

## Surgical Treatment of Inguinal Hernia with Prolapsed Ovary in Young Girls: Emergency Surgery or Elective Surgery

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**Objective:** Inguinal ovarian hernias are common in young girls. Many articles in medical literature recommend early surgery for inguinal ovarian hernia because of the risk of torsion of the prolapsed ovary. However, since many irreducible herniated ovaries in newborn infants and during early infancy undergo spontaneous reduction by the age of 9 months, the policy at our institute is to obtain informed consent from the patient's family and then wait to perform surgery until after 9 months of age. In the present study, we assessed the indications for surgery for inguinal ovarian hernia in newborn infants and during early infancy. **Methods:** Between 2003 and 2011, a total of 673 girls with inguinal hernias (age at the time of onset of symptoms: mean, 42.5 months; median, 39 months) were brought to our outpatient clinic for consultation. We reviewed their age at the time of the onset of hernia symptoms and their age at the time of surgery, their history of surgery, and their history of inguinal ovarian hernia using information obtained from their medical records.

**Results:** Among the 673 outpatients, 71 patients (mean/median age at the time of onset of symptoms: 11.2/1.5 months) were diagnosed as having an inguinal ovarian hernia at the time of diagnosis. Among these patients, surgery was performed for 58 patients (mean/median age at the time of surgery: 21.3/11 months). Of these patients, the ovary had already spontaneously reduced into the abdomen in 35 cases (mean/median age at the time of surgery: 24.1/12 months), whereas the ovaries were on the wall of the hernia sac in 22 cases (mean/median age at the time of surgery: 17.3/10 months). In one case, a testis instead of an ovary was observed in the hernia sac at the time of surgery. Surgeries were performed in 611 of the 673 patients (mean/median age at the time of surgery: 54/50 months). In 35 cases (mean/median age at the time of surgery: 21.6/10 months), the ovary was still on the hernia sac wall at the time of surgery, but an inguinal ovarian hernia had not been diagnosed before surgery in 13 of these cases. A severe complication occurred in only one case, in which a hernia sac that contained a fallopian tube and ovary was ligated. None of the cases exhibited torsion of the ovary within the inguinal canal.

**Conclusion:** Since the ovary can be expected to undergo spontaneous reduction into the abdomen by late infancy in many young patients with inguinal ovarian hernias, patients with inguinal ovarian hernias can be treated by elective surgery at the most convenient age, after 9 months of age.

**Key words:** female inguinal hernia in newborn, inguinal ovarian hernia, ovary prolapsed, torsion, spontaneous regression

### INTRODUCTION

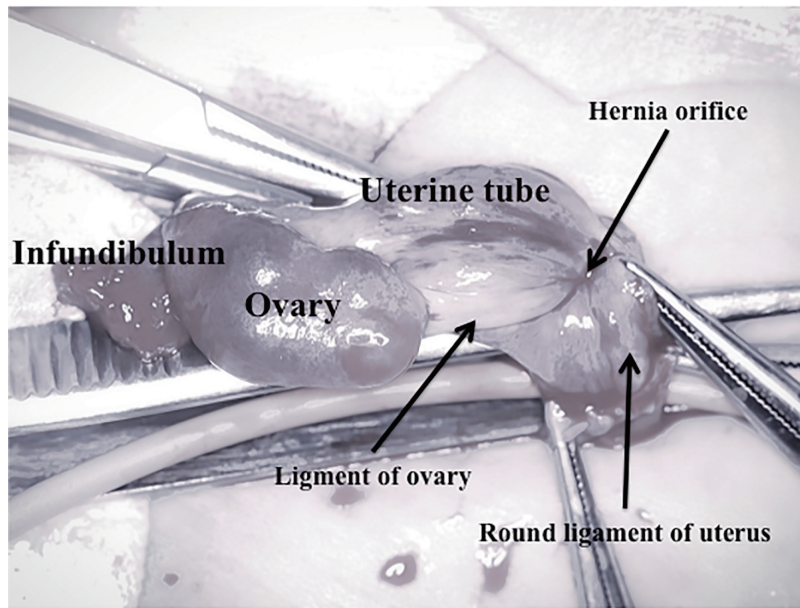
Inguinal ovarian hernias are common in young girls (Fig.1) [1]. However, the medical literature contains little information on inguinal hernias and inguinal ovarian hernias in girls [2].

