

## Original Research Article

# Histological development of ligamentum teres and its vascularisation in the human fetuses

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### ABSTRACT

**Background:** Ligamentum teres is the ligament of the hip joint. It is flat and triangular in shape. The ligamentum teres starts developing in the fetal life during 10-11 weeks. The present work was undertaken chiefly to gain insight into the pattern of sequential development of ligamentum teres and to compare the findings of other authors with the observations made in the present study and to correlate these findings clinically to find out the function of ligamentum teres.

**Methods:** The present study was undertaken on 40 fetuses of varying gestational periods collected from the operation theatre, labour room and obstetrics wards of department of Gynaecology and Obstetrics, Government Medical College, Jammu and other areas of Jammu, 10% Formalin was used as preservative. The hip joints of both the sides were dissected carefully. 5% solution of Gooding and Stewart's was used for decalcification. Paraffin wax embedding method was used for preparing the tissue for section cutting. Staining was done by Harri's Hematoxylin and Eosin stain and Masson's Trichrome stain. The slides were then examined under microscope for important findings.

**Results:** The ligamentum teres is seen by 10½ weeks. Blood vessels appear in 12½ weeks. Ramification of blood vessels in this ligament is seen by 21½ weeks. Through this ligament, the blood vessels are seen limited up to the fovea capitis femoris by about 16½ weeks and by 18½ weeks they penetrate deep into the head of femur. Ligamentum teres is lined by thin synovial membrane at 19<sup>th</sup> week.

**Conclusions:** The ligamentum teres develops by 10½ weeks. It arises in-situ as it develops in the same position as it occupies in the adult but as age advances, it shows much differentiation and resembles the adult features.

**Keywords:** Blood vessels, Fetuses, Head of femur, Hip joint, Ligamentum teres, Weeks

### INTRODUCTION

Ligamentum teres is also known as ligament of head of femur, round ligament of femur. Other names for this ligament are foveal ligament and ligamentum teres femoris.

It is flat and triangular in shape. It has an apex and a base. The apex is attached to the fovea capitis and the base is attached by two bands to the margins of the acetabular notch. Between its attachment to the acetabular notch, it is attached to the transverse ligament of the acetabulum. This transverse ligament is a part of the acetabular labrum which is attached along the acetabular notch.

The ligamentum teres is lined by the synovial membrane. Sometimes, this ligament may be very thin. In some cases, only the synovial fold is present and in rare cases, this ligament may be absent.

The vascular supply of the ligament teres is through the acetabular branches of obturator artery and medial circumflex femoral artery. These also supply the fat in the acetabular fossa by passing through the acetabular notch.

Since 19<sup>th</sup> century, many studies have been there to find out the role of the ligamentum teres of the hip joint. Little work is done on the prenatal histological development of

the ligamentum teres. It was considered by many authors to be a functionless structure.

The articular surfaces of the hip joint are formed of a special variety of hyaline cartilage which reflect their preformation as cartilaginous models in embryonic life. The cartilaginous hip joint is at first quite shallow but extension of cartilage from the pelvis over the head of femur deepens it on all sides except in the region of the acetabular notch. In the region of the ligamentum teres, a fibrous band is differentiated from the blastema of the joint.<sup>1</sup> Ligamentum teres appears by about 10½ weeks. It is avascular at this stage. Vascular loops were observed in it by 12½ weeks. Ligamentum teres is well defined and more fibrous by about 16 weeks. The ligamentum teres is lined by thin and delicate synovial membrane by 19<sup>th</sup> week. Increasing amount of vascularization occurs in the ligamentum teres of older specimens and some of these vessels also enter the head of femur. So, it seems that function of ligamentum teres is to carry blood supply to head of femur and not any other mechanical function.

There is vast controversy regarding the development of the ligamentum teres and its vascularization. So, an attempt is made to compare the findings made in the present study.

