ORIGINAL RESEARCH ARTICLE

INTERNATIONAL JOURNAL OF ANATOMY PHYSIOLOGY AND BIOCHEMISTRY

http://www.eternalpublication.com

IJAPB: Volume: 1; Issue: 3; December 2014 *ISSN(Online):2394-3440*

Morphological study of Gubernaculum Testis

Published online on 31st December 2014©www.eternalpublication.com

DR. PHAD VAIBHAV V. [1]
DR. KATTI AS [2]
DR. JADHAV SS [3]
1 Assistant Professor
2 Associate Professor
3 Associate Professor
Dept. of Anatomy,
Govt. Medical College,
Miraj-416410(Maharashtra, India)
Corresponding Author:

Dr. Vaibhv V. Phad
Assistant Professor,
Dept. of Anatomy,
Govt. Medical College,
Miraj-416410 (Maharashtra, India)
+91 9175960494
drvaibhavphad@gmail.com

Received: 10th Dec2014; Accepted: 30th Dec 2014

How to cite this article: Phad VV, Katti AS, Jadhav SS. Morphological Study of Gubernaculum Testis. International Journal of Anatomy Physiology and Biochemistry 2014;1(3):16-21

Abstract:

Gubernaculum testis was described way back in 1762 since then it had been considered to have a role in descent of testis. We have studied its morphology to through light on its role in descent of testis.

Materials & Method- aborted male human fetuses between 12th to 40thweeks of gestational age with no obvious congenital abnormality weretaken for study. The length of gubernaculum, distal attachments of and position of testis was noted.

Observations and Results- the length of gubernaculum was increased just before descent and decreased with descent. Also the thickness of gubernaculum was increased during descent. The length remained more or less constant from 12th week to 40th week and a slight decrease in length was observed.

Conclusion- the gubernaculum is important structure in descent of testis and along with several other factors helps in descent of testis.

Keywords: Gubernaculum, descent of testis, length of gubernaculum, thickness of gubernaculum, ligaments of lockwood.

Introduction:

John Hunter in 1762 was the first to publish a detailed description of the structurewhich "connects the testis with the scrotum and directs its course in its descent", which he named the gubernaculum (Backhouse, 1964). The Latin word gubernaculum means helm or rudder.[1]

In human fetuses the testes normally migrate from the abdomen to the scrotum, traversing the abdominal wall between the 15th and 28th weeks of gestation (17th to 30thmenstrual weeks). Complications that adversely affect this displacement may lead to cryptorchidism and other testicular abnormalities. However, the mechanisms that regulate testicular migration are not yet well established. The most accepted theories for explaining testicular descent in humans are related to increased intra-abdominal pressure[2,3,4,5,6], the development of the epididymis, vas spermatic, vas deferens andinguinal canal[7], development of the gubernaculum[8,9], stimulusfrom the genitofemoral nerve[9] and various stimuli from hormones and biologically active peptides with systemic and/or paracrine effects[10].

In this study the morphology of gubernaculum is studied in detail to through light on its role in descent of testis.

Material and Methods:

Forty aborted male human foetuses between 12- 40 weeks of gestational age (Intra-Uterine Life, IUL) with no obvious congenital anomalies were obtained from the Department of Obstetrics and Gynecology, GMC, Miraj, & PVPGH, Sangli, with the prior permission of Head of Department and consent of parents. The fetuses were fixed in formalin. The study was approved by the Ethical Committee. Gestational age, sex, weight and crown-rump length were noted in detail (Table no. 1, Photo No. 1).

By taking a median vertical incision on the anterior abdominal wall, the abdominal cavity was opened. Intestines were pushed aside to expose the posterior abdominal wall. The testes were seen along the posterior abdominal wall covered by peritoneum. The position of gubernaculum was noted from lower pole of testis to its distal attachment. The length of gubernaculum was noted with caliper (Photo No. 2). If the testis were in scrotal sac the length of scrotal ligament was noted. The values were quoted in Table no. 2.

Table no. 1. Total no of foetuses taken for study according to gestational age.