The ovarian vessels run within the ovarian suspensory ligament behind the peritoneum, and they reach the ovaries via the mesovarium [3]. Thus, the ovarian vessels approach the ovary from the retroperitoneum. In inguinal ovarian hernias, the ovary is thought to prolapse out into the inguinal canal together with the retroperitoneum containing the ovarian vessels. Because the prolapsed retroperitoneum is thought to provide the blood supply to the ovary in patients with asymptomatic irreducible inguinal ovarian hernia, and thus should not be injured, such patients have been scheduled to undergo operative repair in a customary elective fashion in the past [4].

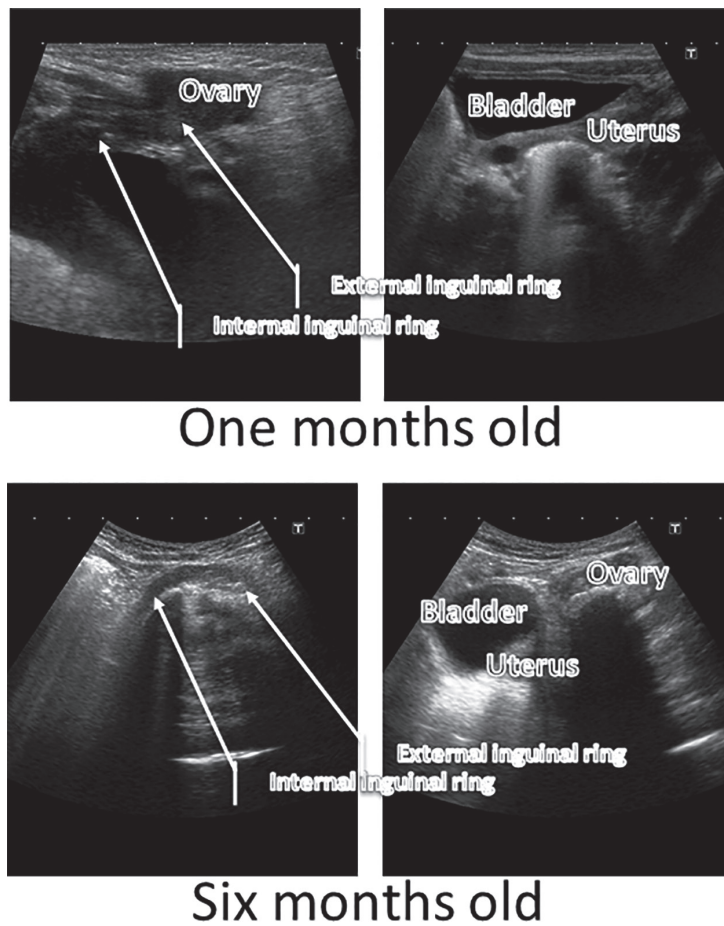
However, several recent reports have described the

torsion of an ovary within the inguinal canal [5, 6]. Some reports have recommended early surgery for inguinal ovarian hernia, including asymptomatic cases, because of the risk of torsion of the prolapsed ovary [7, 8]. However, over a ten-year period at our institute, we have not experienced a single case ovary torsion within the inguinal canal, and many irreducible herniated ovaries in newborn infants and during early infancy have been found to undergo spontaneous reduction during late infancy (Fig. 2). Thus, with the informed consent of the patient's family, we usually keep the patient under strict and careful observation and wait to perform surgery until after the infant has reached more than 6 months of age.

