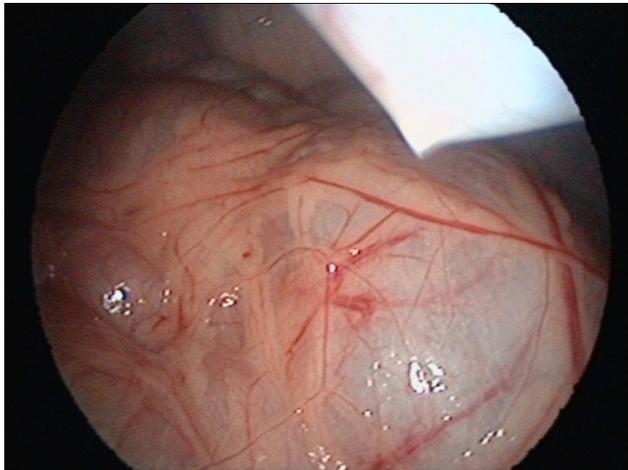


Figure 1. The puncturing needle tip nearly gored peritoneum.



Figure 2. The trocar puncturing direction was turned to maintain a certain direction and angle with the implanted 5 mm trocar.

PATIENTS AND METHODS

Clinical data

From January, 2008 to September 2009, 62 children with communicating hydrocele aged from 1 to 9 years (mean 3.2 years) were treated in our hospital. Physical examination showed a movable mass in a variable size in inguinal groove or scrotum in all patients and scrotum transmittance test was positive. All patients were confirmed by B-type ultrasonography, including left communicating hydrocele in 25 children, right in 33 children and bilateral in 4 children. An informed consent was obtained from their parents before surgery. 58 patients were randomly assigned into two groups in random digits table method and 4 patients with bilateral communicating hydrocele were divided into two groups. All procedures were performed by same surgeons. 32 patients underwent laparoscopic high ligation of vaginal process with traditional method and the remaining 30 patients underwent laparoscopic high ligation of vaginal process with a modified method. The mean age in the traditional and modified group was 3.3 ± 1.2 years and 3.1 ± 1.1

years, respectively ($t = 0.68$; $P > 0.05$). Preoperative routine examinations showed no diseases or abnormality in heart, brain, lungs and other important organs in two groups.

Operating procedures

Preoperative preparation and anesthesia: In both groups, all patients received absolute diet for 12 h before operation and cephalosporin was administered 30 min before operation and urinary catheter was indwelled before operation. All patients received endotracheal inhalation anesthesia and balanced anesthesia in two groups.

Insertion of laparoscope

Olympus 30° laparoscope was used in both groups. After successful anesthesia, patients were placed in a horizontal position and a 0.5 cm incision was made above or below the umbilicus. Then, a *Veress pneumoperitoneum* needle was pierced into the abdominal cavity. After the site of the needle point was confirmed by intraperitoneal injection with water, carbon dioxide (CO₂) was injected into abdominal cavity through this needle and the pressure of pneumoperitoneum was maintained between 8 - 10 mmHg. Then, both sides of the incision was lifted with towel forceps and subcutaneous tissues and anterior sheath of *Rectus abdominis* were dissected with a vascular clamp and then a 5 mm trocar with a puncturing needle was vertically inserted into abdominal cavity by repeated rotation through the incision. After confirmation, the trocar was fixed with suture.

Subsequently, the patient was placed in a trendelenburg position for 10 - 20° and then other trocars were implanted in traditional or modified trocar puncturing method under direct vision of laparoscopy, to avoid the course of blood vessels in anterior abdominal wall.

Traditional trocar puncturing method

A 0.3 cm incision along dermal ridge in right abdominal wall below the umbilicus was made with a sharp-pointed knife and then a 3 mm trocar with a puncturing needle was vertically inserted into the abdominal cavity by repeated rotation through the incision and the insertion direction of trocar was turned to the pelvic cavity to avoid the injury of intestinal canal, arteries or other pelvic blood vessels when the puncturing needle tip pierced peritoneum under direct vision of laparoscopy. Then, the puncturing needle was removed and the trocar was fixed with suture. Similarly, a contralateral 3 mm trocar was inserted.