Age (weeks)	No. of foetuses
12-18 weeks	11
19-24 weeks	11
25-30 weeks	6
31-36 weeks	8
37-40 weeks	4

Observations and Results:

Photo No.-1 Showing fetus no 4 and Instruments used for this study.

Photo No.-2 Showing Method used to measure length of gubernaculum

The gubernaculum was seen as jelly like structure extending from lower pole of testis and epididymis. Testes were resting on gubernaculum. On all sides the gubernaculum was covered by peritoneum except on posterior aspect (Photo No. 3). The thickness of gubernaculum was increased just before 24 weeks when the testes were in relation with deep inguinal ring.

The dissection of inguinal region shows that the superficial and deep inguinal rings were closely approximated to each other. Inguinal canal was very small. The tip of gubernaculum was seen to be protruding outside the superficial inguinal ring.

Photo No. – 3 Showing Gubernaculum as gelatinous material protruding through the superficial inguinal ring

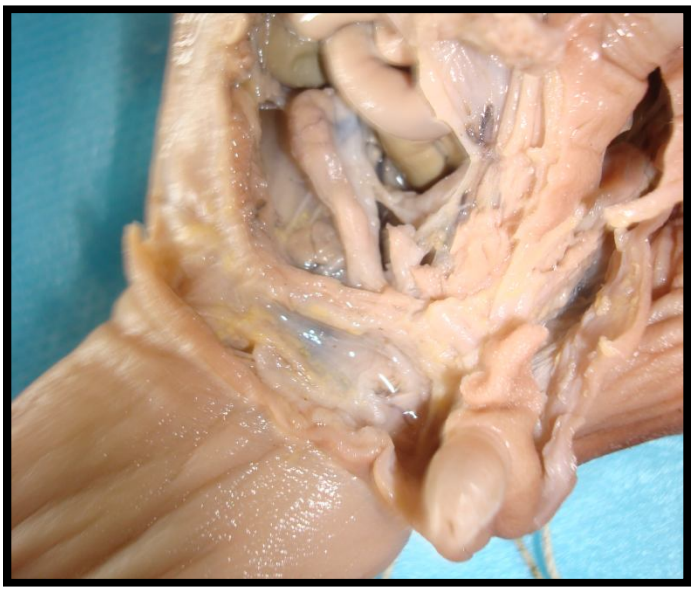
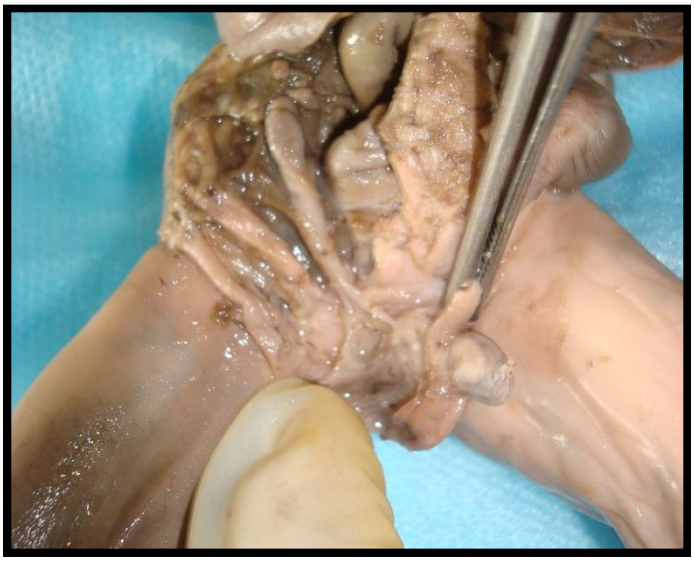


Photo No. – 4 Showing Gubernaculum and distal attachments of ligaments of lockwood



Distal attachments of ligaments of Lockwood were also seen. Up to three distal attachments were distinguishable (Photo No. 4).