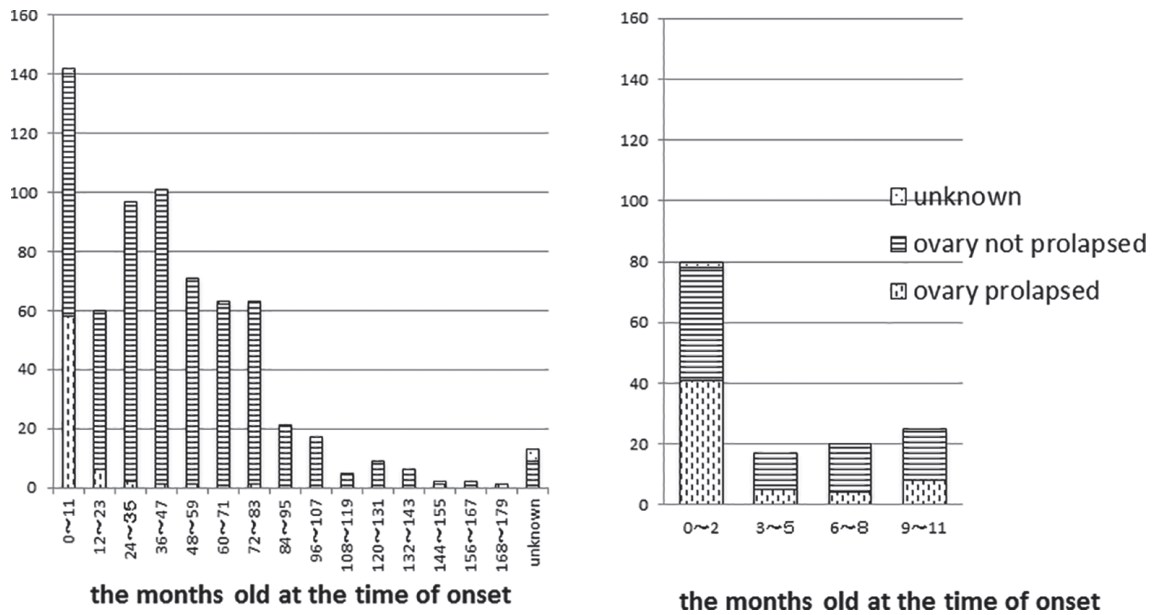
In the present study, we retrospectively assessed the indications for surgery for inguinal ovarian hernias in newborn infants and during early infancy based on the medical records of our institution.



**Fig. 1** A 10-month-old patient with a left inguinal ovarian hernia. The ovary and the fallopian tube were prolapsed on the wall of the inguinal hernia sac.



**Fig. 2** The upper ultrasonography image shows a left inguinal ovarian hernia in a 1-month-old patient. The left ovary is prolapsed in the inguinal canal. The lower ultrasonography image shows the reduction of the left ovary into abdomen in the same patient at the age of 6 months. The left ovary is located near the internal inguinal ring above the pelvic brim.



**Fig. 3** The incidence of inguinal ovarian hernia was significantly higher in the group of patients who were under 12 months old at the time of the onset of symptoms, compared with the other groups ( $P < 0.05$ ,  $\chi^2$  test). Within the group of patients who were under 12 months old, the incidence was higher in the group of patients under 3 months old at the time of the onset of symptoms than in the other groups ( $P < 0.05$ ,  $\chi^2$  test).

## PATIENTS AND METHODS

We diagnosed inguinal hernia with prolapsed ovary, and the torsion of ovary in the inguinal canal by examination by hand and ultrasonography. Usually, we treat inguinal hernia patients who are over 6 months old using a traditional cut-down herniorrhaphy under general anesthesia in the ambulatory surgery, with excellent cosmetic results. Between 2003 and 2011, a total of 673 girls with inguinal hernias were brought to our outpatient clinic for consultation. We reviewed their age at the time of onset of hernia symptom and their age at the time of surgery, their history of surgery, and their history of inguinal ovarian hernia using the information contained in their medical records. This study was approved by the ethics committee of our institution (Approval No. 16R-041).

