*Title Page

Surgical Exploration for Impalpable Testis: Which should be first, inguinal exploration or laparoscopic abdominal exploration?

Akihiro Igarashi, Kenta Kikuchi, Kenjiro Ogushi, Mariko Hasegawa,

Masahiro Hatanaka, Junko Fujino, Yoko Kishi, and Hitoshi Ikeda

Department of Pediatric Surgery, Dokkyo Medical University Koshigaya Hospital, 2-1-50 Minami-Koshigaya, Koshigaya, Saitama, 343-8555 JAPAN

Corresponding author: Hitoshi Ikeda, MD., Department of Pediatric Surgery, Dokkyo Medical University Koshigaya Hospital, 2-1-50, Minami-Koshigaya, Koshigaya, Saitama 343-8555, Japan. Tel.: +81-48-965-1111; fax: +81-48-965-8927.

E-mail address: hike@dokkyomed.ac.jp (H. Ikeda).

Conflict of interest: The authors have no conflicts of interest relevant to this article to disclose.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

This work was presented in part at the 49th Annual Meeting of the Pacific Association of Pediatric Surgeons, Koloa, Hawaii, USA, April, 24-28, 2016.

*Abstract

ABSTRACT

Purpose: To discuss an optimal surgical approach for impalpable testis in children, our own treatment results and those reported in the literature were reviewed.

Materials and Methods: Seventy-two impalpable testes were diagnosed in 68 patients: unilateral in 64 patients and bilateral in 4 patients. All patients underwent surgical exploration at the ages of 6 to 140 months (median, 15 months). The inguinal canal was initially explored, and abdominal exploration was performed with laparoscopy when an extra-abdominal testis was not identified. In addition, articles regarding surgical exploration for impalpable testis, published over the last 20 years, were retrieved and the results were examined.

Results: Testes were detected by inguinal exploration in 28 of 72 (39%) impalpable testes: intracanalicular in 22 testes and at the internal inguinal ring (peeping or low abdominal testis) in 6 testes. All these testes were treated by conventional inguinal orchidopexy. Laparoscopic exploration was performed in 44 (61%) impalpable testes, and 4 (5.6%) high abdominal testes were detected and treated by two-stage Fowler-Stephens orchidopexy. Vanishing or absent testis was the final diagnosis in the remaining 40 testes (55.6%). The literature review showed that the ratios of intra- and extra-abdominal testes were lower in the articles that reported the results of inguinal or scrotal exploration than in those of laparoscopic exploration, although the difference was not significant.

Conclusions: Considering the relatively low incidence of high abdominal testis, we recommend to start with inguinal exploration for impalpable testis. When an extra-abdominal testis is not detected, transinguinal laparoscopic exploration should be indicated.

Key words: Impalpable testis, surgical exploration, laparoscopy

Level of evidence: Treatment study, Level IV

Undescended testis, cryptorchidism, is the most common urologic disorder of male infants, affecting 3 to 4% of full-term new born babies [1]. The incidence decreases to approximately 1% because postnatal spontaneous descent can be anticipated until 3 months of age. Generally, undescended testes are classified into intra-abdominal testis, canalicular testis, testis at the external inguinal ring, suprascrotal testis, and ectopic testis according to the location of the testis. Impalpable or non-palpable testis is another category of undescended testis, and it means that the testis is not detectable in the inguinal-scrotal region by palpation. The testis is non-palpable due to intrauterine loss caused by prenatal circulatory events, agenesis, an intra-abdominal location, or inguinal location but with dysplasia or atrophy [2]. The incidence of impalpable testis has been reported as 12-24% of all undescended testes [3-6].

In patients with impalpable testis, it is necessary to know whether it really is absent or not because orchidopexy is finally required when a testis is present [7]. Ultrasonography has been used to evaluate impalpable testis, but ultrasound has a limited diagnostic performance [8]. Laparoscopy is utilized in various urologic surgeries, and not only evaluation, but also treatment of impalpable testis can be performed without laparotomy [9]. Although laparoscopy is useful, there is still controversy regarding the initial surgical approach for the condition. While some advocate inguinal or scrotal exploration as the initial procedure, others insist that exploration should be started by laparoscopy [4-6]. Since we believe that the incidence of intra-abdominal testis is low compared with that of extra-abdominal testis based on our early experience [10], we use laparoscopy when an extra-abdominal testis is not detected. In this study, we discuss an optimal surgical approach to impalpable testis in children, based on our own treatment results and those reported in the literature.

