Surgical anatomy of the inguinal canal in children

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The surgical anatomy of the inguinal canal, including the measurement of the length of the inguinal ligament and canal in children at different stages of their development has not been thoroughly studied, though the inguinal area is one of the most common sites of surgical procedures in children; therefore this clinical study was conducted to determine the length of the inguinal canal and ligament and to determine whether there is any relationship between the length of the canal and ligament with the child's age, weight or height, as well as to determine if the site of the internal inguinal ring in relation to the inguinal ligament is any different from that described in adults.

Patients and Methods

A total of 113 inguinal ligaments and canals were measured during inguinal operations in 96 children (10 females and 86 males), who ranged in age from 14 days to 12 years (average, 3.01 years). Seventeen patients had bilateral inguinal surgery. Seventy-eight patients had inguinal hernias, 18 patients had undescended testes (UDT) and 17 patients had hydroceles. The patients were arbitrarily divided into five subgroups according to their age: Newborns (up to 2 months), 2.5-12 months, 1-2 years, 2-6 years, and 6-12 years.

Landmarks were taken before the start of the operative procedure by marking both the anterior superior iliac spine (ASIS) and the pubic tubercle and taking the length of the inguinal ligament. The distance between the ASIS and the external ring as well as the distance between the ASIS and the internal ring were taken after exposing the external oblique and opening the inguinal canal respectively; after the incision was made and the external ring was identified, the distance between the ASIS and the lateral edge of the external ring (ER) was taken in centimeters. The distance between the ASIS and the internal ring (IR) was taken after the inguinal canal was opened, the cord dissected and the sac transected and pulled perpendicular to the abdominal wall at the internal ring. This distance (ASIS-IR) subtracted from the previous one (ASIS-ER) represents the length of the inguinal canal. The ratio between the distance (ASIS-IR) and the inguinal ligament was calculated. If it was equal to 0.5, then the deep inguinal ring is at the midinguinal point; if more than 0.5, the IR is medial to the midinguinal point; and if less, the IR is lateral to the midinguinal point.

Results

The length of the inguinal ligament increased steadily from a median of 4.5 cm at less than 2 months of age to 9.3 cm at over 6 years of age with an average of 6.86 cm in the whole study group. The internal ring was situated at or medial to the midpoint of the inguinal ligament throughout childhood. The ratio of the internal ring to the anterior superior iliac spine (ASIS) over the inguinal ligament length was 50% (range, 30-80%) in the whole study group. The length of the inguinal canal increased steadily from a median of 0.7 cm at less than 2 months

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Accepted for publication
June 2006

Ann Saudi Med 2006;26(4):300-302

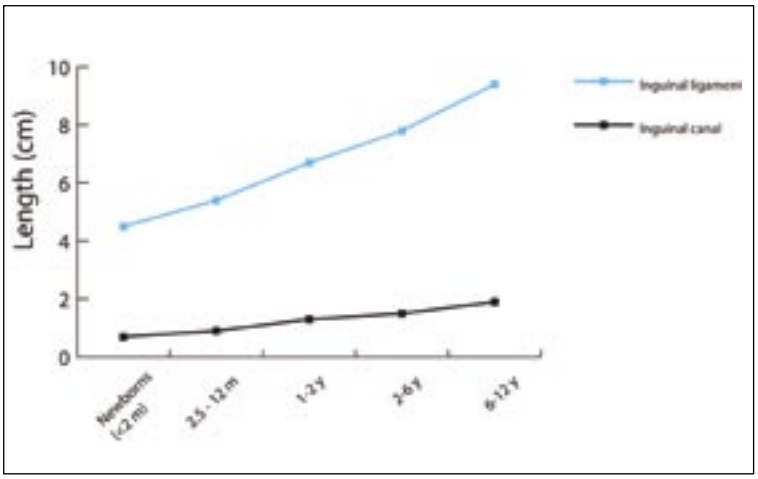
of age to 1.9 cm at over 6 years of age, though the length of the canal remained relatively short, 1.29 cm (range, 0-3.1 cm), in the whole group. Figure 1 shows the relationship between the average growth of the inguinal ligament and the inguinal canal by age group. The average age, height and weight for each age group are shown in Table 1.

In a Pearson's correlation analysis of the 113 inguinal canals (Table 2), a significant correlation was found between age and the length of the inguinal canal (correlation, r=0.599, P<0.01). The correlation between the child's weight or height and canal length was also significant (r= 0.58 and 0.61 respectively). A stronger correlation was found between the length of the inguinal ligament and the patient's age, weight or height (r=0.900, 0.936 and 0.952, respectively). The correlation was stronger if the measurements of both the inguinal canal and ligament were taken against the child's height rather than the age or weight. The length of each can be given by the following formulas:

Inguinal ligament length = 1.577 + 0.06032 _ HT (child's height)

Inguinal canal length = -0.02714+ 0.01501 _ HT (child's height)

Figure 1. The relationship between age group and the average length of the inguinal ligament and canal.



