Testicular Ischemia Caused by Incarcerated Inguinal Hernia in Infants: Incidence, Conservative treatment procedure, and Follow-up

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Purpose: Testicular ischemia and necrosis, especially in the infant age, may result from incarcerated inguinal hernia. Duration of ischemia is a significant factor for the affected testicle. We aimed to present a case series on the conservative management in the testicular ischemia caused by incarcerated inguinal hernia.

Materials and Methods: Inguinal hernia repairs performed in between March 2009 and December 2014 were investigated retrospectively. Patients' characteristics, hernia side, incarceration, testicular ischemia and complications were recorded. Color Doppler ultrasonography was performed in the incarcerated inguinal hernia patients preoperatively and was repeated on 3 and 7 days and then at 1, 3 and 6 months postoperatively. The testicle sizes, volumes, and arterial flow patterns of them were recorded at the same time.

Results: Total 785 inguinal hernias were treated in 738 male patients, ranging from 18 days to 16 years. From all male patients, 44 (5.9%) had the IIH. There were 16 (36.3%) irreducible hernias in 44 incarcerated hernia patients. Of these 16, testicular ischemia was determined in 9 (56.2%) infants with the irreducible incarcerated hernia. Orchidopexy procedure was performed in these patients. Testicular atrophy was occurred in two patients (22.2%). In the others, testicular volumes and perfusions were normal during follow-up (mean 8.3 ± 2.2 months).

Conclusion: Testicular ischemia resulting from incarcerated inguinal hernia may be treated conservatively without orchiectomy for the ischemic testicle and testicular ischemia may be followed with color Doppler ultrasound for at least 6 months. The inguinal hernia repair in infants should be subject to urgent surgery rather than elective surgery. So, the testicular ischemia in infants with the inguinal hernia will be an avoidable complication.

Keywords: incarcerated inguinal hernia; testicular ischemia; testicular necrosis; testicular atrophy; infant.

INTRODUCTION

The incidence of incarcerated inguinal hernia (IIH) ranges from 6% to 31% in children[1,2]. IIH may give rise to intestinal obstruction, ovarian or testicular ischemia. Testicular ischemia being encountered intraoperatively intraoperative in the IIH cases may require orchiectomy. While testicular atrophy incidence secondary to the ischemic injury is 0.3% after the non-incarcerated inguinal hernia repairs, it varies from 2.3% to 50% in the IIH[2-5].

An impairment of the testicular blood supply can be investigated by using noninvasive imaging techniques, preoperatively. Gray-scale ultrasonography combined with color Doppler ultrasound (CDU) imaging has been a clearly accepted technique for assessing testicular lesions and testicular blood perfusion. The insufficient testicular blood supply in CDU examination should alert the physician in terms of the testicular ischemia occurring secondary to IIH[6]. Nevertheless, the most important question to be answered is whether orchiectomy procedure for an ischemic testis should be performed or not.

In the current study, we aimed to present a conservative treatment method and follow-up results of the patients who developed testicular ischemia and necrosis due to IIH, and also to discuss whether this condition is avoidable or not.

PATIENTS AND METHODS

Study population and design

This retrospective study was approved by Institutional Ethics Review Board for Clinical Research (2014/158/604-197) and was conducted in two referral hospital of Yozgat and Tokat in Turkey. We reviewed institutional-based data of 738 male patients who underwent inguinal hernia repair between March 2009 and December 2014, retrospectively. Demographic characteristics of the patients, side of hernia, presence of incarceration and testicular ischemia, follow-up time and complications were recorded. The patients who developed testicular ischemia due to IIH were investigated in terms of surgical approach, postoperative follow-up procedures and results. Duration of incarceration was evaluated according to the history of the symptoms obtained from the parents or caregivers of the patients and calculated. IIH patients scheduled for delayed surgery for reasons such as undescended testis, congenital heart disease, and bleeding diathesis were not included in the study.