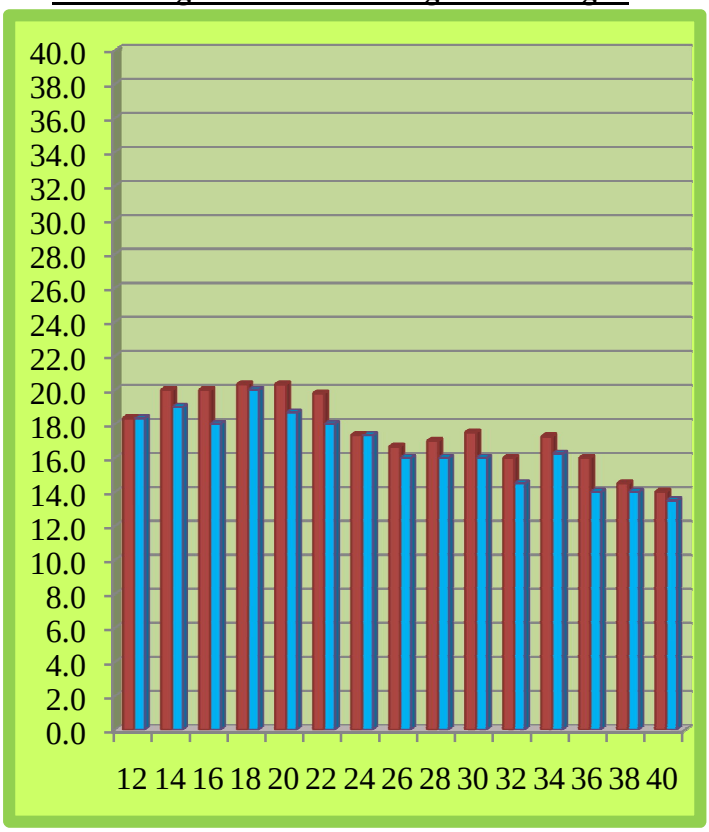
Length of Gubernaculum was measured from lower pole of testis to the superficial inguinal ring[8]. Other attachments of Lockwood ligaments were ignored in these measurements. In case of full term foetus the testis were placed at the bottom of scrotal sac, in them length of scrotal ligament from lower pole of testis to base of scrotal sac was measured. The length was slightly increased from 12th that is 18.3 to 20 in 16th week then it was constant for 22nd weeks after that there was slight decrease in length every week and finally the length of scrotal ligament was 14 cm at 40th week of gestation. There was 4.3 cm decrease observed from 12th to 40th weeks (Table no. 2 and Graph No. 1).

The thickness of gubernaculum was increased between 20 to 26 weeks as compared to the thickness in later stages. The gubernaculum appears thin cord like structure afterwards.

Table no.2. Showing the length of gubernaculum, scrotal ligament and position of testis at different gestational ages.

Gestational Age	Length of Gubernaculum in centimetres		Position of Testis	
(Weeks)	Right	Left	Right	Left
12	18.3	18.3	A	A
14	20.0	19.0	A	A
16	20.0	18.0	A	A
18	20.3	20.0	A	A
20	20.3	18.7	A	A
22	19.8	18.0	A	A
24	17.3	17.3	D, A	D, A
26	16.7	16.0	A, I, Si	A, I
28	17.0	16.0	Si	Ss
30	17.5	16.0	Si, Ss	Si, Ss
32	16.0	14.5	Si, Ss	Si, Ss
34	17.3	16.3	Ss	Ss
36	16.0	14.0	Ss	Ss
38	14.5	14.0	Ss	Ss
40	14.0	13.5	Ss	Ss

Graph 1. - Showing the Length of gubernaculum & Scrotal Ligament at different gestational ages.



Discussion:

The length of gubernaculum was measured from lower pole of testis to superficial inguinal ring when testes were not descended[8]. In elderly foetuses when testes were in scrotum the length of scrotal ligament was measured from lower pole of testis to base of scrotal sac. Scrotal ligament represents the remains of gubernaculum in adult testes. The length was increased from 18.3 mm in 12th week to 20 mm in 22nd weeks after that there was slight decrease in length every week and finally the length of scrotal ligament was 14 mm at 40th week of gestation. The length was fairly constant, slightly increased prior to descent up to 22 weeks.

Heyns CF[8] also found same i.e. prior to descent of the testis there was an increase in the length of the gubernaculum as measured from the apex of the superficial inguinal ring to the inferior pole of the testis. Furthermore he also quotes that descent through the inguinal canal is a rapid process, and occurs anytime between 23 to 31 weeks of gestation.