## METHODS

The study was done on 40 fetuses of varying gestational periods obtained over a period of one year from September 2005 to September 2006. The fetuses were collected from the operation theatre, labour room and obstetrics wards of department of Gynaecology and Obstetrics, Government Medical College, Jammu, Government Gandhi Nagar Hospital, Jammu and various nursing homes operating in and around Jammu City. The materials were obtained as the products of still births, abortions, which were either induced or natural or from hystrotomy procedures. 10% formation was used as preservative with the help of Verneir's Calipers, the Crown Rump (CR) length was measured. Age of the fetuses was measured according to the rule as described by Hamilton, Boyd and Mossman.<sup>2</sup>

After finding out the sex of the fetuses, the hip joints of both the sides were dissected out and fixed in a fixative fluid. Each dissected specimen was kept inside a metallic tissue capsule. Fixation was done for 1-2 days.

The specimens of very small fetuses did not require any decalcification, so were directly transferred to ascending grades of alcohol. Whereas specimens of bigger fetuses were first decalcified in Gooding and Stewart's 5% solution for 2-4 days. Paraffin wax embedding method was used for embedding L-shaped moulds of suitable size were used. With the help of rotary microtome, trimming of the block was done. Sections were taken at a thickness of 7 µ. Wrinkles were removed by transferring the sections to water bath containing lukewarm water. Fixation of sections was

done on glass slides which were smeared with a drop of egg albumin. Staining of the slides was done by Harri's Hematoxylin and eosin staining and Masson's Trichrome stain. The slides were mounted with DPX solution and covered with cover slips. By using Binocular light microscope, examination of the slides was done, and important findings were noted down. After that, photographs of these findings were taken.

### Inclusion criteria

- Apparently healthy fetuses were taken for study.

### Exclusion criteria

- Fetuses with congenital abnormalities were discarded.

**Table 1: The crown rump length of fetuses along with their details.**

S. No.	CRL (mm)	Sex	Estimated age (days)	No. of case studies
1.	53	Male	72	1
2.	58	Female	75	1
3.	75	Female	86	1
4.	77	Male	88	1
5.	95	Female	100	1
6.	98	Male	102	1
7.	100	Female	103	1
8.	105	Female	106	1
9.	110	Female	110	2
10.	112	Female	111	1
11.	115	Female	113	1
12.	117	Female	114	1
13.	118	Female	115	1
14.	120	Female	116	1
15.	128	Female	122	2
16.	132	Female	124	1
17.	133	Female	125	1
18.	134	Male	126	1
19.	135	Male	126	2
20.	136	Female	127	1
21.	140	Female	130	1
22.	142	Female	131	1
23.	143	Male	132	2
24.	144	Female	132	1
25.	145	Female	133	2
26.	146	Female	134	1
27.	168	Male	148	1
28.	172	Female	151	2
29.	190	Male	164	1
30.	195	Female	166	1
31.	210	Female	176	1
32.	220	Female	186	1
33.	240	Male	196	2

Total number of Fetuses= 40

**Statistical analysis**

No complex statistical techniques were used. Only proportions were used.

The CR Length of fetuses along with their details is given in Table 1.

**RESULTS**

Following findings are observed after the histological study conducted on 40 fetuses of different gestational periods ranging from 53-240 mm crown rump length (CR Length). These specimens therefore ranged approximately from 10 weeks to 28 weeks. These 40 fetuses are divided into five groups based on their size as in Table 2.

**Table 2: Group wise distribution of cases according to age and crown rump length.**

Group	Crown rump length (mm)	Age (weeks)	Cases studied (Nos.)
I	53-75	10-12	3
II	77-105	12½-15	5
III	110-136	15½-18	15
IV	140-146	18-19	8
V	168-240	21-28	9

**Group I**

53-75 mm CR-length (10 to 12wks).