Discussion

Reports on the anatomy of the inguinal region in pediatric patients are scarce in the medical literature [3, 4] even though this region is one of the most common areas targeted by pediatric surgeons. In the adult population, the anatomy of the inguinal area, including measurements of the inguinal ligament and canal and the relationship of the deep inguinal ring to the inguinal ligament are well described in the literature. The length of inguinal canal has been reported to be 4.7 cm to 6 cm and the deep inguinal ring is situated half an inch above the midpoint of inguinal ligament in adults.[1,2]

In a previous report, the length of inguinal canal was a mean of 1.0 cm (range, 0.7-1.1) at less than 2 years of age and an average of 1.1 cm (range, 0.7-2.3) over 4 years of age.[3] Our results show that the length of the inguinal canal increases steadily from a mean of 0.7 cm at less than 2 months of age to 1.9 cm at over 6 years of age, though it remained relatively short at a mean of 1.29 cm (range, 0-3.1 cm) in the whole group, which is comparable with results reported in other studies,[3] suggesting that the growth of the inguinal region in this age group occurs mainly outside the canal. The length of inguinal canal does not increase linearly during the first 12 months of life (Pearson's correlation coefficient of 0.301 as compared to 0.599 for the whole age group), which is in agreement with other results in the literature.[4] This finding suggests that the length

Table 1. Measurements of the inguinal canal and ligament by age group.

Age Group	Number of patients	Average age	Average patients weight (kg)	Average patients height (cm)	Inguinal canal average length (cm)	Inguinal ligament average length (cm)	ASIS-IR/ inguinal canal ratio
Newborns (up to 2 months)	14	7 w	4	52	0.7	4.5	0.5
2.5-12 months	27	7 m	6.5	64	0.9	5.4	0.5
1-2 years	20	21 m	11.7	84	1.3	6.7	0.6
2-6 years	30	4 y	16	103	1.5	7.8	0.5
6-12 years	20	8.6 y	27.6	129.2	1.9	9.4	0.6

Table 2. Pearson correlation analysis of age, weight, height and inguinal ligament and canal length.

		Age	Weight	Height	Canal Length	Ligament Length
Age	Pearson's r	1.000	.936*	.931*	.599*	.900*
	P value (2-tailed)	.	.000	.000	.000	.000
	n	113	113	113	113	113
Weight	Pearson's r	.936*	1.000	.943*	.582*	.936*
	P value (2-tailed)	.000	.	.000	.000	.000
	n	113	113	113	113	113
Height	Pearson's r	.931*	.943*	1.000	.614*	.952
	P value (2-tailed)	.000	.000	.	.000	.000
	n	113	113	113	113	113
Canal Length	Pearson's r	.599*	.582*	.614*	1.000	.639*
	P value (2-tailed)	.000	.000	.000	.	.000
	n	113	113	113	113	113
Ligament Length	Pearson's r	.900*	.936*	.952*	.639*	1.000
	P value (2-tailed)	.000	.000	.000	.000	.
	n	113	113	113	113	113

* Correlation is significant at the 0.01 level (2-tailed)

of the canal is proportionally larger versus age and height and weight measurements in infancy compared with older children. Therefore, its growth is relatively retarded.

The steady increase in the length of the inguinal ligament is in agreement with other reported results.[3] Compared with the inguinal canal, a more linear correlation (r= 0.900) was found when the inguinal ligament length was correlated with the patient's height or weight rather than age (r= 0.952 and 0.936, respectively). As seen in Table 2, the correlation was stronger if the measurements of both the inguinal canal and ligament were taken against the child's height rather than the child's age or weight.

The internal ring was situated at the mid point of the inguinal ligament in most age groups, as described by the ratio of the distance from the internal ring (IR) to the anterior superior iliac spine (ASIS) over the inguinal ligament length, which was 50% (range 30-80%) which means that the deep inguinal ring is situated at the mid point of inguinal ligament like in adults, in contrast to what was reported by Parnis et al [3] that the ring was situated medial to the midpoint of inguinal ligament all through childhood. This has a clinical implication in inguinal surgeries for hernia, hydroceles and undescended testicles; proper siting of the inicision is necessary to minimize tissue trauma from undue tension on tissues because of a badly sited incision. Therefore, the knowledge of the detailed anatomy of this region provided in this study is of paramount importance to the pediatric surgeon.

The author would like to thank Prof. Mujalli Mhailan for the great help in preparing the manuscript.

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