



Pediatric Hydrocele: A Comprehensive Review

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Abstract

Pediatric hydrocele is a benign common condition seen by surgeons. It almost always occurs in males although a female equivalent is described. A hydrocele is a collection of fluid within the processus vaginalis (PV) that produces swelling in the inguinal region or scrotum. An inguinal hernia occurs when abdominal organs protrude a large PV, into the inguinal canal or scrotum. Inguinal hernia and hydrocele share a similar etiology and pathophysiology and may coexist. In a healthy male neonate, the testicle is surrounded by a closed cavity; the tunica vaginalis of the scrotum. In postnatal life, this is a potential space that should not communicate with the peritoneal cavity of the abdomen. However up to 60% of neonates have hydroceles. The natural history of PV is that of spontaneous closure due to poorly understood reasons. After 2 years of age, only 0.8% of males have a clinically palpable hydrocele and surgery is recommended for this group. The surgical techniques involve PV resection or closure at internal ring via open surgery or laparoscopically, whichever techniques used; the outcome is highly successful and minimal complications are reported.

Keywords: Pediatric hydrocele; Inguinal hernia

Introduction

History

The description of the abdominal cavity and the tunica vaginalis is attributed to Galen in 176 AD [1]. However, a clear description of the inguinal anatomy and its relationship to groin hernias and hydroceles was not recorded until the 19th century. The first surgically treated series was published in 1934 by a German surgeon [2]. However, earlier successful surgical treatments similar to modern surgery were noted as early as 1915 [3].

Pathogenesis

Hydrocele is defined as an accumulation of serous fluid in a body sac, normally in the scrotum. In an attempt to understand the pathophysiology of pediatric hydroceles, it is necessary to first clarify the normal embryology of testicular descent. During fetal development, the testicle is formed after the migration of Y-containing germ cells from the yolk sac onto the gonadal ridge at 6 weeks of gestation. Gonadal ridge is a mesenchymal structure that is located medial to the mesonephros.

Subsequently and during the rest of fetal development, the testicle descends through the posterior abdominal wall and through the inguinal canal by the shortening of a cordlike structure (gubernaculum). The exact mechanism of this regression is not fully understood and is probably due to a complex local hormonal combination produced by the testicle. There are several androgenic hormones implicated in testicular descent; notably testosterone, which act directly by shortening and finally regressing of Gubernaculum, the descent of testis is however far more complex than that, and it is beyond the scope of the mini-review [4,5]. As part of its descent through the inguinal canal, an opening appears at the internal ring by a saclike extension of the peritoneum, the Processus Vaginalis (PV). There is no information available on the mechanism for the appearance of this extension.

After the testicle descends, the PV obliterates and either disappears or becomes a fibrous cord without a lumen. The distal tip of the PV remains as a membrane around the testicle, which is commonly referred to as the tunica vaginalis.

This obliteration of PV disconnects the inguinal region and scrotum from the abdomen, and therefore, no abdominal organs or peritoneal fluid can pass into the scrotum or inguinal canal. If the PV does not close, it is referred to as a Patent Processus Vaginalis (PPV). If the PPV is small in caliber and only large enough to allow fluid to pass, the condition is referred to as a communicating hydrocele. If the PPV is larger, allowing ovary, intestine, omentum, or other abdominal contents to protrude, the condition is referred to as a hernia.

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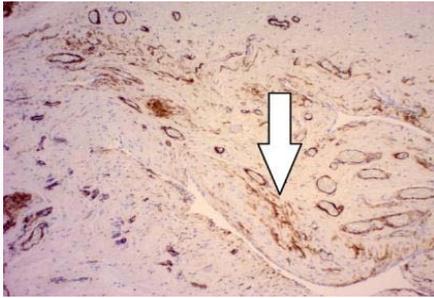


Figure 1: Caldesmon immunohistochemical confirmations of smooth muscle remnant (white arrow) in an excised hernial sac (Courtesy of Dr. P. Schubert, Pathologist) X100 magnification.