Surgical technique

Conventional open inguinal hernia repair with high ligation of patent processus vaginalis at the level of the

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Received August 2016 & Accepted May 2017

Table 1. Characteristics of the male patients with incarcerated inguinal hernia at the time of hernia repair.

	Duration of incarceration (hours) (Mean±SD)	Testicular Ischemia (N)
Ages (n)		
0 – 12 months (11)	11.4 ± 2.3	9
1 – 5 years (3)	8.0 ± 1.4	0
6 – 10 years (2)	5.0 ± 1.4	0

internal inguinal ring was performed in all patients under general anesthesia. Preoperative prophylactic cefazolin sodium (50 mg/kg) intravenously as a single dose was used. When an ischemic testis whose hemorrhagic or necrotic looking was determined macroscopically (**Figure 1**), it was covered with warm physiologic saline-soaked gauze for 10 minutes, and then fixed in the scrotal dartos pouch as performed in orchidopexy procedure.

Outcome assessment

Color Doppler ultrasonography (CDU) examination evaluating arterial blood flow of the testes was performed preoperatively in all the patients diagnosed with IIH in the emergency clinic. In the early period, patients with testicular ischemia were followed up by performing CDU postoperatively on 3rd and 7th days in order to evaluate whether there are testicular blood flow and intra-scrotal abscess formation or not. CDU examination was repeated at 1, 3 and 6 months after discharge. Testes sizes of the patients were measured by ultrasonography without the inclusion of the epididymis. Testicular volume was calculated by using the empirical formula of Lambert: volume = length (L) × width (W) × height (H) × 0.71. Although it has the limited efficacy for infants, it was used for at least predicting the testicle volume measurement[6,7]. The interval between the groin swelling (incarceration onset) and the surgical repair time was accepted as the duration of incarceration.

Data analysis was performed using SPSS software (Statistical Package for the Social Sciences, 18.0; SPSS Inc, Chicago, IL, USA). The data were expressed as mean ± 1SD. In statistical analysis, the Wilcoxon signed-rank test was used to evaluate the volume of the affected testes. The Mann-Whitney *U* test was used to compare the volumes between ischemic and contralateral testes in the follow-up. The relationship between the ages of patients with IIH and the duration of incarceration were assessed with the Spearman's rank correlation. The statistical significance was set at $P < .05$.

RESULTS

A total 785 inguinal hernias were treated in 738 male patients whose mean ages were 2.3 ± 2.5 years (range, 18 days to 16 years). Seven IIH patients were excluded from the study because they meet the exclusion criteria. From all male patients, 44 (5.9%) had IIH.

Out of 44 IIH patients, the study group, manual hernia reduction was successfully performed in 28 (63.6%) patients in the pediatric emergency service. Sixteen (36.6%) patients underwent emergency surgery due to

Table 2. Testicle volumes of the patients with testicular ischemia at the time of the preoperative evaluation and during 6-month follow-up

Patients no	Age (months)	Pre-op ATV	Post-op ATV (3th month)	Post-op ATV (6th month)	CTV
1	4	0.93	0.56	0.58	0.52
2	4	1.14	0.48	0.48	0.54
3	6	1.23	0.64	0.61	0.57
4	3	0.89	0.45	0.42	0.39
5	2	1.48	0.38 †	0.12 *	0.63
6	4	1,27	0.68	0.72	0.63
7	3	0.96	0.49	0.45	0.47
8	4	1.19	0.53	0.54	0.56
9	4	1.62	0.41 †	0.13 *	0.69

Pre-op ATV: Affected testis volume preoperatively (milliliter)
Post-op ATV: Affected testis volume postoperatively (milliliter)
CTV: Postoperative contalateral testis volume(mililitter)
When the affected testis volume compared with the contralateral testis volume;
*: $p < 0.001$, at the end of 6 months follow-up
†: $p > 0.05$, at the end of 3 months follow-up

