Int J Clin Exp Med 2019;12(5):5703-5709
www.ijcem.com /ISSN:1940-5901/IJCEM0088410

Original Article

Tension-free hernioplasty is better than traditional herniorrhaphy for pediatric inguinal hernias

Xin Zhao, Guangjian Tian, Peng Liu, Pei Yang, Feng Qiu

Department of General Surgery, Beijing Luhe Hospital, Capital Medical University, Beijing, China

Received November 14, 2018; Accepted December 7, 2018; Epub May 15, 2019; Published May 30, 2019

Abstract: Objective: The aim of this study was to compare surgery efficacy, postoperative complications, and recurrence rates using traditional herniorrhaphy or tension-free herniorrhaphy for treatment of pediatric inguinal hernias. Methods: A total of 122 children with inguinal hernias were randomly divided into a study group (62 cases) and control group (60 cases). Children treated with tension-free hernioplasty were included in the study group, while children that underwent traditional herniorrhaphy were included in the control group. Both groups were followed up for one year. Surgery efficacy, operation time, intraoperative blood loss, body temperature change, times of analgesic use, out of bed activity time, hospitalization time, postoperative complications, and recurrence of the disease were compared between the two groups. Results: Surgery efficacy in the study group was significantly higher than the control group (χ^2 = 5.886, P = 0.019). Operation time in the study group was significantly shorter than the control group (t = 16.590, P<0.001). Intraoperative blood loss in the study group was significantly less than that in the control group (t = 6.926, P<0.001). Temperature change in the study group was significantly less than that in the control group (t = 20.780, P<0.001). Analgesic use in the study group was significantly less than that in the control group (t = 17.400, P<0.001). Out of bed activity time in the study group was significantly shorter than that in the control group (t = 5.910, P<0.001). Hospital stays in the study group were significantly shorter than the control group (t = 8.825, P<0.001). Incidence of complications in the study group was significantly lower than that in the control group (χ^2 = 18.696, P <0.001). Recurrence rates in the study group were significantly lower than those in the control group (χ^2 = 4.481, P = 0.042). Conclusion: Application of tension-free hernioplasty in children with inguinal hernias can improve surgical treatment effects. It has the advantages of a short operation time, less trauma, quick recovery, less complications, and low recurrence rates. It is worthy of widespread application in clinical practice.

Keywords: Traditional herniorrhaphy, tension-free herniorrhaphy, pediatric inguinal hernia, clinical efficacy comparison

Introduction

Inguinal hernias are common in pediatric surgery. Most cases present as oblique hernias caused by congenital failure of the peritoneum to close. The incidence rate is 0.8%-4%. Males are affected approximately 10 times more than females and incidence is much higher in premature infants [1, 2]. Incidence of an occult patent processus vaginalis in inguinal hernias is 20%-40%, decreasing gradually with increasing age. Incidence at the ages of 1, 2, and 2-8 years are 40%, 35%, and 20%, respectively [3, 4].

In the early human embryo, the testicles are in the retroperitoneum. With embryonic growth and development, the testicles gradually descend and induce scrotal development. After the scrotum develops, the testicles gradually descend and form the processus vaginalis [5]. The processus vaginalis is a potential lumen. Its upper segment, or the entire segment, may not close due to increases in abdominal pressure with the development of abdominal wall muscles. Abdominal tissue may enter into the processus vaginalis to form a congenital inguinal hernia [6]. An inguinal hernia in an infant may become strangulated. With growth and development, the abdominal wall muscles are strengthened. Abdominal pressure in children is constantly increased by crying, screaming, and other activities, which can induce the gradual enlargement of an inguinal hernia sac. A

strangulated and enlarged hernia sac will block the blood supply to the testis, leading to necrosis and atrophy of the testicles, affecting sexual function and fertility [7, 8]. Therefore, pediatric inguinal hernias, with the absence of surgical contraindications, should be treated with surgery when the child is aged >1 year.