### Statistical analysis

The mean/median  $\pm$  standard deviation of the age at the time of onset of inguinal hernia symptoms and at the time of surgery was calculated. The percentage of girls with an inguinal ovarian hernia in our outpatient clinic and the percentage of girls with an ovary that was on the inguinal hernia sac wall at the time of surgery were analyzed using a  $\chi^2$  test and the Fisher's exact probability test, with a value of  $P < 0.05$  regarded as significant.

## RESULTS

A total of 673 girls with inguinal hernia (mean/median age at the time of onset of inguinal hernia symptoms: 42.5/39  $\pm$  32.5 months) were brought to

our outpatient clinic for consultation between 2003 and 2011. The inguinal hernia symptoms spontaneously resolved in 20 patients (mean/median age at the time of onset of inguinal hernia symptoms: 2.7/1  $\pm$  7.6 months). Forty-two of the 673 were lost to follow up. Surgery was performed in 611 patients (mean/median age at the time of onset of inguinal hernia symptoms: 44.2/40  $\pm$  32.2 months, and mean/median age at the time of surgery: 54.0/50  $\pm$  32.7 months). A severe complication occurred in only one case, in which a hernia sac containing a fallopian tube and ovary was ligated.

### Inguinal ovarian hernia at outpatient clinic

In total, 71 (mean/median age at the time of onset of inguinal hernia symptoms: 11.2/1.5  $\pm$  28.1 months) of the 673 patients had an inguinal ovarian hernia detected. None of these 71 cases exhibited torsion of the ovary in the inguinal canal. The onset time of the inguinal hernia symptoms was usually under 12 months of age, and most of the cases were under 3 months old (Fig. 3).

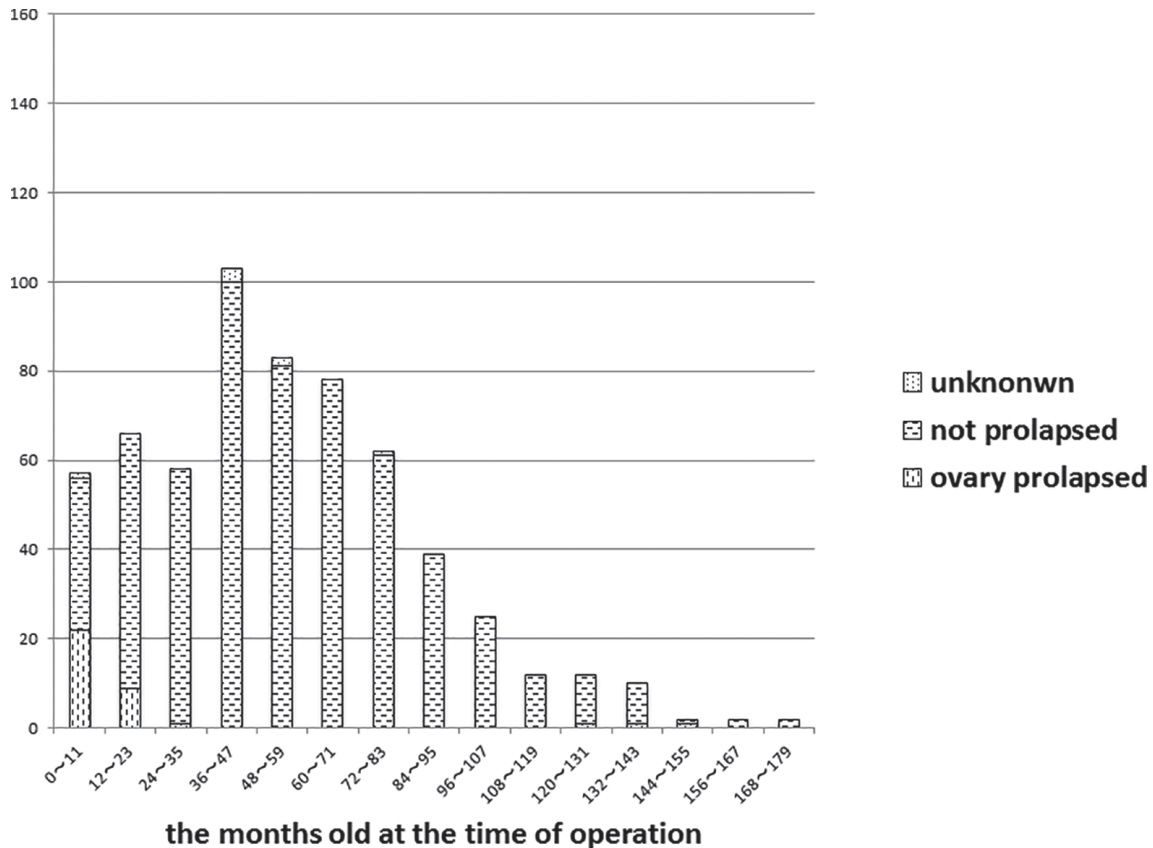
In 10 (mean/median age at the time of onset of inguinal hernia symptoms: 0.9/1.0  $\pm$  0.7 months) of the 71 patients with inguinal ovarian hernias, the symptoms of the inguinal hernias resolved spontaneously. Three of the 71 outpatients were lost to follow-up. Surgery was performed in 58 (mean/median age at the time of surgery: 21.3/11  $\pm$  10.5 months) of the 71 patients with inguinal ovarian hernia.