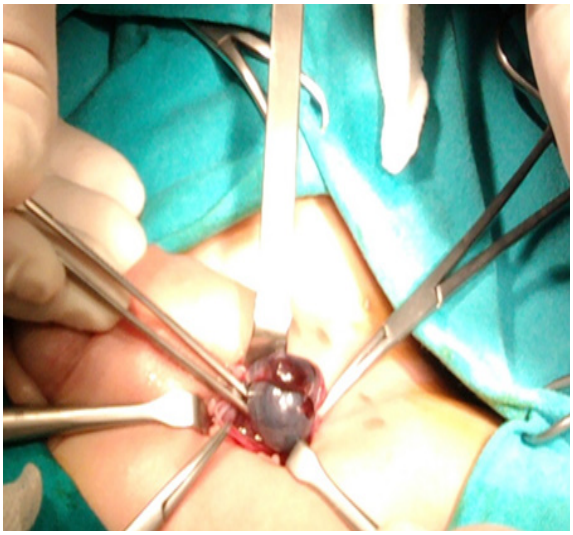

Figure 1. Testicular ischemia caused by the incarcerated inguinal hernia in a 4-month-old infant.

the irreducible IIH. Minimal hydrocele composed of serous and hemorrhagic fluid was observed in all the irreducible IIH, but not in patients with reducible IIH. When the hydrocele sac was opened intraoperatively, there was the purple looking testicle in these patients. Despite application of warm fluid to the testicle, its ischemic-purple appearance did not change (**Figure 1**). There were testicular ischemia and hemorrhagic necrosis in 9 (56.2%) of the irreducible IIH patients whose mean ages were 3.7 ± 1.3 months (range, 2 to 6 months). Additionally, the testicular ischemia rate was 20.4% for all 44 IHH patients. Hernia site of these 9 patients were right in 7 and left in 2. The mean duration of incarceration was 11.4 ± 2.3 hours in the symptomatic interval. Incarceration time was found less in older children (**Table 1**). There was a significant negative correlation between the mean ages of the IIH patients and mean duration of the incarceration (r = -0.90, *P* = .03).

No patient underwent orchiectomy during hernia repair. Ibuprofen (10 mg/kg/day) was used as an analgesic and anti-inflammatory drug in all IIH patients for one week postoperatively.

While the testicular arterial blood flow (TABF) of the nine irreducible IIH patients in the CDU examination revealed decreasing pattern preoperatively compared to the contralateral testis, TABF of these affected testicles was normal on 3rd and 7th postoperative days. There was no abscess formation in these testicles in the early postoperative period. Testicular atrophy took place only in two (22.2%) patients with the irreducible IIH during the 6-month follow-up. On the other hand, the testicular atrophy incidence was 4.5% in all patients with IIH. The testicular size of two patients with the irreducible IIH approximately decreased up to 10% of their volumes within 6-months, postoperatively (**Table 2**). On the other hand, the testicular atrophy incidence was 4.5% in all patients with IIH. In the irreducible IIH patients without atrophy, the postoperative testicle volumes were not decreased when compared with the preoperative volumes in the 6-month follow-up (*P* = .10) (**Table 2**).

In the hernia sac of the patients with irreducible IIH, small bowel segments was observed in 7 cases, and small bowel together with omentum in 9 cases. No need for intestinal resection occurred. In the current series, we did not encounter any complications except two patients with the testicular atrophy during follow-up. The mean follow-up period of the patients with IIH were 8.3 ± 2.2 months (range, 6 to 12 months).