Traditional herniorrhaphy is the primary treatment for pediatric inguinal hernias. However, disadvantages include unsatisfactory healing, postoperative complications, and recurrence [9]. Tension-free herniorrhaphy can strengthen and repair the posterior wall of the inguinal canal by reasonable application of artificial biological materials. Inguinal tissues and structures are effectively protected, adverse effects of traditional herniorrhaphy on tissue structures are avoided, and anatomical features are preserved. Tension-free hernioplasty will not only improve the quality of surgery but also reduce mechanical injuries during surgery. It may be able to reduce rates of postoperative recurrence and complications in pediatric inguinal hernias [10].

Previous studies have shown that tension-free herniorrhaphy has benefits for children with inguinal hernias, but little is known about its effects on postoperative complications and recurrence of the disease. In this study, both traditional herniorrhaphy and tension-free herniorrhaphy were applied to children with inguinal hernias. Clinical efficacies of the two different surgical procedures and the impact on postoperative complications and recurrence in children were explored.

Methods and materials

General information

A total of 122 children with inguinal hernias, that underwent surgical treatment, were randomly divided into a study group and control group. Children that underwent tension-free hernioplasty were included in the study group (62 cases), while those that underwent traditional herniorrhaphy were included in the control group (60 cases). The study group included 57 boys and 5 girls. The average age was 5.16±1.25 years (range 4-12 years). There were 20 left inguinal hernias, 23 right inguinal hernias, 7 bilateral inguinal hernias, and 12 direct inguinal hernias. The control group included 57 boys and 3 girls. The average age was 5.28±1.07 years (range 3-11 years). There were 17 left inguinal hernias, 25 right inguinal hernias, 5 bilateral inguinal hernias, and 13 direct inguinal hernias. Both groups were followed up for one year. This study was approved by the Ethics Committee of the Beijing Luhe Hospital, Capital Medical University. Informed consent was obtained from all patients and family members.

Inclusion and exclusion criteria

Inclusion criteria: Diagnostic criteria met for inguinal hernia [11]; Presence of an inguinal mass observable in the standing position, accompanied by a sense of local distension; Aged 1-14 years. Exclusion criteria: Allergic contraindication or intolerance to surgical treatment; Cryptorchidism, hydrocele, or testicular mass; Severe liver or kidney dysfunction; Prior history of inguinal surgery; History of psychiatric or mental disorder.

Therapeutic method

Traditional herniorrhaphy: Patients that underwent traditional hernioplasty [12] were included in the control group. Traditional hernioplasty was performed under epidural analgesia, with high ligation of the hernia sac and suturing of tendons and ligaments to repair the posterior wall of the inguinal canal.

Tension-free hernioplasty: Patients that underwent tension-free hernioplasty [13] were included in the study group. A 15 × 10-cm polypropylene patch was applied. Surgery was performed under epidural analgesia. Inguinal tissue was incised layer by layer, separating the skin with an oblique. A 6-cm incision, cutting the external oblique aponeurosis, was made to search for the spermatic cord and oblique muscle fascia, separating the spermatic cord and hernia sac and neck to within 1 cm of the inner ring. A small hernia sac was not cut and instead was placed directly into the abdominal cavity. If the hernia sac was large, transection and high ligation was performed and the repaired and organized sac was inserted into the abdominal cavity. The hernia ring was filled with appropriate cone-shaped plugs to achieve uniformity. The transverse abdominal fascia and hernia ring filled with cone-shaped plugs were sewn and fixed with absorbable suture. The spermatic

Table 1. Baseline data of study and control groups [n (%)] (x ± SD)

Category	Study group (n = 62)	Control group (n = 60)	t/X^2	P
Gender			0.467	0.717
Male	57 (91.94)	57 (95.00)		
Female	5 (8.06)	3 (5.00)		
Age	5.16±1.25	5.28±1.07	0.568	0.570
Body weight (kg)	14.63±6.25	15.01±4.63	0.380	0.704
Clinical type			0.667	0.880
Left side	20 (32.26)	17 (28.33)		
Right	23 (37.10)	25 (41.67)		
Bilateral	7 (11.29)	5 (8.33)		
Straight	12 (19.35)	13 (21.67)		
Hb (gg/L)	136.15±10.22	139.47±11.37	1.697	0.092
RBC ($\times 10^{12}$/L)	4.58±0.56	4.63±0.43	0.551	0.582
PLT ($\times 10^{9}$/L)	153.25±21.68	150.67±19.58	0.689	0.492
ALT (U/L)	9.52±4.26	10.47±5.63	1.053	0.294
AST (U/L)	32.12±2.36	31.63±1.58	1.343	0.181