Costa WS et al[11] in another study stated that during testicular migration gubernacular connective tissue undergoes extensive remodeling and ultimately becomes an essentially fibrous structure rich in collagen and elastic fibers. Such changes should decrease the size of the gubernaculum and, thus, contribute to other forces that cause the testes to move toward the scrotum. In fact, because of the lack of smooth muscle cells, and the amount and organization of striated muscle cells, active contraction of the gubernaculum is less likely to be an important factor in testicular descent. Both studies agree with the role of gubernaculum in descent of testes. They also agreed that length of gubernaculum remains constant during the whole gestational period.

There are various theories relating to descent of testis and role of gubernaculum in it. Such as; the pulling theories propose that the contraction of striated or unstriated muscle fibres or the contracture of connective tissue intrinsic to or surrounding the gubernaculum acts to pull the testis down (Curling[12]1840; Wyndham[13]1943). These theories state that the gubernaculum has firm attachments both cranially and caudally, and up to 6 distal attachments have been described (Hunter[3] 1926)Which were named following Lockwood as *ligaments of lockwood*. The forces of gravity, (Hunter[2] 1841), peristaltic and secretory activity in the epididymis changing its centre of gravitation were also considered under pulling theories (Hadziselimovic[7] 1983). The findings of present study suggest that there is no active contraction of gubernaculum causing pulling of testis but length of it decreases helping in descent.

The theories of pushing suggest that the testis is expelled from the abdomen by the force of increased intra-abdominal pressure, which may be the result of contraction of the abdominal wall muscles, respiratory efforts of the fetus, and the forces of labour (Hunter[2] 1841), distension of the bowel by meconium (Hunter[3] 1926), growth of the

liver and other viscera (Wells[4]1943) and closure of the physiological hernia (Rajfer & Walsh[5]1977). These pressures are supposed to cause herniation of the gubernaculum and testis through the 'weak' part of the abdominal wall, the inguinal canal (Shrock[6] 1971). The above mentioned factors have a role in descent as length of gubernaculum decreases slightly not sufficient to cause descent.

Growth theories consider testicular descent as more apparent than real, with differential growth of the lumbar vertebral column, pelvis and abdominal wall being responsible for the testis entering the inguinal canal, while the gubernaculum passively anchors it to the internal ring (Hart[14] 1909). Other theories have stressed the downward growth of the Processus vaginalis (Cleland[15] 1856); the penetrating power of unstriated muscle fibres in the gubernacular tip, enabling it to burrow its way downwards, possibly by a process of phagocytosis (Hart[14] 1909); dilatation of the inguinal canal and scrotum through the uptake of water by hyaluronic acid in the extracellular substance of the gubernaculum (Backhouse[1] 1964). Differential growth also contributes to descent as length of gubernaculum remains more or less constant and also the scrotal ligament also has same length as that of gubernaculum. But the role of gubernaculum cannot be denied.

The regression theories state that atrophy, degeneration or shrinking of the gubernaculum brings about testicular descent (Cleland[15] 1856; Hart[14] 1909; Rajfer & Walsh[5] 1977). Whatever the mechanical factors at work, there is a large body of clinical and experimental observations suggesting that the process of testicular descent is under hormonal control (Wells[4] 1943). Maternal, placental or fetal pituitary gonadotropins are thought to stimulate androgen secretion by the fetal testis, with testosterone or one of its metabolites acting in some way to bring about descent of the testis (Elder et al[16] 1982), also the Mullerian inhibiting substance is important for descent (Donahoe, Ito, Morikawa& Hendren[17] 1977). It has also been suggested that the gubernaculum is not necessary for descent at all (Wells[4] 1943). There is slight regression as shown by decrease in length of gubernaculum in this study also.

Conclusion:

The gelatinous structure of gubernaculum was changed to cord like in the late gestational period due to extensive remodeling. Although the length of gubernaculum decreases slightly this decrease does not contribute to active pulling of testis hence causing descent but this helps in descent. So the gubernaculum is important structure in descent of testis and along with several other factors helps in descent of testis.

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