1. MATERIALS AND METHODS

1.1. Diagnosis of impalpable testis

Between June 2000 and June 2016, 1,395 boys with undescended testis underwent an operation at the Department of Pediatric Surgery, Dokkyo Medical University Koshigaya Hospital. Impalpable testis was diagnosed in 68 patients (4.9%). Sixty-four patients had unilateral impalpable testis: right in 15 patients (22%) and left in 49 patients (72%), and 4 patients (6%) had bilateral impalpable testis. The diagnosis of impalpable testis was made by attending surgeons in outpatient clinics. Namely, impalpable testis was defined as a testis that was not palpable and could not be detected by ultrasonography in the inguinal-scrotal region. When a testis was found on the abdominal side of the internal inguinal ring by ultrasonography, the patient was also diagnosed with impalpable testis and included in those requiring surgery for impalpable testis. Patients were re-examined by palpation under general anesthesia just before surgical exploration was started. Such re-examination might reveal the presence of a palpable testis in some patients. However, they were also included in this study, because the purpose of the study was to summarize the results of surgery for patients who were diagnosed with impalpable testis in an outpatient clinic setting. Actually, the operative procedure was the same irrespective of the findings of re-examination.

1.2. Operative procedure

All patients with impalpable testis underwent exploration, and their age at the time of the operation ranged from 6 to 140 months (median, 15 months). Briefly, the inguinal canal was opened by incising the skin just above the internal inguinal ring. When the testis was found in the inguinal canal or just beneath the internal inguinal ring (peeping or low abdominal testis), the operation proceeded to conventional inguinal orchidopexy. So the patent processus vaginalis was highly ligated, and then the testis was pulled down into the scrotum and fixed in a pouch

under the scrotal skin.

When the testis was not found in the inguinal canal, abdominal exploration with laparoscopy was performed. The laparoscope was introduced into the abdomen through the umbilical port in several patients initially, and laparoscopic exploration thereafter was performed through the ipsilateral processus vaginalis (internal inguinal ring) without making a port incision. The presence or absence of the testis was revealed by identifying the testicular vessels coursing down the retroperitoneum over the psoas muscle. When the abdominal testis was found, two-stage Fowler-Stephens orchidopexy was performed. Termination or blind-ending of the testicular vessels was deemed as a sign of vanishing or absent testis. Even if this finding was observed, laparoscopic examination was performed to ensure that an abdominal testis was not missed. When the vas was identified in the spermatic cord without accompanying vessels, abdominal exploration was indicated, although such complete separation of the vas deferens suggested the absence of the testis. The testicular nubbin was excised for histological examination. The testicular volume was measured with an orchidometer and was recorded along with the presence or absence of abnormal attachment of the epididymis.

1.3. Literature review

Articles regarding surgical exploration for impalpable testis, published over the last 20 years, were retrieved and the percentages of viable testes (intra- and extra-abdominal testes) and vanishing or absent testes among the explored impalpable testes were examined. Extra-abdominal testes include testes at the internal inguinal ring, intracanalicular testes, and testes distal to the external inguinal ring, all of which are able to be approached by inguinal exploration. The ratio of intra- and extra-abdominal testes was compared between the articles that reported the results of inguinal or scrotal exploration and the articles that described laparoscopic

exploration. Statistical analysis was performed using Mann-Whitney's U-test with SPSS 20 (SPSS Japan Inc., Tokyo, Japan) and p-values less than 0.05 were defined as significant.

This study was approved by the institutional review board of Dokkyo Medical University Koshigaya Hospital.

2. RESULTS

2.1. Treatment results involving our own patients

The results of exploration of the 72 impalpable testes in 68 patients are summarized in Table 1. In 64 patients with unilateral impalpable testis, the testis was detected in the inguinal canal or at the internal inguinal ring in 22 patients, while it was undetectable in 42 patients. Laparoscopic exploration of the abdomen was performed in the latter group of patients, and a high abdominal testis was detected in the retroperitoneum in 2 patients. Vanishing or absent testis was diagnosed in the remaining 40 patients. In 4 patients with bilateral impalpable testis, viable testes were bilaterally detected in the inguinal canal or at the internal inguinal ring in 2 patients. In the other 2 patients, one testis was identified in the inguinal canal or at the internal inguinal ring while contralateral testis was detected in the retroperitoneum.