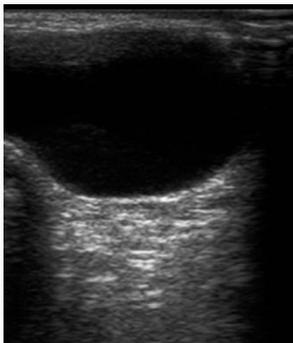


Figure 2: Typical sonar of a unilateral communicating hydrocele.

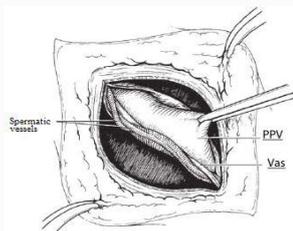


Figure 3: Standard open mobilization of PPV.

A number of theories have been postulated concerning the failure of PV closure at birth. The most likely pathogenesis is the role of smooth muscle within the PV and its subsequent contraction, resulting in the closure of the PV. Smooth muscle of unknown origin has been identified in PPV tissue in both males and females (Figure 1), including adult patients, but it is not present in the normal peritoneum. Paradoxically, higher amounts of smooth muscle have been noted in inguinal hernia sacs than in the PPV of children with hydroceles. This suggests that smooth muscle keeps the PPV open rather than closed. Further research is needed to explain these contradictory findings [6-9].

Familial inheritance is a well-known entity in which approximately 8% of parents reported having a groin operation as a child, more likely for an inguinal hernia rather than a hydrocele [10]. Few people remember the age of surgery, and hence, no clear data are available.

Differential Diagnosis

A hydrocele, based on its cause, can be categorized as primary or secondary

A primary hydrocele is due to the failure of the PV to close and

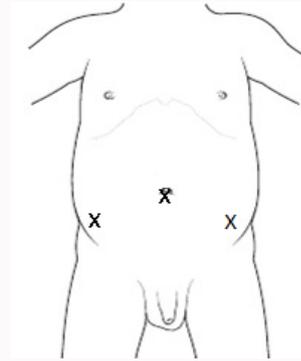


Figure 4: Port placement for laparoscopy of the groin region.

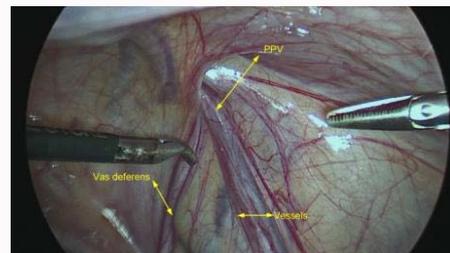


Figure 5: Laparoscopic identification of PPV, vas deferens and testicular vessels.

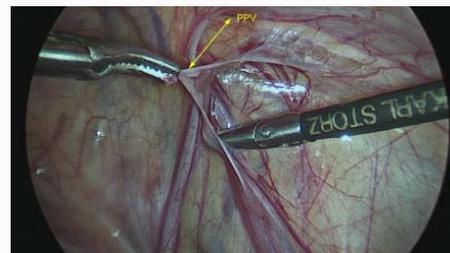


Figure 6: The lateral aspect of the PPV is dissected first with scissors.

is by far the most common pathology seen by pediatric surgeons. A primary hydrocele is the result of a poorly understood abnormality in PV closure.

In some cases, PV is closed at the time of surgery and simple drainage of a large fluid collection is all that is needed.

A secondary hydrocele in children is often due breakdown of hematoma after groin surgery, mistaken ligation and excision of PV during routine surgery. Secondary hydrocele can have a different etiology in the adult population. Its pathology is more complicated, and there are exhaustive descriptive pathologies. Careful clinical examination is sufficient in most cases to ascertain as to the primary or secondary nature of the hydrocele; however, in equivocal cases, an ultrasound is often required as an aid to diagnosis.

In decreasing order of incidence in children

Inflammatory conditions: Otherwise known as epididymitis/orchitis, the former is associated with descending infection from the urinary tract via the vas deferens as well as occasional case reports in patients with ano-rectal malformation. If there is any doubt, an urgent ultrasound may help with the diagnosis. In most cases, broad-spectrum antibiotics are prescribed for 7-10 days.