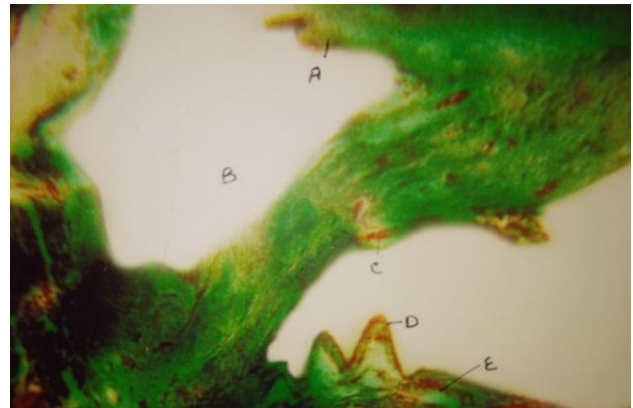
In transverse sections of 10½ weeks, fetuses, the ligamentum teres is seen as a cellular structure attached to the head of femur. The transverse acetabular ligament is seen as a fibro cellular structure attached to the acetabular labrum on either side (Figure 1).



**Figure 1: Ligamentum teres at 58 mm CRL fetus in H and E Stain X25 A) Head of femur B) Acetabular cartilage C) Ligamentum teres D) Joint cavity.**

**Group II**

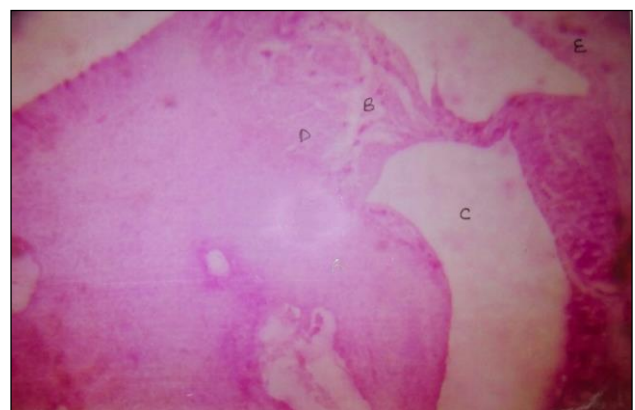
77-105 mm CR length (12½-15 weeks). In the transverse sections of 12½ weeks fetuses, the ligamentum teres has been found extending from the forea capitis femoris to the acetabular fossa and contains condensed cells and few blood vessels. But none of these blood vessels have been observed to enter the femoral head via this ligament (Figure 2).



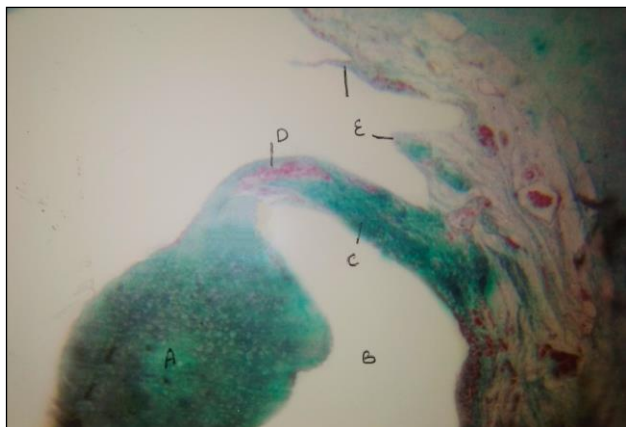
**Figure 2: Ligamentum teres and synovial villi at 77 mm CRL fetus in masson's trichrome stain X25 A) Head of femur B) Joint cavity C) Blood vessels in Ligamentum teres D) Synovial villi E) Acetabular fossa.**

**Group III**

110m-136 mm CR length (15½-18 weeks). The ligamentum teres is well defined and more fibrous at this stage. It appears to be triangular in shape. Apex is attached to the head of femur and base is seen over the acetabular fossa where it is attached to the margins of this fossa. A large number of blood vessels along the fibers are entering into it through acetabular fossa but penetration of its blood vessels in the femoral head is still lacking and are limited only upto fovea capitis femoris (Figure 3) and (Figure 4).