Modified trocar puncturing method

A 0.3 cm incision in right abdominal wall below the umbilicus was made and then a 3 mm trocar with a puncturing needle was vertically inserted by repeated rotation through skin, subcutaneous tissues and muscular layer. After the puncturing needle tip nearly gored peritoneum (Figure 1), the puncturing direction of trocars was turned to maintain a certain direction and angle with the implanted 5 mm trocar (Figure 2) and the puncturing needle tip always aimed at the internal lumen of the 5 mm trocar (Figure 3) and then the 3 mm trocar was further inserted until the tip of the 3 mm trocar entered the internal lumen of the 5 mm trocar (Figure 4). Subsequently, the puncturing needle was removed and the trocar was fixed with suture. Similarly, a contralateral 3 mm trocar was inserted.

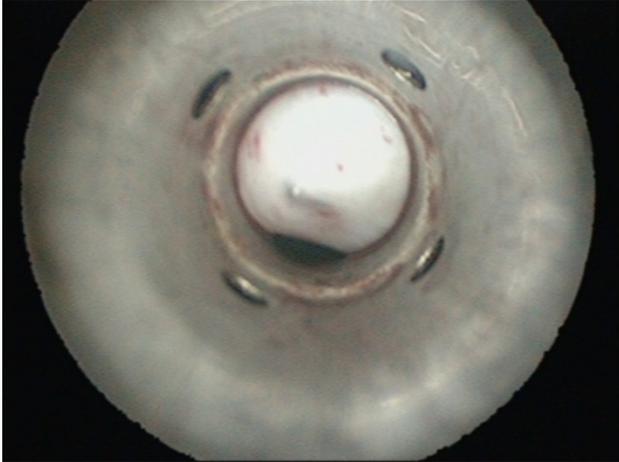


Figure 3. The puncturing needle tip always aimed at the internal lumen of the 5 mm trocar.

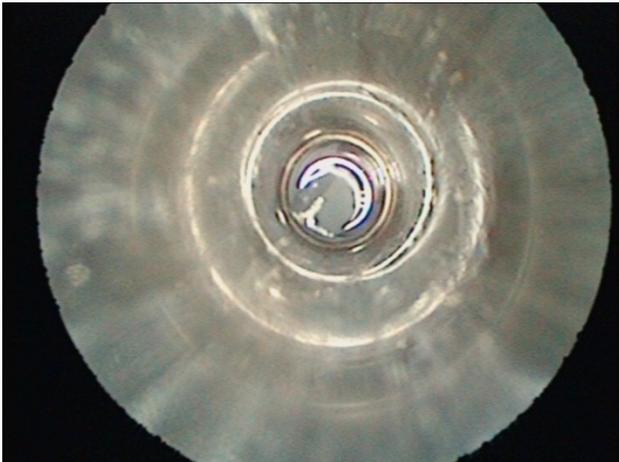


Figure 4. The 3 mm trocar was further inserted until the tip of the 3 mm trocar entered the lumen of the 5 mm trocar.

High ligation of vaginal process

The patients were placed in supine position with a 10° lateroversion to the uninjured side and with lateral umbilical ligament as an identification marker and bilateral inner ring openings were explored to identify whether or not bilateral vaginal processes were patent. Testis and hydrocele within spermatic cord was pushed into abdominal cavity from scrotum. If there was a closed sac in the distal end of inner ring opening, vaginal process was opened to expose capsule walls and then capsule walls were opened with an electric hook to release fluid and the bleeding was stopped with an electric coagulation. With the guide of laparoscopy, 1# syringe needle was subcutaneously pierced into the abdominal cavity at the projection site of inner ring opening on body surface. Then, 5 ml normal saline was injected into the extraperitoneal cavity near the inner ring opening to separate peritoneum from spermatic duct and blood vessels of spermatic cord and protect from injury of the inner ring at suturing and ligation.

A 2 mm incision at the projection site of inner ring opening on body surface was made and then a needle with 2-0 terylene sutures pierced into abdominal cavity through the incision and the suture tail

remained out of skins. Posterior wall of open vaginal processes were continuously sutured in clockwise out of peritoneum and we must ensure that peritoneum at vaginal process was completely ligated to reduce the recurrence of hydrocele. Subsequently, anterior wall of open vaginal processes were continuously sutured and we should pay attention to protect blood vessels below abdominal walls, anterior and posterior semi-rings were sewed together.