Torsion of appendix testis: One of the remnants of the Mullerian ducts in males persists as an appendage on the upper pole of the testes. For unknown reasons, this tissue can undergo torsion, causing significant pain. Despite ultrasonic confirmation, parents are sufficiently concerned about testicular torsion and the severity of pain that they request scrotal exploration and excision of the pathology.

Omental plug at the internal ring: In this pathology, the PPV is large, but an omental plug obstructs the entrance to the PV. This pathology is essentially an inguinal hernia. The treatment is to repair the inguinal hernia after releasing the omentum, which is partially attached to the PV.

Testicular torsion: This is a complex rare pathology noted in teenagers where the testis twists on its axis, causing ischemia. Urgent de-torsion and pexy of both side are mandatory.

Tumors: There are numerous primary and metastatic tumors (occasionally called a sanctuary location) that can result in minimal fluid collection. Clinically, these conditions are readily distinguishable from a primary hydrocele. Treatment is by trans-inguinal resection in most cases.

Parasitic infection: The most quoted parasitic infection in the hemi-scrotum is due to *Wuchereria bancrofti* round worms [11] although *Echinococcus* infections are also described [12]. Clinically, they can be difficult to diagnose preoperatively, and ultrasonography is necessary to identify testicular pathology in equivocal cases. They are managed by medical, supportive bandaging and rarely surgery.

Ascites: Increased pressure from excess fluid of the intra-abdominal cavity could result in a large hydrocele that was not present prior to the disease process. The common cause is ascites due to renal or hepatic failure as well as a newly placed ventricular peritoneal shunt. Management is directed towards the cause of ascites.

Post-varicocele fluid collection: This condition is due to lymphatic fluid collection after surgical ligation of spermatic vessels for varicocele. Lymphatic sparing ligation is advocated to avoid this complication. There is no consensus as to the best modality for its definitive treatment.

Incidence

There are no demographic or racial differences. It is not easy to ascertain an exact hydrocele incidence because of underreporting by many parents or children. Scrotal fluid collection is present in 60% to 80% of males at birth but declines to under 0.8% over 2 years of age. The overall male to female ratio is calculated at 500:1 [13].

Clinical presentation of pediatric hydrocele

A hydrocele in males is a collection of fluid in a potential space between the tunica vaginalis and the testicle. Hydroceles may be considered communicating due to a small-caliber PPV that allows only fluid to pass into the scrotum. If there is no connection between the hydrocele and the abdominal cavity, the condition is called a non-communicating hydrocele. Non-communicating hydroceles are common in infants, with an incidence close to 60% in newborns. The non-communicating hydrocele usually spontaneously reabsorbs before the age of 2 years. In most children with a congenital hydrocele, there is a long history of an asymptomatic, painless, soft fullness in the hemi-scrotum that is usually noticed by the caregiver or during routine school physical screenings. Pain is not a symptom, and if present, the possibility of an incarcerated or strangulated inguinal

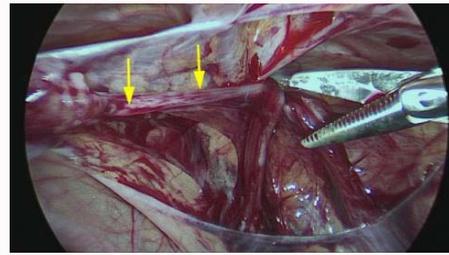


Figure 7: A section of PPV (yellow arrows) is gently pulled inside the abdominal cavity.

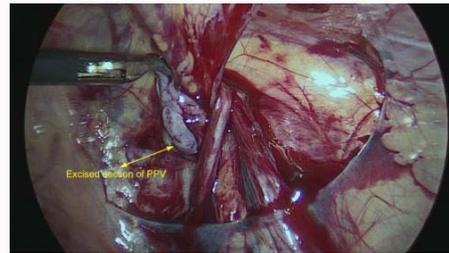


Figure 8: Excised section of a PPV.