In 35 (mean/median age at the time of surgery: 24.1/12  $\pm$  31.1 months) of these 58 patients with inguinal ovarian hernias who underwent surgery, the

**Table** Prognosis of inguinal ovarian hernia outpatients who are under 3 months old

Prognosis	Ovary during operation			total
	Months at operation	On the hernia sac	In the abdomen	
Operation	~8months	9	5	14
	9months~	6	34	40
Spontaneous resolve of inguinal hernia				18
Unknown				8

The incidence of a prolapsed ovary on the hernia sac at the time of surgery was significantly higher in the group of patients who were operated on at an age of under 8 months old, compared with the group of patients who were operated on at an age of over 9 months.



**Fig. 4** The incidence of ovary prolapse on the hernia sac during surgery was significantly higher in the group of patients who were under 12 months old at the time of operation ( $P < 0.05$ , by  $\chi^2$  test).

ovary had already spontaneously reduced into the abdomen before surgery, while the ovaries were still on the hernia sac wall at the time of surgery in 22 cases (mean/median age at the time of surgery:  $17.3/10 \pm 29.5$  months). In one case, a testis instead of an ovary was observed at the time of surgery.

In many of patients with the inguinal ovarian hernia under 3 months old, the ovaries had spontaneously reduced into the abdomen before elective surgery at an age of over 9 months old. Furthermore, the inguinal hernia symptoms spontaneously resolved in about a quarter of the patients (Table).

#### Ovary on the wall of the inguinal hernia sac at surgery

Hernia repair was performed in 611 patients. In 35 (mean/median age at the time of onset of inguinal hernia symptoms:  $16.3/6.0 \pm 35.9$  months, and mean/median age at the time of surgery:  $21.6/10 \pm$

$36.4$  months) of the 611 repaired patients, the ovary was still prolapsed within the hernia sac at the time of surgery, but in 13 cases (mean/median age at the time of onset of symptom:  $24.3/6.0 \pm 41.9$  months, and mean/median age at the time of surgery:  $28.8/11.0 \pm 44.9$  months), an inguinal ovarian hernia had not been diagnosed prior to surgery. Almost all of the patients with a prolapsed ovary within the hernia sac at the time of surgery were under 24 months old (Fig. 4).

#### DISCUSSION

Since 176 A.D., indirect inguinal hernia has been considered to arise from the failed closure of the processus vaginalis [9, 10]. The canal of Nuck, or the processus vaginalis in females, was first described in 1691 [11]. The first mention of an inguinal ovarian hernia was made by Soraus of Ephesus early in the second century [12].

The traditional open herniorrhaphy in girls is



minimally invasive when performed by expert pediatric surgeons, and the cosmetic results are excellent. Inguinal hernia in girls has not attracted much interest until now; surgical textbooks contain little information on the traditional herniorrhaphy in girls, and few reports have commented on inguinal ovarian hernias [2].