**Figure 3: T.s showing ligamentum teres at 120 mm CRL fetus in H and E stain X25. Head of femur B) Ligamentum teres C) Joint cavity D) Fovea capitis femoris E) Acetabular Fossa.**

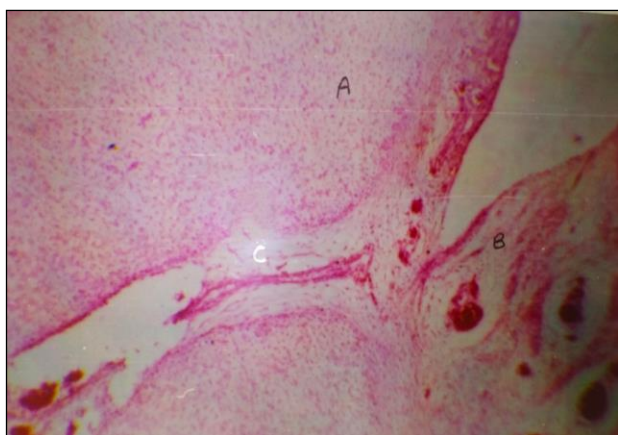


**Figure 4: Ligamentum teres over the acetabular fossa at 120 mm CRL fetus in masson's trichrome stain X25 A) Head of femur B) Joint cavity C) Ligamentum teres D) Blood vessels in ligamentum teres E) Synovial villi.**

**Group IV**

A 140-146 m CR length (18½ to 19 weeks).

Ligamentum teres contains many blood vessels and is more collagenous. Some of the blood vessels are penetrating deep into the head of femur (Figure 5). The acetabular labrum can be easily demarcated from the adjoining hyaline acetabular cartilage. The collagenous fibers have increased in it. The ligamentum teres is lined by thin and delicate synovial membrane (Figure 6).



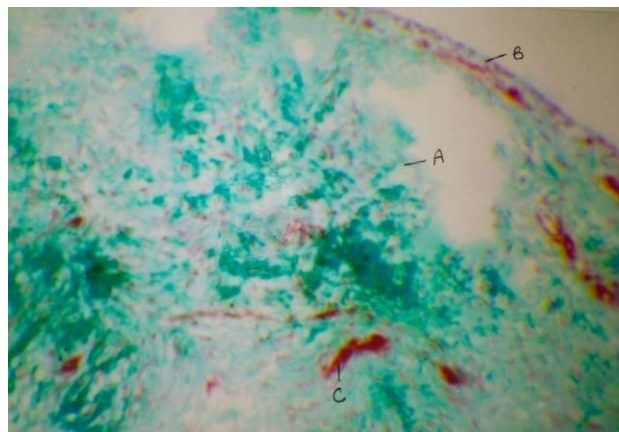
**Figure 5: Extension of blood vessels into femoral head at 143 mm CRL fetus in H and E stain X50 A) Head of femur B) Ligamentum teres C) Blood vessels entering head of femur.**

**Group V**

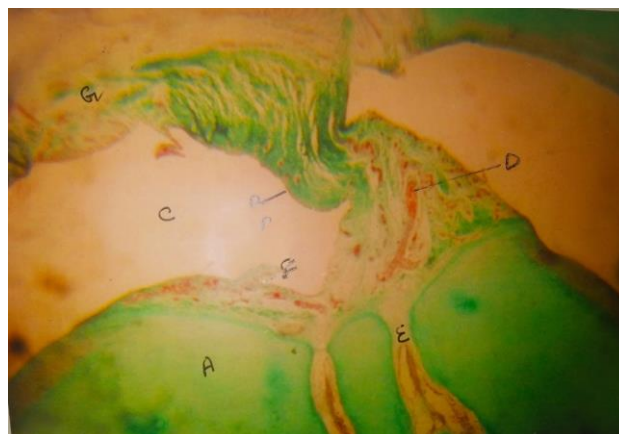
168-240 mm CR length (21 to 28 weeks)

The ligamentum teres can be seen extending from femoral head to the margins of the acetabular fossa. Numerous blood vessels are present in it, some of them are extending into the head of the femur. These are

anastomosing with one another. Also, the collagenous fibers have increased in it. Ramification of blood vessels can be seen in the ligamentum teres (Figure 7).