cord was slowly elevated, then a patch was placed behind the cord to cover the femoral canal and fix the patch. Heavy-duty tension-free sutures were used on the external oblique aponeurosis, subcutaneous tissue, and skin. Caution: The hernia sac was gently manipulated to prevent injury to the nerves or blood vessels, including the femoral nerve and lower abdominal arteries. If the hernia sac was smaller, ligation was not performed. If the sac was larger, extensive dissection was not performed. The lower mesh patch was placed around the spermatic cord to avoid curling or folding. Postoperative antibiotics were used to prevent infections. Sandbags were pressurized, the scrotum was elevated, and an indwelling bladder catheter was maintained for 1-3 days after the operation.

Outcome measures

Surgery efficacy was classified by three levels. Cure: After surgery, the lesion tissue had been fully repaired, the symptoms had disappeared, and no recurrence had emerged for one year after follow-up; Effective: Lesion tissues had been basically repaired, the symptoms had improved, and recurrence had occurred after half a year. Ineffective: Lesion tissue repair was not good and the symptoms were not improved.

Efficacy rate = (cure + effective)/total cases × 100%

Based on literature recommendations [14] and according to observation indices in this study, primary outcomes were operative time, intraoperative blood loss, body temperature changes during hospitalization, times of analgesics use, out of bed activity time, length of hospital stay, and incidence of postoperative complications. Patients were followed-up for 1 year postoperatively. Telephone follow-ups were performed at the first month, the third month, the sixth month, and the 12th month after discharge. The children went to the hospital for follow-up consultations. Recurrence rates in the study and control groups were recorded in detail.

Statistical methods

Statistical analysis was performed with SPSS 18.0 (Beijing Sichuangweida Information Technology Co., Ltd.). Measurement data are expressed as mean ± standard deviation (x ± SD) and Student's t-test was used to compare data between groups. Count data between the two groups were compared with Chi-squared test. *P* values <0.05 indicate statistically significant differences.

Results

Baseline data of the study and control groups

There were no statistical differences in general clinical baseline data, including sex, age, weight, clinical type, hemoglobin (Hb), red blood cell (RBC) count, platelet (PLT) count, alanine transaminase (ALT), and aspartate transaminase (AST) (**Table 1**).

Treatment effect of the study group and control group

In the study group, 26 cases (41.94%) were cured after the operation, 32 cases (51.61%) were effective, 4 cases (6.45%) were ineffective, and the efficacy rate was 93.55%. In the control group, 23 cases (38.33%) were cured after the operation, 24 cases (40.00%) were

Table 2. Comparison of surgical treatment results between study group and control group [n (%)]

Group	n	Get well	Effective	Invalid	Surgery efficacy (%)
Research group	62	26 (41.94)	32 (51.61)	4 (6.45)	93.55
Control group	60	23 (38.33)	24 (40.00)	13 (21.67)	78.33
χ^2	-	-	-	-	0.019
P	-	-	-	-	5.886

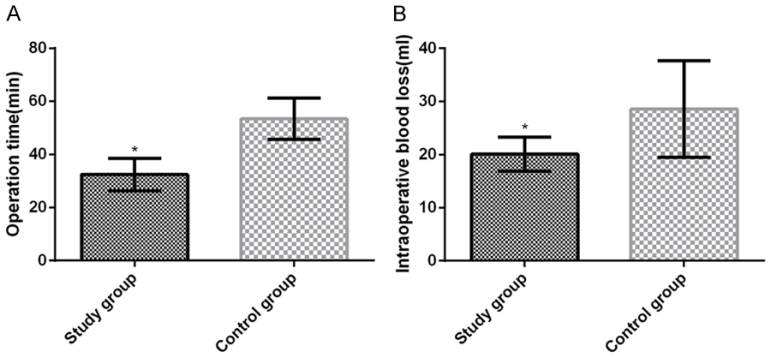

Figure 1. Comparison of surgical operation time and intraoperative blood loss in study group and control group. Note *P<0.001 compared with control group.