Recently, some reports have pointed out the risk of torsion of the ovaries prolapsing into the inguinal canal [7, 8]. However, in a 10-year period at our institute, the torsion of an ovary in an inguinal canal has never been experienced, whereas many irreducible herniated ovaries in newborn infants and during early infancy have been observed to reduce spontaneously by late infancy.

In this study, we reviewed the medical records of 673 girls with inguinal hernias between 2003 and 2011, paying particular attention to the records of 71 girls with inguinal ovarian hernias. We then retrospectively assessed the indications for surgery for inguinal ovarian hernias in newborn infants and during early infancy.

The herniation of the ovary into the ipsilateral patent processus vaginalis is thought to be closely correlated with ovarian descent and the formation of the processus vaginalis in the inguinal canal. Before the gonadogenesis stage during the fifth week of fetal development, the gubernaculum attaches to the caudal portion of the gonadal complex from the lateral peritoneal floor, and the cranial suspensory ligament anchors the gonads to the posterior abdominal wall in both sexes. By the thirty-second week of fetal development, the inguinal canal is generated by the caudal migration of the gubernaculum from the lateral peritoneal floor to the future internal inguinal ring, the internal surface of the labioscrotal swellings, and the future labia majora. The canal of Nuck, or the processus vaginalis in females, develops ventral to the gubernaculum, followed by the migration of the gubernaculum; [13, 14] in females, it closes around the seventh month of gestation, which is earlier than in males [15]. Simultaneously, the ovarian descent down to the pelvic cavity and the formation of the uterus are processing in the abdomen (Fig. 5). Finally the ovary and the fallopian tube become located beneath the pelvic brim and in the pelvic cavity. In the pelvis, the broad ligament neighbors the round ligament anteriorly, the ovary posteriorly, and the fallopian tube superiorly [16, 17]. Ando demonstrated that when the round ligament, which runs along the hernia sac, was pulled upward, the mid-portion of the fallopian tube near the ovary is dragged out [18].

The mechanism responsible for inguinal ovarian hernias is still being debated. The mechanism is also regarded as being homologous to the normal descent of the testes [19]. A mouse experiment in which exogenous androgens induced the regression of the suspensory ligament of the ovary in mouse fetuses, making the ovaries and fallopian tubes mobile, supported this hypothesis [21, 22]. Meanwhile, the ovaries in neonates are known to be larger than those in toddlers and preschoolers [22], so the volume of the ovaries and the volume of the pelvic cavity are unbalanced. Recently, laparoscopic observation showed that the attachment of the ovarian suspensory ligament to the abdominal

wall is dislocated ventrally in many cases of inguinal hernia in girls under 2 years old with and without a history of ovarian hernia [23]. For these reasons, the ovary may remain near the pelvic rim and the deep inguinal ring in newborns. Then, the ovary may be easily pushed out of the patent processus vaginalis by the intra-abdominal pressure (Fig. 6).

A prolapsed ovary within an inguinal hernia can only be fixed with the ovarian ligament and fallopian tube cranially, and not with the round ligament and hernia sac (Fig. 6). However, an ovary located in an inguinal hernia is thought to be less mobile than in the pelvic cavity, because the inguinal canal is much smaller. Some reports have pointed out the risk of the torsion of ovaries that have prolapsed into the inguinal canal [7, 8]. In the present study, however, no case of ovary torsion in the inguinal canal was observed. Furthermore, several newborns and young infants with an ovary that had prolapsed into the inguinal hernia exhibited spontaneous reduction into the abdomen during late infancy. The mechanism responsible for the reduction of the prolapsed ovary is attributed to reduction of the ovarian volume and the enlargement of the pelvic volume during growth. However, the exact mechanism remains unclear and continues to be debated.