Pneumoperitoneum pressure was decreased and the gas in scrotum was exhausted to sew semi-rings and the knots of two semi-rings were imbedded in subcutaneous tissues. Then, the gas was injected to examine the ring closure sutures and bleeding in the operating field. After all surgical procedures were performed, pneumoperitoneum was stopped and the residual gas in cavity was exhausted and all trocars were removed. The incisions were sewed with 6-0 absorbable sutures and fascial layer was additionally sewed in the incisions for 5 mm trocars.

Statistical analyses

All statistical analyses were performed with SPSS version 11.0 statistical software and group comparison was compared with t test. $P < 0.05$ was considered significantly different.

RESULTS

All operations were successfully performed in both groups. No intra-abdominal organ injuries, spermatic duct injury or blood vessel injuries of spermatic cord were found in both groups. In 2 patients with closed fluid sac in inner ring opening, vaginal process was opened and capsule wall was lifted and sac was opened with an electric hook. There were 5 patients with unilateral hydrocele who were accompanied with patent vaginal process in each group and all of them were successfully treated by laparoscopic high ligation of vaginal process. The mean puncturing time in the traditional puncturing group was significantly longer than that in the modified puncturing group (11 ± 2.7 min vs. 5.2 ± 1.0 min, $t = 11.07$, $P < 0.05$). The total operating time in the traditional group was significantly longer than that in the modified group (24 ± 4.0 min vs. 19 ± 3.1 min, $t = 5.48$, $P < 0.05$). Postoperative hemoglobin level in the two groups was 146.5 ± 10.3 and 144.6 ± 9.7 g/L, respectively ($t = 0.75$, $P > 0.05$). Postoperative blood bicarbonate level in the two groups were 23.2 ± 3.0 and 21.8 ± 4.2 mmol/L, respectively ($t = 0.63$, $P > 0.05$). There was no significant difference in postoperative administration of analgesics between both groups (3.8 ± 1.3 mg vs 3.6 ± 1.2 mg, $t = 0.63$, $P > 0.05$) (Table 1).

Mean length of stay in the two groups was 2.3 ± 0.6 and 2.2 ± 0.5 days, respectively ($t = 0.71$, $P > 0.05$). Expect that 2 patients lost follow-up, the remaining 60 patients were followed up for 3 - 12 months and no hydrocele recurrence, incisional hernia and testicular atrophy was found.

DISCUSSION

Laparoscopic high ligation of vaginal process has been

Table 1. The patient demographics and surgery results ($x \pm s$).

Group	Case (n)	Age (year)	Puncturing time (minute)	Operating time (minute)	Analgesics dose(mg)	Length of stay (day)
Traditional group	32	3.3±1.2	11±2.7	24±4.0	3.8±1.3	2.3±0.6
Modified group	30	3.1±1.1	5.2±1.0*	19±3.1*	3.6±1.2	2.2±0.5

recognized as a standard surgical treatment for communicating hydrocele in children, with many advantages such as safe, fast, effective, minimally invasive and cosmetic advantages. Especially, contralateral patent vaginal process which has not developed into scrotal mass can be easily found and treated under the direct vision of laparoscope (Liu et al., 2000). 31 - 39% patients with unilateral patent vaginal process were usually accompanied with contralateral occult patent vaginal process (Chan and Tam, 2004; Valusek et al., 2006). In this study, 10 patients (16.1%) were accompanied with contralateral patent vaginal process and these contralateral occult patent vaginal processes were simultaneously treated by laparoscopic surgery. Laparoscopy can reliably evaluate the contralateral inguinal region and is the best method to evaluate for the presence of a contralateral patent *Processus vaginalis* (Valusek et al., 2006).

Compared with open surgery, only laparoscopic high ligation of vaginal process can obtain really high ligation of vaginal process and the inguinal canal can not be reached and the abdominal muscles and spermatic cord can not be isolated under a laparoscopic surgery. Therefore, the injuries of abdominal muscles, cremaster muscle, spermatic duct, blood vessels and nerves of spermatic cord can be avoided as soon as possible and meanwhile the recurrence rate of postoperative hydrocele and the incidence of postoperative scrotal hematoma are decreased as soon as possible (Palmer and Rastinehad, 2008). In this study, except that two patients lost follow-up and the follow-up showed no recurrence in 60 patients (96.8%) and thus the curative effects of laparoscopic high ligation of vaginal process were satisfactory.