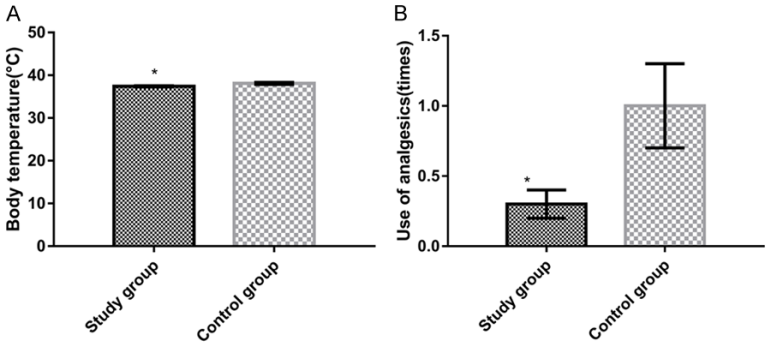

Figure 2. Comparison of body temperature and analgesic use times between study group and control group. Note *P<0.001 compared with control group.

effective, 13 cases (21.67%) were ineffective, and the efficacy rate was 78.33%. The efficacy rate of surgery in the study group was significantly higher than that of the control group (χ^2 = 5.886, P = 0.019) (**Table 2**).

Operation time and intraoperative blood loss of the study group and control group

Operation times of the study group and control group were (32.4±6.1) minutes and (53.4±7.8) minutes, respectively. Intraoperative blood loss was (20.1±3.2) mL and (28.6±9.1) mL, respectively. Operation time of the study group was significantly lower than that of the control group (t = 16.590, P<0.001). Intraoperative blood loss of the study group was significantly lower than that of the control group (t = 6.926, P<0.001) (**Figure 1**).

Body temperature and administration times of analgesics of study group and control group

Body temperatures of the study group and control group were (37.1±0.13)°C and (38.1±0.23)°C and analgesic administration times were (0.3±0.1) times and (1.0±0.3) times. The body temperature of the study group was significantly less than that of the control group (t = 20.780, P< 0.001). Analgesic administration times in the study group were significantly lower than those of the control group (t = 17.400, P<0.001) (**Figure 2**).

Out of bed activity time and hospitalization time of study group and control group

Out of bed activity time of study group and control group was (48.3±7.1) hours and (56.9±8.9) hours, respectively. Hospitalization time was (5.7±1.4) days and (8.1±1.6) days. Out of bed activity time in the study group was significantly lower than that in the control group (t = 5.910, P<0.001). Hospitalization time of the study group was significantly lower than that of the control group (t = 8.825, P<0.001) (**Figure 3**).

Incidence of postoperative complications and recurrence rates at 1-year-follow-ups in the study and control groups

The study group had 1 case of ischemic orchitis (1.61%), 1 case of wound infection (1.61%), 6 cases of incisional pain (9.68%), 1 case of poor abdominal incision healing (1.61%), and 1 case

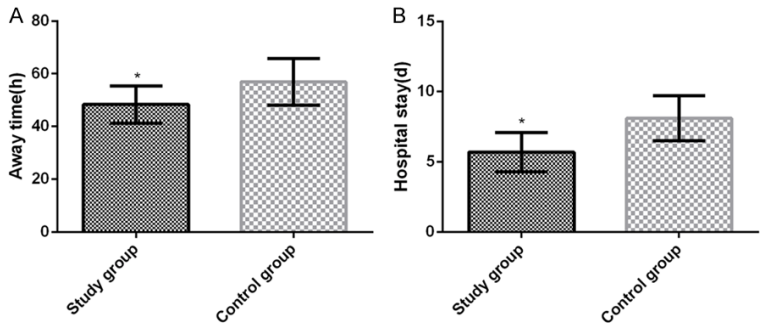

Figure 3. Comparison of bedtime activity time and hospitalization time between study group and control group. Note *P<0.001 compared with control group.

of mild fever (1.61%). Incidence of complications was 16.13%. The control group had 3 cases of ischemic orchitis (5%), 6 cases of wound infections (10.00%), 10 cases of incisional pain (16.67%), 5 cases of poor abdominal incision healing (8.33%), 4 cases of mild fever (6.67%), and 4 cases of scrotal edema (6.67%). Incidence of complications was 53.33%. Incidence of complications in the study group was significantly lower than that in the control group (χ^2 = 18.696, P<0.001). At 1-year follow-ups, recurrence rates in the study group were significantly lower than those in the control group (χ^2 = 4.481, P = 0.042) (**Table 3**).