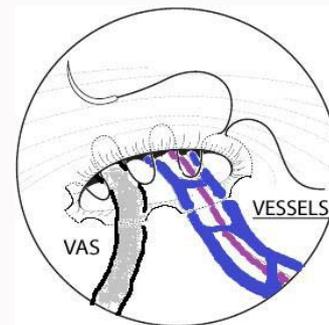


Figure 9: Intra peritoneal purse string closure for pediatric hydrocele.

hernia must be considered.

Communicating hydroceles vary in size during a 24 h period, with an increase in volume during daytime activity. If communicating, a large hemi-scrotal fullness may extend into the inguinal area and can be associated with discomfort during physical activity.

Occasionally, a hydrocele can extend from the scrotum through the inguinal canal into the retro-peritoneum as an abdomino-scrotal hydrocele. This is due to a minute “trap-door” opening in the PPV; fluid that enters the hydrocele becomes entrapped, and the hydrocele continues to enlarge upward toward the abdomen. This condition can be mistaken for an indirect inguinal hernia during clinical examination and is often operated on.

When a small communication with the peritoneum persists and the PPV obliterates further distally, a hydrocele of the cord can form. It presents as a tense, fluid-containing, painless, round, mobile mass. It is palpable in the inguinal canal or upper scrotum and usually resorbs by 1-2 years of age.

An acute presentation of a hydrocele may be secondary to an underlying disease process inside the tunica vaginalis or testis. In many patients, there is an acute respiratory tract infection or gastroenteritis associated with significant scrotal pain due to sudden

distension of a small hydrocele. In this unusual circumstance, increased intra-abdominal pressure during coughing or straining forces large amounts of fluid through a small-caliber PPV.

The majority of premature hydroceles resolve with time, and therefore, surgery is only considered if the hydrocele is present at the age of 2 years and is not decreasing further in size [2].

Physical examination is normally sufficient to distinguish a hydrocele from an inguinal hernia. If the clinician is able to feel the spermatic cord above the mass, a hydrocele can be confidently diagnosed. This may be difficult to appreciate in the presence of a tense inguino-scrotal hydrocele. An additional feature in the clinical findings of a hydrocele includes the ability to trans-illuminate. This does not fully exclude an inguinal hernia, since an incarcerated inguinal hernia in premature infants can also trans-illuminate [14].

Imaging studies

Most cases of pediatric hydroceles can be diagnosed with a good history and adequate physical examination alone. A minority of patients require further radiological investigation to aid in diagnosis. Historically, contrast herniography was performed, but this has been replaced by ultrasonography.

Herniography: This procedure is of historical interest only. Water soluble contrast is injected into the peritoneal cavity via an infra-umbilical fluoroscopic-guided injection. With gravity, the contrast accumulates into the PPV, which is identified by serial plain X-rays.

Ultrasonography, using a 7.5 MHz transducer, is the current modality of choice as an aid for diagnosis, with a reported accuracy of 91.7% [15], compared to herniography, this modality has the distinct advantage of being noninvasive (Figure 2). Indications for usage of ultrasonography include: trauma with possible testicular rupture, torsion of a testicle or ovary, concern of a testicular or spermatic cord tumor, or equivocal physical findings. Ultrasound performed with the patient at rest and straining: standing, coughing or crying. Detection of the inflow of peritoneal fluid in the inguinal canal is diagnostic for a hydrocele with ultrasound examination.

Surgical techniques

Unlike in adults, sclerotherapy has no place in the definitive management of pediatric hydroceles. Standard open surgical management has been the gold standard for the definitive treatment of hydroceles, and the procedure is identical to an inguinal herniotomy. The main difference is that the PPV is small in caliber. Excision of a section of PV is thought to be as effective as ligation, with reports in other series that have shown low or no recurrence with non-ligation of the sac in inguinal hernia [16,17]. The safety and efficacy of laparoscopic repair for both an inguinal hernia and a hydrocele in children are demonstrated to be similar to open procedures without any minor or major complications. Several known advantages of the laparoscopic approach are that it is a less painful approach for patients, patients return to their normal activity more rapidly, and it provides superior cosmetic results.