In summary, testes were detected in the extra-abdominal region by inguinal exploration in 28 of 72 (39%) impalpable testes (Figure 1). The location was intracanalicular in 22 testes and at the internal inguinal ring (peeping or low abdominal testis) in 6 testes. Testicular volumes of these 28 testes ranged from 0.2 to 4.5 mL (median, 0.5 mL), and 5 testes were hypoplastic even though they appeared to be viable testes. Abnormal fusion of the epididymis was observed in 6 testes. These 28 testes were treated by inguinal orchidopexy. With a median follow-up time of 24 months (range, 0.3-77 months), there was no atrophy of the testis, but redo-orchidopexy due to re-ascent was necessary in one intracanalicular testis.

Laparoscopic abdominal exploration was performed for 44 (61%) impalpable testes. Four high abdominal testes (5.6%) were detected in the retroperitoneum and two-stage Fowler-Stephens orchidopexy was performed for these testes. One testis with abnormal fusion of the epididymis disappeared after the first stage of the procedure, and another testis atrophied after the second stage of the procedure.

Vanishing or absent testis was the final diagnosis for 40 testes (55.6%).

2.2. Results of the literature review

Results of surgical exploration for impalpable testis reported in the literature are listed in Table 2. The percentage of vanishing or absent testes ranged from 5 to 85%, and the percentage of viable testes detected by exploration ranged from 15 to 95%. The ratio of intra- and extra-abdominal testes ranged from 0.15 to 3.30 (median, 1.19) in the articles that reported the results of inguinal or scrotal exploration, and 0.60 to 5.00 (median, 1.58) in those of laparoscopic exploration. Although the difference was not significant, the ratios in the former group were lower than those in the latter group (Figure 2).

3. DISCUSSION

There is an ongoing discussion regarding the best surgical approach to impalpable testis in children [25]. Since we consider that the incidence of intra-abdominal testis is low compared with those of extra-abdominal testis and vanishing or absent testis, the initial surgical approach to impalpable testis was inguinal exploration for our patients. When a testis was undetectable in the inguinal-scrotal region, then laparoscopic exploration was performed to find an intra-abdominal testis. Laparoscopy was also used when inguinal findings suggested vanishing or absent testis to ensure that an intra-abdominal testis was not missed. On the other hand, in the

case of initial laparoscopy, inguinal exploration is necessary when a testis is not detected in the abdomen. If the vas and vessels are seen exiting the internal ring, either a testis or nubbin may be found distally. In our patients, intra-abdominal testis was seen in only 6% of impalpable testis. Therefore, if exploration had been started with laparoscopy, most patients would have required both umbilical and groin incisions, which may be alternatively performed with umbilical and scrotal incisions [15, 16]. In contrast, if exploration is started by an initial inguinal incision, laparoscopic exploration of the abdomen can be performed through the inguinal incision without making another port incision. This is an advantage of initial inguinal exploration.

Why was the incidence of intra-abdominal testis in our patients lower than the incidences reported in previous papers? One possible reason is the difference in the genetic or environmental background of patients between races. The reported incidences of intra-abdominal testis among impalpable testis in Japanese children are 9 and 15% [14, 23]. The relatively low incidences reported support such a hypothesis. However, more large-scale studies will be indispensable to test the hypothesis. Another possible reason may be explained by the presence of so-called peeping testes. A peeping testis resides at or just proximal to the internal inguinal ring and may appear in the inguinal canal. This may sometimes make classification of the testicular location and the interpretation of the results of surgery difficult. However, movement between the intra- and extra-abdominal locations itself may cause a variable ratio of intra- and extra-abdominal testes. If peeping testes are reached by inguinal exploration, this would result in a lower ratio of intra-abdominal testis among impalpable testis. However, if they are counted as intra-abdominal testes by a laparoscopic approach, this would cause a higher ratio of intra-abdominal testis. Although it was not significant, the ratio of intra- and extra-abdominal testes was actually higher in articles that reported the results of laparoscopic

exploration than articles that described the results of inguinal or scrotal exploration. If such an overestimation is present, it will result in a higher proportion of orchidopexy treated with the Fowler-Stephens procedure that is technically more complicated than conventional inguinal orchidopexy. We think that most peeping testes can be treated by conventional inguinal orchidopexy, and so it may be a disadvantage for patients with such a low abdominal testis.

In our patients, the incidence of vanishing or absent testis was 56%. Belman reported that patients with unilateral impalpable testis should be initially evaluated by scrotal exploration because perinatal testicular torsion, which causes vanishing testis, occurs after testicular descent into the scrotum [26]. The authors recommended that laparoscopy should be reserved for patients in whom a testicular nubbin is not found in the scrotum. As mentioned above, we performed laparoscopy through the patent processus vaginalis even when the findings suggested a vanishing or absent testis. In these instances, exploratory laparoscopy might be omitted. However, it has yet to be concluded whether the extra-abdominal findings precisely predict the presence or absence of intra-abdominal testis. Zaccara suggested the presence of a contradiction between laparoscopic and extra-abdominal findings in a small percentage of patients [27]. We recommend laparoscopy through the processus vaginalis, which is technically easy and non-invasive, when the absence of a viable extra-abdominal testis is revealed by inguinal exploration.

