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Testicular migration chronology: do the right and the left testes migrate at the same time? Analysis of 164 human fetuses

Luciano A. Favorito and Francisco J.B. Sampaio

Urogenital Research Unit, State University of Rio de Janeiro, Rio de Janeiro, Brazil

Objective

To determine if the right and the left testes migrate at the same time during the human fetal period.

Subjects and Methods

We studied 164 human fetuses (328 testes) ranging in age from 12 to 35 weeks post-conception. The fetuses were carefully dissected with the aid of a stereoscopic lens at ×16/25. The abdomen and pelvis were opened to identify and expose the urogenital organs. Testicular position was classified as: (a) Abdominal, when the testis was proximal to the internal ring; (b) Inguinal, when it was found between the internal and external inguinal rings); and (c) Scrotal, when it was inside the scrotum.

Results

The testes were abdominal in 71% of the cases, inguinal in 9.41%, and scrotal in 19.81%. There was asymmetry in testicular migration in nine cases (5.5%). In three of these nine cases, one testis was situated in the abdomen and the other in the inguinal canal; in another three one testis was situated in the abdomen and the other in the scrotum, and in the remaining three, one testis was in the inguinal canal and the other in the scrotum. In five of the nine cases of asymmetry, the right testis completed the migration first, but this was not statistically significant.

Conclusion

Asymmetry in testicular migration is a rare event, accounting for <6% of the cases. The right testis seems to complete migration first.

Keywords

testes, testicular migration, cryptorchidism, embryology, asymmetry

Introduction

During the human fetal period, the testes migrate from the abdomen to the scrotum, traversing the abdominal wall and the inguinal canal between the 15th and the 28th week post-conception (WPC) [1,2]. Testicular migration happens in two distinct phases: the first phase involves testicular migration from the abdomen to the internal inguinal ring, and the second phase involves the transition of the testes through the inguinal canal until their definitive arrival at the scrotum [1–3].

Several theories have been developed to explain testicular migration. The most accepted ones are: (a) the increase in the intra-abdominal pressure [4,5]; (b) the development of the epididymis, spermatic vases, deferent ducts and inguinal canal [6]; (c) stimulus originating in the genitofemoral nerve [7]; (d) hormonal stimulus by placental gonadotrophin and testosterone produced by the fetal testes [8]; and (e) the gubernaculums development [1,9].

The gubernaculums seems to be the most important anatomical structures in the process of testicular migration and by contraction and shortening impose traction on the testicle [10]. Recent studies have shown that the cremaster muscle plays a role in the descent of the testes [1,11]. Remodelling of the cremasteric muscle is important to enable gubernacular eversion and to allow rhythmic contraction to guide the testes into the scrotum [1,11,12].

There are only a few published reports about the chronology of testicular migration comparing the right and the left testis [13,14]. The objective of the present study was to analyse the testes' positioning during the human fetal period and determine which of the testes migrates first, and elucidate whether there is asymmetry in the process of the testicular migration.

Subjects and Methods

The present work received Institutional Review Committee and parental approval. This study was carried out in accordance with the ethical standards of the hospital's Institutional Committee on Human Experimentation.

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Table 1 Data on the 164 fetuses (328 testes) studied divided by age groups (in WPC). For each group, the number and position of the testes studied and the position of the right testis (RT) and the left testis (LT) by group are shown.