Due to different physiological and anatomical characteristics in children compared with adults, trocar puncturing is the critical step of laparoscopic high ligation of vaginal process, especially in laparoscopic surgery with multiple trocars. We previously reported that laparoscopic high ligation of vaginal process with three trocars could safely and effectively perform fenestration of closed sac at inner ring opening and repair weak abdominal walls around direct hernia, femoral hernia and larger inner ring opening (Wang et al., 2009). However, different trocar puncturing methods not only directly affect the safety and time of operation, but also impact the incidence of trocar's complications (McManus et al., 2004). At present, there are three trocar puncturing methods including direct incision method, closed puncturing method (pneumoperitoneum needle puncturing method) and puncturing method with visual trocar under

direct vision and the choice of trocar puncturing method mainly depended on surgeon's habit and experience (Dong et al., 2008). Currently, direct incision method and closed puncturing method are frequently used. The main disadvantage of direct incision method is a larger incision compared with closed puncturing method, which easily results in intraoperative air leakage to be subcutaneous emphysema. After trocar implantation, full-thickness suture including muscular layer, fascial layer and skin is performed to firmly fix trocar without space with surrounding tissues. After operation, muscular and fascial layers must be carefully sutured to prevent from the occurrence of postoperative incisional hernia (Hassan et al., 2006). Therefore, the operating procedures of direct incision method are relatively complicated and larger incision can not obtain satisfactory aesthetic effects.

Thus, to minimize the invasion of trocar puncturing, we used closed puncturing method or combined puncturing method (first trocar with direct incision method and the remaining trocars with closed puncturing method) in this study. Because the capacity of pediatric abdominal cavity is significantly smaller than that of adults, space for trocar puncturing is relatively narrow, especially in children younger than 1 year. Thus, it is recognized that children with hydrocele who are treated by laparoscopic high ligation of vaginal process should be older than 1 year 6 months (Göbel and Stuhldreier, 2008). Because high pneumoperitoneum pressure interferes breathing and endotracheal closed inhalation anesthesia, laparoscopic pneumoperitoneum pressure should be ≤ 10 mmHg in children (Jialin et al., 2007). Another feature of pediatric laparoscopic surgery is that weaker and more flexible abdominal walls significantly increases the difficulty of trocar puncturing in narrow puncturing space with low abdominal pressure. Although trocars for single use have many advantages including clean, sterile and easy for puncturing, they are very expensive and thus reusable mental trocars are still widely used in many hospitals. However, needle tip of mental trocars easily becomes blunt because of repeated uses and disinfections and thus more power must be paid for blunt mental trocar puncturing which easily injures intestinal canal or abdominal organs. Thus, mental trocar puncturing must be performed more gently and slowly and thus it often consumes more puncturing time.

It was previously revealed that trocars could be more easily implanted at exterior margin of *Rectus abdominis* and 3 cm below the umbilicus (Jialin et al., 2007), but currently it is controversial on this viewpoint. First, it is

very hard to accurately identify *R. abdominis* in children. Second, needle puncturing on weak abdominal wall at this site easily injures intestinal canal or intra-abdominal organs (Chang et al., 2010). In this study, we modified trocar puncturing method to overcome the disadvantages. After it was observed under direct vision of laparoscope that the puncturing needle tip nearly gored peritoneum, the trocar puncturing direction was turned to maintain a certain direction and angle with the implanted 5 mm trocar and the puncturing needle tip always aimed at the internal lumen of the 5 mm trocar and then the 3 mm trocar was further inserted until the tip of the 3 mm trocar entered the internal lumen of the 5 mm trocar. This modified puncturing method could effectively minimize the injury of intra-abdominal organs, increase the safety of trocar puncturing and shorten the puncturing and operating times.

In this study, the mean puncturing time and total operating time in the modified puncturing group was significantly shorter than that in the traditional puncturing group ($P < 0.05$). This modified trocar puncturing method can improve the safety of trocar puncturing, decrease postoperative complications and save puncturing and operating times. This method is worthy of application in extensive clinical practice.

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