There are some limitations in this study. The number of patients was relatively small, and it might be a specific patient population. However, based on the results of this study, we think that exploration for impalpable testis should be started with inguinal exploration, considering the relatively low incidence of high abdominal testis that requires Fowler-Stephens orchidopexy. When an extra-abdominal testis is not detected, intra-abdominal exploration should be performed with laparoscopy, which can be carried out through the processus vaginalis

without having to make another port incision.

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LEGENDS FOR FIGURES

Fig.1 Results of inguinal exploration for 72 impalpable testes.

Fig.2 Surgical approach to impalpable testis and the ratio of intra- and extra-abdominal testes.

The box and whisker plots indicate the range, first and third quartiles, and median.

Figure 1

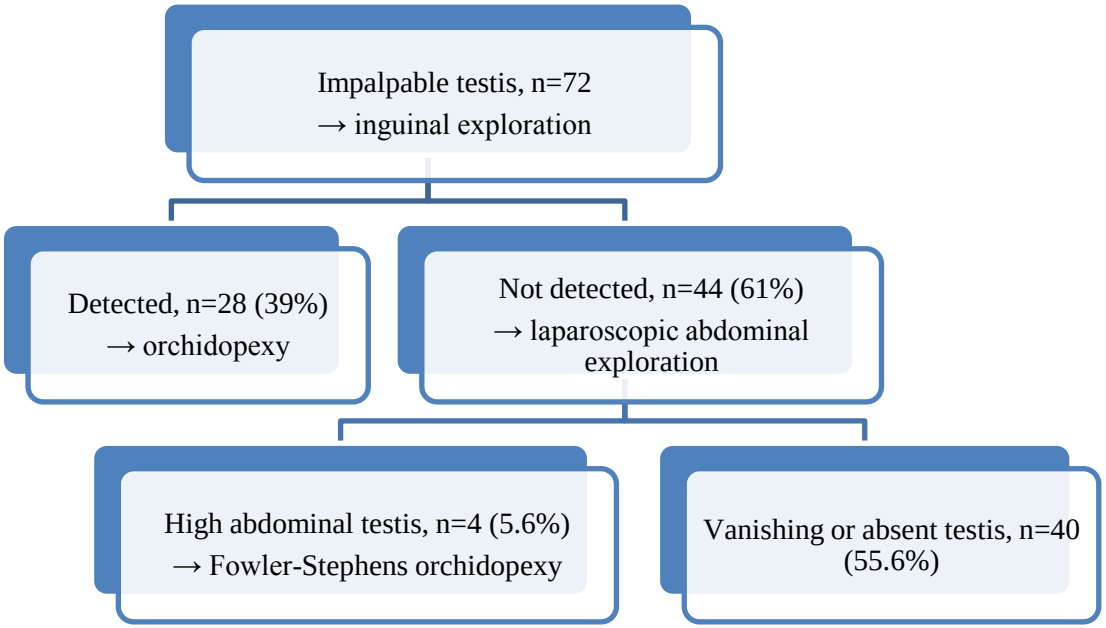
Impalpable testis, n=72
→ inguinal exploration
Detected, n=28 (39%)
→ orchidopexy
Not detected, n=44 (61%)
→ laparoscopic abdominal exploration
High abdominal testis, n=4 (5.6%)
→ Fowler-Stephens orchidopexy
Vanishing or absent testis, n=40 (55.6%)