Age, WPC	Number of fetuses (number of testes)	RT position, *n* (%) or *n*/*N*	LT position, *n* (%) or *n*/*N*	RT and LT position, *n* (%) or *n*/*N*
12–15	30 (60)	Abdomen, 30 (100)	Abdomen, 30 (100)	Abdomen, 60 (100)
		Inguinal, 0	Inguinal, 0	Inguinal, 0
		Scrotum, 0	Scrotum, 0	Scrotum, 0
16–20	42 (84)	Abdomen, 41 (97.6)	Abdomen, 42 (100)	Abdomen, 83 (98.8)
		Inguinal, 1 (2.4)	Inguinal, 0	Inguinal, 1 (1.2)
		Scrotum, 0	Scrotum, 0	Scrotum, 0
21–25	55 (110)	Abdomen, 42 (76.4)	Abdomen, 41 (74.5)	Abdomen, 83 (75.5)
		Inguinal, 12 (21.8)	Inguinal, 13 (23.6)	Inguinal, 25 (22.7)
		Scrotum, 1 (1.8)	Scrotum, 1 (1.8)	Scrotum, 2 (1.8)
26–30	25 (50)	Abdomen, 3 (12)	Abdomen, 4 (16)	Abdomen, 7 (14)
		Inguinal, 1 (4)	Inguinal, 2 (8)	Inguinal, 3 (6)
		Scrotum, 21 (84)	Scrotum, 19 (76)	Scrotum, 40 (80)
31–35	12 (24)	Abdomen, 0	Abdomen, 0	Abdomen, 0
		Inguinal, 1/12	Inguinal, 0	Inguinal, 1 (4.2)
		Scrotum, 11/12	Scrotum, 12/12	Scrotum, 23 (95.8)
Total	164 (100)	Abdomen, 116 (70.7)	Abdomen, 117 (71.3)	Abdomen, 233 (71)
		Inguinal, 15 (9.1)	Inguinal, 15 (9.1)	Inguinal, 30 (9.1)
		Scrotum, 33 (20.1)	Scrotum, 32 (19.5)	Scrotum, 65 (19.8)

We studied 164 male human fetuses ranging in age from 12 to 35 WPC, during the period from January 1996 to June 2013. The fetuses were macroscopically well preserved. The gestational age of the fetuses was determined in WPC, according to the foot-length criterion. The foot-length criterion is currently considered the most acceptable parameter to calculate gestational age [15–17]. The fetuses were also evaluated for crown–rump length (CRL) and body weight immediately before dissection. The same observer analysed the measurements.

After the measurements, the fetuses were carefully dissected with the aid of a stereoscopic lens at ×16/25. The abdomen and pelvis were opened to identify and expose the urogenital organs and inguinal canal and to show the testes' positions.

Testicular position was classified after dissection into: (a) Abdominal, when the testis was proximal to the internal ring; (b) Inguinal, when the testis was found between the internal and external inguinal rings; and (c) Scrotal, when the testis had passed beyond the external inguinal ring and was inside the scrotum.

Mean values were statistically compared using the unpaired *t*-test, with a $P < 0.05$ considered to indicate statistical significance.

Results

The gestational ages of the fetuses ranged between 12 and 35 WPC. Of the 328 testes (164 fetuses) studied, 233 (71%) were located in the abdomen, 30 (9.14%) in the inguinal canal and 65 (19.81%) in the scrotum. The vast majority (99.3%) of the fetuses aged 12–20 WPC had the testes situated in the abdomen. We found 28 (93.3%) of the 30 testes located in the inguinal canal in fetuses aged 21–30 WPC. While in fetuses aged >30 WPC, 95.8% of the testes were located in the scrotum. The relationship between the testicular position by side and age is shown in Table 1 and Fig. 1.

In 155 fetuses (94.5%), the right and left testes were found in the same region during the dissection. In nine cases (5.5%), we noticed the presence of asymmetry in testicular position. The fetuses with testicular asymmetry ranged in age from 18 to 31 WPC. The position of the testes, weight and CRL of the fetuses presenting asymmetric testicular position are given in Table 2.

In three of the nine cases of asymmetrical testicular migration, one of the testes was situated in the abdomen and the other in the inguinal canal (Fig. 2). In this group, the right testicle was positioned in the inguinal canal in all cases. In another three of the nine cases, one of the testes was located in the abdomen and the other in the scrotum. In this group, the left testicle was scrotal in two cases and abdominal in the other. In the remaining three of the nine cases, one of the testicles was positioned in the inguinal canal and the other in the scrotum. In this group, the right testicle was situated in the scrotum in one case and in the inguinal canal in two cases. In five of the nine fetuses with asymmetry of testicular migration, the right testis was in a lower position than the left, but this was not statistically significant.