## CONCLUSION

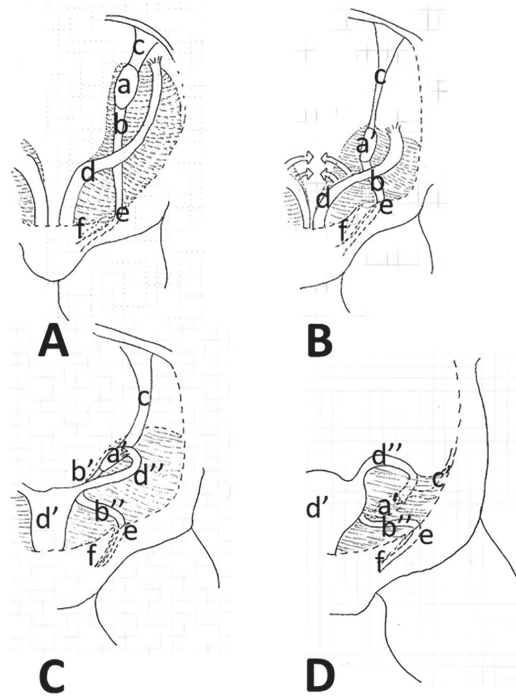
Many cases of ovary prolapse into inguinal hernias in newborns and young infants can be expected to undergo spontaneous reduction into the abdomen spontaneously during late infancy. The risk of the torsion of a prolapsed ovary in an inguinal hernia is thought to be lower than previously described, but could not be ignored. General anesthesia in newborn infants and during early infancy is thought to increase the risk for both minor and major morbidity [24]. Consequently, we recommend that inguinal ovarian hernias in newborns and young infants should be strictly and carefully observed and that elective surgery should only be performed in infants after 9 months of age (Fig. 7).

## CONFLICT OF INTEREST STATEMENT

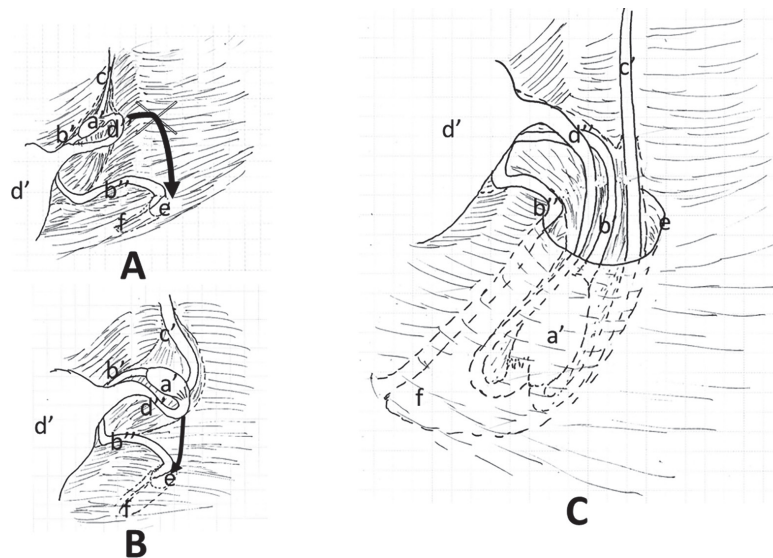
T.Hirabayashi and other co-authors have no conflicts of interest.