**Figure 6: Synovial membrane lining the ligamentum teres at 146mmCRL fetus in masson's trichrome stain X50 A) Ligamentum teres B) Synovial membrane C) Blood vessels.**



**Figure 7: Extension of blood vessels into femoral head at 172 mm crl fetus in masson's trichrome stain X 25 A) Head of femur B) ligamentum teres C) joint cavity D) blood vessels E) blood vessels entering head of femur F) synovial membrane G) acetabular fossa.**

**DISCUSSION**

The present work was undertaken chiefly to gain insight into the pattern of development of ligamentum teres and its vascularization. The available literature exhibits that various authors have already done the work on the histological development of the ligamentum teres and its vascularization. So, an attempt has been made to compare the findings of other authors with the observations made in the present study.

The histological findings show that at 10 weeks, the head and the proximal end of the femur have already been established. This finding is well in accordance with other authors.<sup>3-5</sup>

The ligamentum teres was noticed at 6 at 51 mm CR length. Ligamentum teres was noticed as a cellular structure at 30-33 mm CR length fetus.<sup>5</sup> Blood vessels were noticed by them in this ligament at 50 mm stage. These entered femoral head by 195-198 mm CR lengths. Ramification of blood vessels in the ligamentum teres was observed at 156-270 mm CR length fetus. Whereas in the present study, ligamentum teres is found as cellular condensation at 10½ weeks fetus. Blood vessels make their appearance in the ligamentum teres at 12½ weeks. These vessels reach up to fovea capitis femoris by 16½ weeks and at 18½ weeks, they enter the femoral head. Ramification of blood vessels is seen at 21½ weeks. Synovial membrane lines the ligamentum teres at 19<sup>th</sup> week. Extension of blood vessels into femoral head was also noted beyond 20 weeks.<sup>7</sup>

Ligamentum teres is found to be a fibro cellular structure lined by synovial membrane. This finding is also reported by Romanes.<sup>8</sup> Ligamentum teres becomes more collagenous in older fetuses. The grouping of the bundles of collagenous fibers seems to be less regularly arranged in the ligaments like ligamentum teres when compared with tendons.<sup>9</sup> Author have noted that an increasing amount of vascularization occurs in the ligamentum teres of older specimens and some of these vessels also enter the head of femur. So, it seems that function of ligamentum teres is to carry blood supply to head of femur and not any other mechanical function. This was also endorsed by Henle.<sup>10</sup> The histological study of ligamentum teres indicates that this ligament is first evident as a cellular condensation in the same position which it occupies in the adult. This idea of its development-in-situ is also favored by others.<sup>5,11</sup>

The rapidity with which the early developmental processes take place and the consistency of the various patterns they assume, support the belief that these processes are determined genetically.

## CONCLUSION

The ligamentum teres is seen at 10½ weeks of fetal age as a cellular structure attached to the femoral head. It is collagenous and vascular at 12½ weeks. Extensive vascularization occurs in older fetuses. In 16½ weeks stage, blood vessels are limited to fovea capitis femoris only and extend into femoral head at 18½ weeks. They penetrate farther deep into femoral head and ramification of blood vessels in the ligamentum teres is seen at 21½ weeks.

The ligamentum teres, acetabular labrum and transverse acetabular ligament are seen as cellular or fibro cellular structures at the positions they occupy in the adult though they become highly differentiated in older fetuses. It indicates that all these structures arise in situ.

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