Of the 18 testes with asymmetry, six were located in abdomen, six in the inguinal canal and six in the scrotum (Table 2). The processus vaginalis was patent in the six testes located in the inguinal canal and in the six located in the abdomen. The six testes located in sctrotum had the processus vaginalis closed. We did not observed epididymal anomalies and anatomical

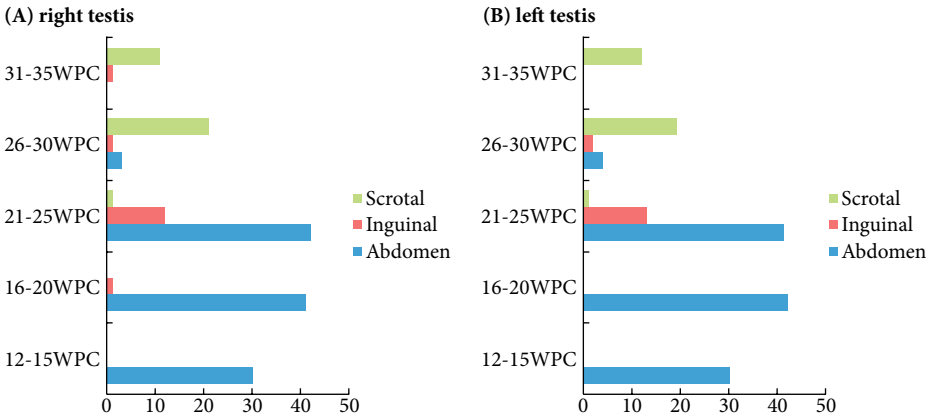


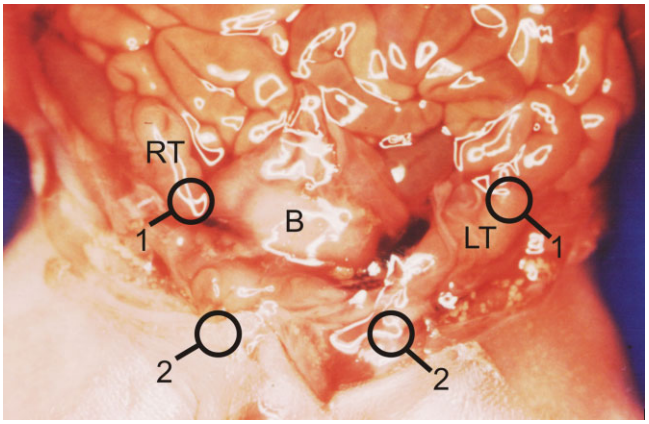
Fig. 1 The relationship between the position of each testes (scrotal in green, inguinal in red and abdomen in blue) with gestational age in WPC of the 164 human fetuses (328 testes) studied. (A) Testicular position X gestational age in right side. (B) Testicular position X gestational age in left side.

Table 2 Position of the testes of the nine fetuses with asymmetric testicular migration. In five of the nine cases, the right testicle is located in a lower position than the left.

Age, WPC	Weight, g	V–C, cm	RT	LT
18	264	16	Inguinal	Abdomen
23	626	22	Scrotum	Abdomen
25	741	23	Abdomen	Scrotum
25	751	24	Inguinal	Scrotum
25	750	25	Scrotum	Inguinal
26	805	24	Inguinal	Abdomen
27	1029	26	Abdomen	Scrotum
28	1220	27	Inguinal	Abdomen
31.4	1420	34	Inguinal	Scrotum

V–C, vertex–coccyx length; RT, right testicle; LT, left testicle.