All techniques are performed under general anesthesia, the child's abdomen, groin, and scrotum are cleaned and draped. The patient is placed in the supine position. Thereafter, there are at least four surgical options available.

Open inguinal herniotomy for pediatric hydrocele: High ligation of the PPV with or without drainage of the scrotal hydrocele

is the standard method of open repair for a hydrocele performed via an inguinal incision [2].

In older children, the internal inguinal ring is more lateral, increasing the distance between the two rings. The external ring lies superior and lateral to the pubic tubercle.

A transverse skin incision is made in the groin, above the external inguinal ring on the symptomatic side, within a skin crease. Dermis and the subcutaneous tissues are spread bluntly, exposing Scarpa's fascia. The fascia is incised to expose the external oblique fascia mediolaterally. The inguinal ligament is exposed laterally and medially up to the level of the external ring. The external oblique fascia, 1 cm to 2 cm above the inguinal ligament, is opened superiorly and laterally near the external inguinal ring in the direction of the muscle fibers. Two clamps are placed on both cut edges of the fascia (Figure 3). The spermatic cord containing PPV is mobilized through the opening of the fascia and the cord structures are elevated out of the wound. Fibers attached to the hernia sac are released until a clear space inferior to the cord is created and artery forceps are placed underneath this space. The spermatic fascia is bluntly dissected the, vas deferens and vessels are dissected away from the sac. A clamp is placed across the vas deferens and vessels, and the proximal end of the hernia sac is freed of cord structures to the level of the internal ring and ligated with monofilament absorbable sutures. A small window is cut into the hydrocele and fluid drained from the distal sac and /or scrotum with digital pressure. The testicle is pulled down, and cord structures returned to the scrotum. The two clamps are elevated on the edges of the external oblique fascia, and closed with interrupted absorbable sutures. Surgical wound is closed in layers; Scarpa's fascia is closed with a single interrupted absorbable suture, skin with an absorbable subcuticular continuous suture and a wound dressing is applied.

There are at least 3 laparoscopic approaches, practiced mostly in academic teaching centers. The simplicity of the operation and the fine dissection required to separate the cord vessels and vas deferens make laparoscopic PPV excision an ideal procedure for pediatric surgical trainees in minimally invasive surgery. During laparoscopy, the contralateral inguinal ring can be inspected for patency. These approaches are gaining popularity with pediatric surgeons with cheaper ports and instrumentations; increased cost is no longer an important debate. These techniques are particularly useful for recurrent cases where a scarred groin is avoided by attending to open PV trans-abdominally.

The laparoscopic approaches to pediatric hydrocele include: ligation or excision of a section of PPV and extra- or intra-peritoneal repair.

Intra-peritoneal PPV excision with non-ligation: The surgeon and assistant stand at the head of the operating table with the screen/monitor at the foot of the table.

A 5 mm supra or infra-umbilical camera port is inserted via the open Hasson approach. Pneumoperitoneum is achieved via insufflation of CO₂ at pressures of 8 mmHg to 10 mmHg. PPV, vas deferens, and testicular vessels are identified. The contralateral side is evaluated for a concurrent hydrocele, which is found in 10% of cases and can be repaired at the same time. Under direct vision, two other 3 mm instruments are placed, one in the right lower quadrant and left lower quadrant at 90 degree working angles (Figure 4). In one approach, favored by the authors, a section of PPV is excised

without its ligation (Figures 5-8). The pneumoperitoneum is released, the umbilical incision is closed with an absorbable suture, and the wounds of the two working sites are closed with stri-strips. There is no report of recurrence with this technique in 75 cases over a 5-year follow-up (accepted manuscript, awaiting publication).