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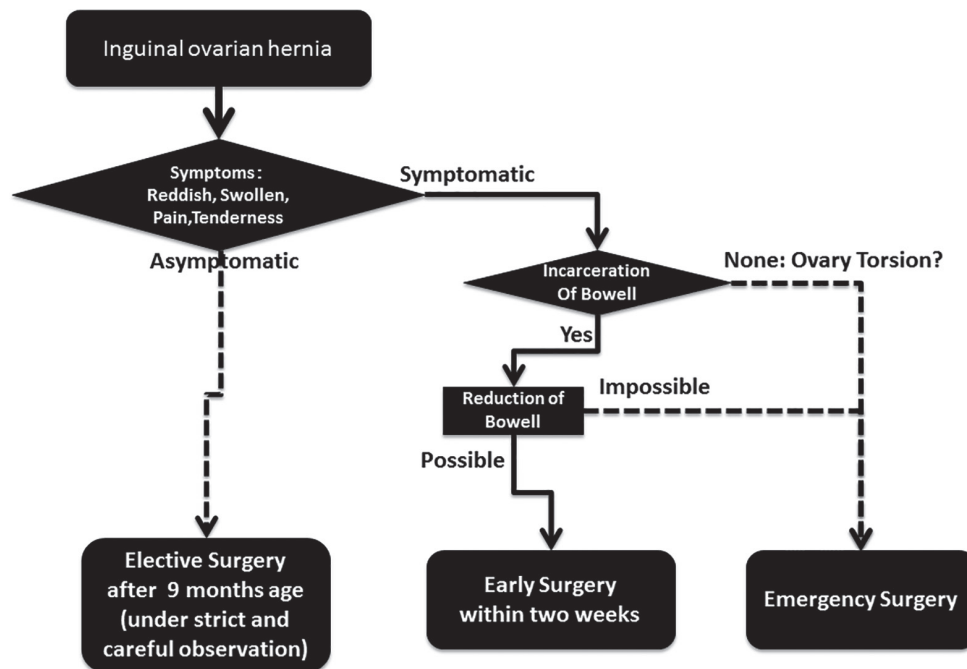
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**Fig. 5** A) Before the gonadogenesis stage, the gubernaculum attaches to the caudal portion of the gonadal complex from the lateral peritoneal floor, and the cranial suspensory ligament anchors the gonads to the posterior abdominal wall in both sexes. In females, the cranial gubernaculum does not swell or shorten and the cranial suspensory ligament persists, allowing the ovary to remain high within the abdomen. During the 7<sup>th</sup> week, the gubernaculum becomes attached to the developing müllerian ducts [13, 14]. B) During the 3<sup>rd</sup> month, the müllerian ducts zip together to the uterus from their caudal ends and pull the attached gubernaculum medially. The ovary simultaneously drops into the pelvic cavity [13, 14]. C) During the 7<sup>th</sup> month, the superior cranial gubernaculum becomes the ovarian ligament, and the inferior caudal gubernaculum forms the round ligament of the uterus. The cranial end of the Müllerian duct becomes the fallopian tube [13, 14]. D) Finally, the ovaries lie on the posterior aspect of the broad ligament. The fallopian tubes extend laterally from the superolateral angles of the uterus and run along the superior free border of the broad ligament. The round ligament of the uterus attaches to the uterus anteroinferiorly to the uterotubal junction, runs to the pelvic side-walls on the anterior surface the broad ligament, and enters the deep inguinal ring [16, 17]. The small letters a, a', b, b', b'', c, c', d, d', d'', e, and f indicate the position of the gonadal complex, ovary, gubernaculum, ovarian ligament, round ligament of uterus, cranial suspensory ligament, ovarian suspensory ligament, müllerian duct, uterus, fallopian tube, deep inguinal ring, and processus vaginalis respectively.



**Fig. 6** A) Usually, the ovary is located in the pelvic cavity beneath the pelvic brim, while the deep inguinal ring is located above the pelvic brim. Thus, the ovary cannot herniate into the processus vaginalis easily. B) In some newborns and young infants, the ovary is located near or above the pelvic brim, allowing it to herniate into the processus vaginalis easily. C) An ovary that has prolapsed into the processus vaginalis should be fixed with the ovarian ligaments, the ovarian suspensory ligament, and the fallopian tube cranially, and not with the round ligament and processus vaginalis. The small letters a', b', b'', c', d', d'', e, and f indicate the position of the ovary, ovarian ligament, round ligament of uterus, ovarian suspensory ligament, uterus, fallopian tube, deep inguinal ring, and processus vaginalis respectively.



**Fig. 7** Schema showing the therapeutic algorithm for inguinal ovarian hernia in young girls.

We recommend that asymptomatic inguinal ovarian hernias in newborns and young infants should be strictly and carefully observed and that elective surgery should only be performed in infants after 9 months of age.

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