DISCUSSION

Incidence of inguinal hernia in children is between 0.8 - 4.4% in term and 30% in premature babies[3]. The incarceration risk of an inguinal hernia varies between 6% and 31% [2,3,8]. Intestinal necrosis or testicular ischemia secondary to compression of vascular structures in the inguinal canal is an undesirable consequence of the IIH[3,7]. Although intestinal damage resulted from IIH may be seen as low as 0.1%, testicular ischemia may occur at higher rates ranging from 0.3% to 15% [2-4,8]. The infants aged under 6-month are more vulnerable to testicular ischemia resulting from incarceration than older children[5,8]. Moreover, it has been reported that the tendency for testicular ischemia in the infants is mostly due to vascular structures where there is no rich collateral vessel network of the testicle [2,4,8,9]. In contrast to the infants, adults have several collateral blood flows in both arterial supply and venous drainage protecting the testes from ischemic damages following impairment of blood flow through inguinal canal [10-12]. In children with the IIH, however, an increased pressure result from the hernia contents in relatively narrow and inflexible superficial inguinal ring may lead to congestive testicular infarction with venous obstruction, especially in infants. As the incarceration continues, venous thrombosis, hemorrhage, and arterial insufficiency inevitably result in the infarction[10,13]. In the current study, the rate of testicular ischemia in the IIH patients was 20.4%. This rate seems to be high, but the ischemia rate was 1.2% for all male boys with an inguinal hernia. Diagnosis of the testicular ischemia in the patients with IIH may be confirmed on the CDU examination, preoperatively[8]. However, there is no data on the reversible time interval of the ischemia of the compressed testicle and the vasculature in the IIH. Complexities in the evaluation of testicular ischemia secondary to IIH derive from a paucity of long-term follow-up. It has also been reported that lack of long-term imaging follow-up makes it impossible to know whether there is a long-term effect of an inguinal hernia on testicular volume [8]. We have observed that the duration of incarceration was 2.3 times longer in infants compared with older children. We have also determined a significant negative correlation between the patients' ages and the average duration of incarceration (r = -0.90, *P* = .03). The impact of late diagnosis on the treatment in infants is a handicapping factor in addition to challenges related to anatomical variations and restrictions. If a practitioner detects an ischemic and necrotic testicle at surgery in IIH, he or she must sensibly decide to what surgical procedure (orchiectomy or orchidopexy) is required. Some authors have supported that visualization of the testicle is not routine during hernia repair[8,14,15]. As defined in our study, however, the testicle can be evaluated by opening its tunica vaginalis during surgery, especially in the IHH cases. It has been reported that orchiectomy can be performed in the infants after a certain waiting period if the testicular bleeding via the incision of the tunica albuginea does not occur[16,17]. In the current study, we preferred orchidopexy procedure

in these IIH patients. We have thought that the incision of the tunica albuginea in the ischemic testicles may not contribute to the follow-up results. It is impossible to know macroscopically whether the degree of testicular ischemia is low or high or is there a segmental infarction or not. TABF may be followed with CDU in the early postoperative period in terms of flow pattern and abscess formation. Testicular abscess did not occur in any cases in the postoperative period of the current study. The incidence of testicular atrophy after inguinal hernia repair varies from 0.3% to 50% in the several series[2-5]. Although the testicular size may be of normal volume up to 6 weeks in the postoperative period, the ischemic orchitis leading to the testicular atrophy might occur up to 12 months[5]. In our study, testicular atrophy occurred in two patients (56.2%) with irreducible IIH at the end of the postoperative period of 6 months. We determined that the testicular size of two patients with the irreducible IIH began to decrease in the postoperative on month 3 and approximately decreased up to 10% of their volumes within 6 months after operation. This decrease in the volume was statistically significant ($P < .001$).

An increased pressure originated from hernia content in the IIH, especially in infants, results in gradual vascular failure leading to congestive testicular infarction. Incision of the tunica albuginea to figure out the testicular vitality may not be necessary. However, a standard orchidopexy procedure should be performed in the male infants with the IIH with testicular ischemia. The patients should be closely followed up by CDU examination at least 6 months. The most common elective surgical procedure in children is inguinal hernia repair [18]. Because of risk described above, we cannot ignore the necessity that the inguinal hernia repair in infants especially under six months should be urgent surgery rather than semi-urgent or elective, thus probably preventing testicular ischemia occurred secondary to IIH.

CONFLICT OF INTEREST

Authors declared that they have no conflict of interest.

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