Fig. 2 Fetus at 23 WPC. The anterior abdominal wall is extirpated. Note that the right testis (RT) is located in the abdomen and the left testis (LT) is located in inguinal canal. B, Bladder; 1, Internal inguinal ring; 2, External inguinal ring.



alterations in proximal insertion of the gubernaculum in any of the nine fetuses with testicular asymmetry, the 18 testes had the proximal insertion of the gubernaculum attached to the testis and tail of the epididymis.

Discussion

The testes start their migration from the abdomen during the second trimester of gestation after 17 WPC [1]. Testicular migration is a complex process pertinent for the comprehension of cryptorchidism. Cryptorchidism is a very common congenital anomaly, with an incidence of 2–5% in boys born at term and 30% of premature boys [18]. A few studies of baby boys presenting with cryptorchidism show a tendency of predominance of this anomaly on one side. Scorer and Farrington [19], in a study of 224 boys, reported that the cryptorchidism occurred more often on the right side (49%), with 41% occurring on the left side and in 10% of the cases the anomaly was bilateral. Cendron et al. [20], in a study of 759 boys showed cryptorchidism on the right side in 49.8% of the cases, on the left side in 29.5% and bilateral in 20.7%. In the present sample, the right testis was in a lower position than the left in five of nine cases with asymmetry of testicular migration, but this was not statistically significant. This finding differs from the results of previous publications [19,20], where the left testis migrated first.

It has been reported that the transition of the testes through the inguinal canal is a fast process, lasting 3–4 weeks, between 21 and 25 WPC [1,2,13,21]. Authors in general report that it is unusual to find a testicle in the inguinal canal during the fetal period. Heyns [14] found only 2.6% of the examined testes in the inguinal canal, in fetuses of 21 to 29 WPC. In a study with 45 human fetuses, the authors did not observed any testes in the inguinal canal [21]. Nevertheless, in the present study with more fetuses, we found 9.14% of the testicles located in the inguinal canal.

Asymmetrical testicular migration is a rare process. A theory to explain this occurrence is an imbalance in the testicular gubernaculum and the vaginal process [22]. On the side where the gubernaculum is more developed, the testes migrate faster [22]. In the present sample we did not find any alterations in proximal gubernaculum insertions in the cases with asymmetry of testicular migration.

Studies that refer to asymmetrical testicular migration during the human fetal period are rare. Heyns and Hutson [1] described in their historical review the presence of asymmetrical testicular migration in all of the 40 human fetuses examined. But Heyns [14] reported asymmetry in only 17% of the human fetuses examined, with an age range of 23 to 31 WPC. In the cases of asymmetry in testicular migration during the human fetal period described, Heyns [14] observed that the left testicle was located lower in 70% of the cases.

In 1962, in a study of human fetuses, Scorer [13] showed that the left testis is the first to migrate in cases of asymmetry, and this, according to him, also suggests a strong tendency of cryptorchidism to the right, which is confirmed by the previously cited studies [13,14].

Malas et al. [21], in a study of 45 fetuses, observed that fetuses aged between 12 and 26 WPC had the testes in an intra-abdominal position and the testis that migrated first was the right testis at 27 WPC. In the present study, with a very significant sample, we found a 5.5% rate of asymmetry, smaller than other published data [13,14], and noticed a discrete predominance of the migration of the right testis in these cases.

The present study is limited by the fact that we could not predict whether these testicles with asymmetrical migration would have generated cases of cryptorchidism. However, we can conclude that asymmetrical testicular migration is very rare and when this asymmetrical migration occurs, there is a discrete predominance of migration of the right testis first.

Acknowledgments

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Conflict of Interest

None declared.

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Correspondence: Luciano Alves Favorito, Rua Professor Gabizo, 104/201 Tijuca, Rio de Janeiro, RJ, Brazil, CEP: 20271-320.

e-mail: lufavorito@Yahoo.com.br

Abbreviations: CRL, crown–rump length; WPC, weeks post-conception.