Intra-peritoneal purse string closure of PPV: Here, a sub-peritoneal saline injection is used to separate the vas deferens and testicular vessels from the peritoneum. The peritoneum overlying the testicular vessels and vas deferens is grasped, and 2 ml to 4 ml of saline is injected. The neck of the hernia sac is incised with a scissor or diathermy. An absorbable suture is passed under visual control through the abdominal wall. The purse string suture is placed around the hernia ring and must include the whole ring of the peritoneum. Exit and entry sites of successive bites of peritoneum should be as close as possible (Figure 9). Intra-peritoneal pressure is decreased to 2 mmHg to 4 mmHg before tying the suture. Complete closure of the processus vaginalis is tested by increasing intra-peritoneal pressure to 15 mmHg and palpating for crepitus; if present, another suture can be placed. Ports are removed under direct vision, and the insufflation is terminated. Wounds are closed as described. Recurrence rate of 1.4% are reported with this technique [18].

Extra-peritoneal purse string closure of PPV (2 or one trocar technique): After placement of the camera port and creation of pneumoperitoneum, a 3 mm grasper is placed midway between the umbilicus and the supra pubic tubercle under direct vision. A small stab wound is made just lateral to the internal ring, and a hernia hook containing a 3/0 non-absorbable suture is passed through the tract into the pre-peritoneal space. The deep ring is dissected from medial, lateral, and posterior aspects. Care is taken to avoid the vas deferens and testicular vessels. The tip of the hook is used to pierce the peritoneum. Halfway around the internal ring, the suture is pulled into the peritoneum, and the hook is withdrawn and reinserted into the antero-medial peritoneal space. The medial semicircle of the internal ring is similarly dissected as before. The hook then re-enters the peritoneum. The suture is placed through the eye of the hook, it is withdrawn, and the suture entirely encircles the internal ring. Pneumoperitoneum is released, and the suture is tied extra-corporally. The complete closure of the PV can again be tested by increasing the intra-abdominal pressure, and palpating for crepitus as described before. A recurrence rate of about 1% has been recorded in this approach [19-22].

Complication of Surgery

There are many anesthetic complications, notwithstanding the recently described toxicity of volatile anesthetic agents in children <4 years of age [23].

Open and laparoscopic techniques can result in a myriad of complications, which, although rare, are routinely discussed with parents/caregivers as part of the consent process. Commonly mentioned complications include partial to complete transection of the vas deferens as well as spermatic cord vessel injury. Recurrence is due to failure in recognizing and resecting the small-caliber PPV by inexperienced surgeons. However, unlike inguinal herniotomy, damage to other structures, such as the bladder, are never reported.

Wound infections or dehiscence are rare, and there is no literature regarding trocar injury during laparoscopic PPV surgery.

Conclusion

The exact mechanism of the formation of hydroceles and non-closure of PV is yet to be determined.

The definitive repair of hydroceles in children over 2 years of age is a relatively simple, regardless of the technique used. It has a very high success rate with minimal morbidity.