Discussion

Inguinal hernias may appear immediately after birth. As a congenital dysplasia, an inguinal hernia is mainly caused by failure of the peritoneum to close, with a prominent clinical manifestation of protrusion of abdominal tissues or organs through the abdominal wall to form a palpable mass [15]. There is a male predominance of pediatric inguinal hernias, with unilateral inguinal hernias accounting for a large proportion. Because the right testicle descends later than the left testicle, incidence of right hernia is about 60%, while that of left hernia is about 25%. Incidence of bilateral hernia is approximately 16% [16]. Incidence of bilateral hernias in female children is 18%-24%, while that in premature infants is 20%-48% [17]. Inguinal hernias can cause obstruction of testicular blood flow in male children and induce atrophy and necrosis. Female children with reproductive organ torsion will develop oviduct and ovarian ischemia and necrosis, affecting fertility in adulthood [18, 19]. Therefore, if a pediatric inguinal hernia is diagnosed, surgical treatment should be promptly performed if there is no surgical contraindication.

The most commonly used surgical method for pediatric inguinal hernias is traditional herniorrhaphy with suturing of non-homologous tissues. This high-tension surgical method is not based on the peritoneal fascia and is not consistent with anatomical principles, resulting in a high rate of adverse postoperative incisional outcomes [20]. Traditional herniorrhaphy requires extensive dissection of surrounding tissue. It creates trauma, with additional disadvantages of intraoperative blood loss, long operative time, slow healing of the incision, and high risk of postoperative complications and recurrence [21]. Tension-free herniorrhaphy is simple, less traumatic, and consistent with the physiological characteristics of anatomy. It enables reduced tension during the operation, therefore decreasing recurrence rates to some extent [22]. Results of this study showed that the effective rate of surgery in the study group was significantly higher than that of the control group. The recurrence rate of the 1-year follow-up of the study group was significantly lower than that of the control group, indicating that the application of tension-free hernioplasty in children with inguinal hernias can improve surgical treatment effects and reduce incidence of postoperative complications. Results of this study showed that the 1-year recurrence rate in the study group was significantly lower than in the control group, suggesting that tension-free herniorrhaphy could reduce postoperative recurrence in children, similar to the report by Magnusson [23]. In the process of tension-free herniorrhaphy, the hernia sac is completely dissected and high ligation is performed to disperse the abdominal pressure. The mesh patch used is made of polypropylene, with the advantages of stability and better tensile strength, softness, and resistance to aging, as well as the ability to prevent infections [24].

During the operation, an evenly-placed reticular patch can stimulate the biological characteris-

Table 3. Incidence of postoperative complications and recurrence rates at 1-year follow-up in the study and control groups [n (%)]

Category	Study group (n = 62)	Control group (n = 60)	χ^2	P
Ischemic orchitis	1 (1.61)	3 (5.00)	-	-
Incision infection	1 (1.61)	6 (10.00)	-	-
Incision pain	6 (9.68)	10 (16.67)	-	-
Bad healing of abdominal incision	1 (1.61)	5 (8.33)	-	-
Low heat	1 (1.61)	4 (6.67)	-	-
Scrotal edema	0 (0.00)	4 (6.67)	-	-
Incidence of complications	10 (16.13)	32 (53.33)	18.696	<0.001
Recurrence	3 (4.84)	10 (16.67)	4.481	0.042