Figure 2

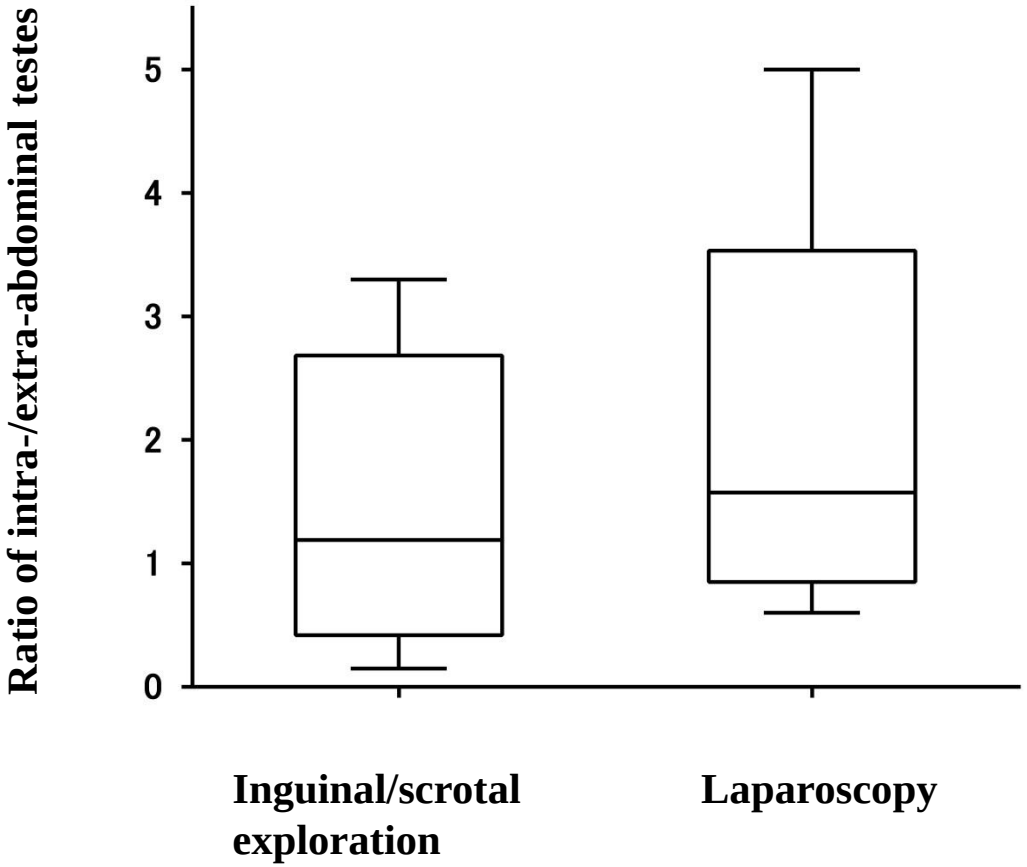
Ratio of intra-/extra-abdominal testes
0
1
2
3
4
5
Inguinal/scrotal exploration
Laparoscopy

Table1

Table 1 Results of exploration for 72 impalpable testes in 68 patients

Impalpable testis	Results of exploration
Unilateral (64 patients)	Viable testis in the inguinal canal or at the internal inguinal ring (IC/IIR) (22 patients)
	High abdominal testis in the retroperitoneum (RP) (2 patients)
	Vanishing or absent testis (40 patients)
Bilateral (4 patients)	Bilaterally viable testis in IC/IIR (2 patients)
	One testis in IC/IIR and contralateral testis in RP (2 patients)

Table2

Table 2 Results of surgical exploration for impalpable testis

Author [reference]	Year	Initial approach (exploration)	Operative findings (%)			
			Vanishing or absent testis	Viable testis		
				Intra-abdominal	Extra-abdominal	I/E ratio*
Kirsch [3]	1998	Inguinal	41	20	39	0.51
Merguerian [11]	1998	Laparoscopy	27	55	18	3.06
Cisek [12]	1998	Laparoscopy	39	37	24	1.54
Ferro [13]	1999	Inguinal	20	57	23	2.48
		Laparoscopy	39	48	13	3.69
Kanemoto [14]	2002	Inguinal	85	9	6	1.50
Snodgrass [15]	2004	Scrotal	58	33	10	3.30
Snodgrass [16]	2007	Scrotal	70	14	16	0.88
Sharifiaghdas [17]	2008	Laparoscopy	20	66	15	4.40
Khairi [18]	2009	Laparoscopy	42	25	33	0.76
Hassan [19]	2010	Laparoscopy	35	34	32	1.06
Singh [20]	2011	Laparoscopy	40	37	23	1.61
Abbas [21]	2012	Laparoscopy	37	18	30	0.60
Alzahem [22]	2013	Laparoscopy	5	55	40	1.38
Ueda [23]	2013	Laparoscopy	81	15	3	5.00
Budianto [24]	2014	Laparoscopy	13	65	22	2.95
Chan [6]	2015	Laparoscopy	43	25	32	0.78
Present study		Inguinal	56	6	39	0.15

* IE ratio: the ratio of intra- and extra-abdominal testes among the explored impalpable testes. Extra-abdominal testes include testes at the internal inguinal ring, intracanalicular testes, and testes distal to the external inguinal ring.