References

- Charles S. A short history of anatomy from Greeks to Harvey. 1957;46-56.
- Langer M. About the Hernia and Hydrocele of the Childhood. Arch f Klin Chir. 1934;18:418.
- Gross RE. Hydrocele. In: The Surgery of Infancy and Childhood. London: WB Saunders Publishers; 1953. p. 463-6.
- Hutson JM, Li R, Southwell BR, Newgreen D, Cousinery M. Regulation of testicular descent. *Pediatr Surg Int*. 2015;31(4):317-25.
- Sadler TW. Urogenital system. *Langman's Medical Embryology*, 9th ed. Philadelphia: Lippincott Williams; 2004. p. 321-62.
- Stickel WH, Manner M. Female hydrocele (cyst of the canal of Nuck): sonographic appearance of a rare and little-known disorder. *J Ultrasound Med*. 2004;23(3):429-32.
- Schneider CA, Festa S, Spillert CR, Bruce CJ, Lazaro EJ. Hydrocele of the canal of Nuck. *N J Med*. 1994;91(1):37-8.
- Tanyel FC, Mufutuoclu S, Dagdeviren A, Kaymas FF, Buyukpamukch N. Myofibroblast defined by electron microscopy suggest the dedifferentiation of smooth muscle within the sac walls associated with congenital hernia. *BUJ international*. 2001;87:251-5.
- Mouravas VK, Koletsa T, Sfougaris DK, Philippopoulos A, Petropoulos AS, Zavitsanakis A, et al. Smooth muscle cell differentiation in the processus vaginalis of children with hernia or hydrocele. *Hernia*. 2010;14(2):187-91.
- Burcharth J, Pommegaard HC, Rosenberg J. The inheritance of groin hernia: a systematic review. *Hernia*. 2013;17(2):183-9.
- Aguiar-Santos AM, Leal-Cruz M, Netto MJ, Carrera A, Lima G, Rocha A. Lymph scrotum: an unusual urological presentation of lymphatic filariasis. A case series study. *Rev Inst Med Trop Sao Paulo*. 2009;51(4):179-83.
- Khan RA, Wahab S, Chana RS, Fareed R. Isolated retroperitoneal hydatid cyst in a child: a rare cause of acute scrotal swelling? *J Pediatr Surg*. 2010;45(8):1717-9.
- Ben-Ari J, Merlob P, Mimouni F, Rosen O, Reisner SH. The prevalence of high insertion of scrotum, hydrocele and mobile testis in the newborn infant (36-42 weeks gestation). *Eur J Pediatr*. 1989;148(6):563-4.
- Naji H, Ingolfsson I, Isacson D, Svensson JF. Decision making in the management of hydroceles in infants and children. *Eur J Pediatr*. 2012;171(5):807-10.
- Hasanuzzaman SM, Chowdhury LH, Sarker RN, Bari MS, Talukder SA, Islam MK. Ultrasonographic evaluation of contralateral exploration of patent processus vaginalis in unilateral inguinal hernia. *Mymensingh Med J*. 2011;20(2):192-6.
- Mohta A, Jain N, Irniraya KP, Saluja SS, Sharma S, Gupta A. Non-ligation of the hernial sac during herniotomy: a prospective study. *Pediatr Surg Int*. 2003;19(6):451-2.
- Rafei MH, Jazini A. Is the ligation of hernial sac necessary in herniotomy for children? A randomized controlled trial of evaluating surgical complications and duration. *Adv Biomed Res*. 2015;4:97.
- Yang XD, Wu Y, Xiang B, Wong K, Pei J, Li FY. Ten year experience of laparoscopic repair of pediatric hydrocele and the long-term follow-up results. *J Pediatr Surg*. 2015;50(11):1987-90.

19. Saka R, Okuyama, Sasaki T, Nose S, Yoneyama C. Safety and efficacy of laparoscopic percutaneous extra peritoneal closure of inguinal hernias and hydroceles in children: a comparison with traditional open repair. *J Laparoendosc Adv Surg Tech A*. 2014;24(1):55-8.
20. Wang Z, Xu L, Chen Z, Yao C, Su Z. Modified single-port minilaparoscopic extraperitoneal repair for pediatric hydrocele: a single-center experience with 279 surgeries. *World J Urol*. 2014;32(6):1613-8.
21. Shalaby R, Ismail M, Gouda S, Yehya AA, Gamaan I, Ibrahim R, et al. Laparoscopic management of recurrent inguinal hernia in childhood. *J Pediatr Surg*. 2015;50(11):1903-8.
22. Peng Y, Li C, Han Z, Nie X, Lin W. Modified single-port vs two-port laparoscopic herniorrhaphy for children with concealed deferent duct: a retrospective study from a single institution. *Hernia*. 2016.
23. Lin D, Liu J, Kramberg L, Ruggiero A, Cottrell J, Kass IS. Early-life single-episode sevoflurane exposure impairs social behavior and cognition later in life. *Brain Behav*. 2016;6(9):e00514.