tics of fibroblasts and strengthen the muscles of the abdominal wall. The cushioning and reparative posterior wall function of filling materials will provide double reinforcement. Therefore, the indications for surgery are relatively broad in the elderly, children, and patients with dysuria and habitual constipation [25]. Results of this study show that surgery efficacy in the study group was significantly higher than that in the control group. Operative time, intraoperative blood loss, times of analgesics use, out of bed activity time, and length of hospital stay were significantly less in the study group than in the control group. Body temperatures were significantly less in the study group than in the control group. Present findings suggest that tension-free herniorrhaphy has better curative effects, with less trauma, than traditional herniorrhaphy. It relieves postoperative pain and promotes physical rehabilitation, complying with modern medical principles. Karatepe et al. [26] showed that tension-free herniorrhaphy was a safe and effective method for recurrent inguinal hernias, with fewer complications and lower recurrence rates. The difference is that the subjects included were patients with recurrence of inguinal hernias on the same part of body. This study further found that incidence of postoperative complications and recurrence rates in the study group were significantly lower than those in the control group, indicating that the application of tension-free herniorrhaphy in children with inguinal hernias can reduce occurrence of postoperative complications. Present findings are in accord with the study by Magnusson et al. [23]. Tension-free herniorrhaphy is characterized by a simple operation and less trauma. It conforms to the physiological characteristics of human anatomy, thus it can reduce tension during the operation, reducing incidence of postoperative complications and recurrence rates.

The current study selected subjects according to strict inclusion and exclusion criteria. Study and control groups showed no differences in sex, age, weight, clinical type, Hb, RBC count, PLT count, ALT, and AST, ensuring rigorous methodology and reliability. This study had limitations, however. The number of subjects was limited and some postoperative complications still occurred. In future studies, the surgical methods should be more detailed and incidence of postoperative complications should be reduced.

In summary, tension-free herniorrhaphy for pediatric inguinal hernias offers the advantages of shorter operative time, less trauma, quicker recovery, fewer complications, and lower recurrence rates. Thus, it should be widely used in clinical practice.

Disclosure of conflict of interest

None.

Address correspondence to: Guangjian Tian, Department of General Surgery, Beijing Luhe Hospital, Capital Medical University, No. 82 Xinhua South Road, Tongzhou District, Beijing 101149, China. Tel: 13501276534; E-mail: guangjiantianyx@163.com

References

[1] Farouk A, Selimah MA and El-Fakharany M. Safety and stability of inguinal hernia repair in Egyptian patients suffering from portal hypertension-associated ascites using ultrasound-guided nerve block. The Egyptian Journal of Surgery 2017; 36: 156.

[2] Cui Z, Xie B and Zhang R. Laparoscopic inguinal hernia repair and Lichtenstein tension-free hernia repair for children in 13-18 years old: a prospective, randomized, single-blind controlled trial. Biomedical Research 2018; 3: 29.

[3] Dsouza R, Shankar N, Gurubatham R, Rajaleelan W and Menon N. Absent external oblique musculo-aponeurotic complex during inguinal hernioplasty: a case report and review of literature. Surg Radiol Anat 2017; 39: 1045-1048.

[4] Brar NS and Bajwa RS. Prospective study on clinical outcomes of lichtensteins tension free inguinal hernioplasty under local anaesthesia. International Surgery Journal 2017; 4: 3611-3616.
[5] Talha AR, Shaaban A and Ramadan R. Preperitoneal versus lichtenstein tension-free hernioplasty for the treatment of bilateral inguinal hernia. The Egyptian Journal of Surgery 2015; 34: 79.
[6] Brar N, Singh A and Bajwa R. Prospective studies on clinical outcomes of lichtenstein's tension free inguinal hernioplasty under local anaesthesia. International Surgery Journal 2017; 4: 3474-3476.
[7] Jamnagerwalla J and Kim HH. Groin pain etiology: spermatic cord and testicular causes. In: editors. The SAGES manual of groin pain. Springer; 2016. p. 111-135.
[8] Rosales A, Falk GA and Burnweit CA. Laparoscopic management of testicular disorders: cryptorchidism and varicocele. In: editors. The SAGES Manual of Pediatric Minimally Invasive Surgery. Springer; 2017. p. 667-684.
[9] Nawaz A, Mansoor R, Butt UI, Khan A, Umair M, Bilal S and Ayyaz M. Comparison of laparoscopic total extraperitoneal repair with lichtenstein repair in inguinal hernia. Journal of Surgery Pakistan (International) 2015; 20: 2.
[10] Cai LZ, Foster D, Kethman WC, Weiser TG and Forrester JD. Surgical site infections after inguinal hernia repairs performed in low and middle human development index countries: a systematic review. Surg Infect (Larchmt) 2018; 19: 11-20.
[11] Lichtenstein IL, Shulman AG, Amid PK and Montllor MM. The tension-free hernioplasty. Am J Surg 1989; 157: 188-193.
[12] Zulu HG, Mewa Kinoo S and Singh B. Comparison of Lichtenstein inguinal hernia repair with the tension-free desarda technique: a clinical audit and review of the literature. Trop Doct 2016; 46: 125-129.
[13] Yenli EMT, Abanga J, Tabiri S, Kpangkpari S, Tigwii A, Nsor A, Amesiya R, Ekremet K and Abantanga FA. Our experience with the use of low cost mesh in tension-free inguinal hernioplasty in northern ghana. Ghana Med J 2017; 51: 78-82.
[14] Gupta S, Bhau PS and Kachroo S. A prospective, comparative study of tension free hernioplasty using prolene hernia system (PHS) and lichtenstein patch method (LPM) in inguinal hernia. Journal of Evolution of Medical and Dental Sciences 2016; 5: 1586-1589.
[15] Liu Y, Shen Y and Chen J. Effects of non-woven mesh in preperitoneal tension-free inguinal hernia repair: a retrospective cohort study. Minerva Chir 2017; 72: 311-316.
[16] Magnusson J, Nygren J, Gustafsson UO and Thorell A. UltraPro hernia system, prolene hernia system and lichtenstein for primary inguinal hernia repair: 3-year outcomes of a prospective randomized controlled trial. Hernia 2016; 20: 641-648.
[17] Zamkowski MT, Makarewicz W, Ropel J, Bobowicz M, Kakol M and Smietanski M. Antibiotic prophylaxis in open inguinal hernia repair: a literature review and summary of current knowledge. Wideochir Inne Tech Maloinwazyjne 2016; 11: 127-136.
[18] Kohl AP, Andresen K and Rosenberg J. Male fertility after inguinal hernia mesh repair: a national register study. Ann Surg 2017; 268: 374-378.
[19] Kim JH, Chong GO, Lee JY, Lee YH, Hong DG, Park SY and Park JY. Laparoscopic repair of indirect inguinal hernia containing endometriosis, ovary, and fallopian tube in adult woman without genital anomalies. Obstet Gynecol Sci 2014; 57: 557-559.
[20] Wang F, Liu S, Shen Y and Chen J. A comparative study of the single-site laparoscopic herniorrhaphy using needle instruments and double-site laparoscopic herniorrhaphy in the minimally invasive treatment of inguinal hernias in children. Exp Ther Med 2018; 15: 2896-2900.
[21] Jia Z, Zhang J and Kong CJ. Perioperative management of groin ascitic hernia by hernia-roof technique: a 14-year experience. Archives of Medicine 2017; 9.
[22] Kokkinos C, Anagnostopoulos G, Filippou D and Skandalakis P. Modified three-stitch hernioplasty technique. Avicenna J Med 2018; 8: 63-64.
[23] Magnusson J, Gustafsson UO, Nygren J and Thorell A. Rates of and methods used at reoperation for recurrence after primary inguinal hernia repair with prolene hernia system and lichtenstein. Hernia 2018; 22: 439-444.
[24] Fan Q, Zhang DW, Yang DY, Li HW, Wei SB, Yang L, Yang FQ, Zhang SJ, Wu YQ, An WD, Dai ZS, Jiang HY, Wang FR, Qiao SF and Li HY. Anterior transversalis fascia approach versus preperitoneal space approach for inguinal hernia repair in residents in northern China: study protocol for a prospective, multicentre, randomised, controlled trial. BMJ Open 2017; 7: e016481.
[25] Shen YM, Liu YT, Chen J and Sun L. Efficacy and safety of NBCA (n-butyl-2-cyanoacrylate) medical adhesive for patch fixation in totally extraperitoneal prosthesis (TEP): a prospective, randomized, controlled trial. Eur Rev Med Pharmacol Sci 2017; 21: 680-686.
[26] Karatepe O, Acet E, Altiok M, Adas G, Cak RA and Karahan S. Preperitoneal repair (open posterior approach) for recurrent inguinal hernias previously treated with lichtenstein tension-free hernioplasty. Hippokratia 2010; 14: 119-121.