



HISTOMORPHOGENESIS OF CAVITY OF HIP JOINT IN HUMAN FETUSES

Anatomy

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ABSTRACT

Introduction: Hip joint is a multi-axial, diarthrodial, synovial, ball and socket type of joint. The cavity of hip joint is a space between head of femur and cup shaped fossa of acetabulum. **Aims & Objectives:** The present work was undertaken to gain insight into the sequential development of cavity of hip joint and shape of head and neck of femur. **Materials & Methods:** The present study was undertaken on 40 fetuses of varying gestational periods collected from operation theatre and labour room of department of Gynaecology and obstetrics, Government Medical College Jammu and other areas of Jammu. Specimen obtained were fixed in 10% formalin. The hip joints of both the sides were dissected carefully. Histological processing of tissue was done and sections obtained. Staining was done by Harri's Haematoxylin and Eosin stain and Masson's Trichrome stain. The slides were then examined under microscope for important findings. **Results:** The cavity of hip joint was seen by 72 days in the lateral part and it was ill defined in the medial part. It was symmetrical at 75 days stage. There was increase in the depth of the acetabulum from 72 days to 196 days. Blood vessels appeared in the acetabular fossa at 88 days and they extended into the adjacent acetabular cartilage by 111 days. Fat appeared in the acetabular fossa at 186 days. **Conclusion:** The cavity of hip joint is already present by 72 days. The acetabulum is cup shaped and not flat. The acetabular depth increases as the diameter of head of femur increases.

KEYWORDS

Hip joint, Head of femur, Acetabulum.

INTRODUCTION

The manner in which one bone articulates with the other in the human body varies considerably. This variation is related to the presence or absence of movement at the joint. Movable articulations range from joints at which little more than a slight play is allowed to ball and socket joints which allow quite extensive mobility. Hip joint is a classical example of this type of joint which is a multi-axial, diarthrodial synovial joint of ball and socket type. It is formed between head of femur and cup shaped fossa of the acetabulum. The articular surfaces are reciprocally curved. Acetabular depth is increased by the acetabular labrum, a fibrocartilaginous rim attached to the acetabular margin¹.

Since 19th century, many studies have been there to find out the development of components of the hip joint and its cavity formation. The majority of reports have emphasized the changes in early stages of development and a relatively little attention has been paid to changes during later fetal months. There is no indication of the site of the future synovial joint until after the differentiation of the cartilaginous models of the future bones. Soon after cartilaginous models are laid down, the mesenchyme between the ends of adjacent cartilaginous elements becomes arranged to form interzones². 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. Some controversies do exist on the development of cavity of hip joint and shape of head and neck of femur and acetabulum. So, an attempt is made to compare the findings of other authors with the observations made in the present work.

MATERIALS AND METHODS

The study was done on 40 fetuses of varying gestational periods obtained over a period of one year. The fetuses were collected from the operation theatre and labour room 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 hysterotomy procedures. 10% formalin was used as preservative. With the help of Vernier Calipers, the Crown Rump (CR) length was measured. Age of the fetuses was measured according to the rule as described by Hamilton, Boyd and Mossman². The hip joints of both the sides were dissected out and fixed in 10% formalin. 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 to obtain Sections with thickness of 7 μ . 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 Haematoxylin 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.

Observations

Following findings were observed after the histological study conducted on 40 fetuses of different gestational periods ranging from 53mm-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: Showing Group wise distribution of Cases according to Age and Crown Rump

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

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

In transverse sections of 10 weeks fetuses, the head and neck of femur have been formed, though the neck is short and thick. Head and neck lack any sign of vascularization. The cavity of hip joint between femoral head and acetabulum is already present but is not uniform in width. It has extended towards the neck for a short distance. It is ill defined medially and wider laterally (fig.1). The acetabular labrum is seen as a fibrocellular structure continuous with the adjacent hyaline acetabular cartilage.

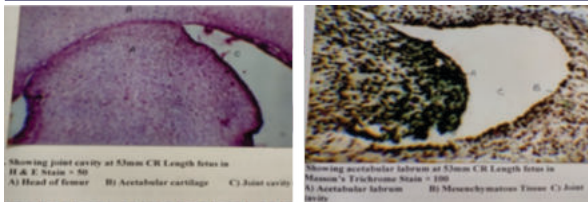


Fig 1

Fig2

Group-II

77mm-105 mm CR length (12½ - 15 weeks)

In 100 days fetus, the transverse sections show increase in length in neck of femur. The lesser and greater trochanters are well formed and the cavity of hip joint is large and has extended along the femoral neck (fig.3). Femoral head is more rounded and shows capitis femoris at its upper end (fig.4).

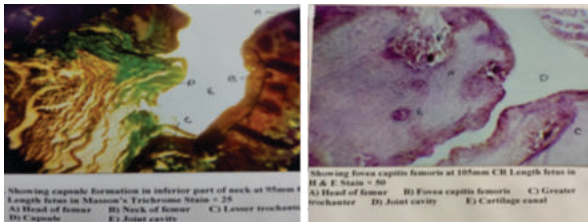


Fig3

Fig4

Group-III

110mm- 136 mm CR length (15½-18 weeks)

The acetabular fossa is highly vascular. Some of blood vessels from the acetabular fossa have been noticed to enter adjoining acetabular cartilage (fig.5). There is further increase in the dimensions of head, neck and greater trochanter. The cavity of hip joint over femoral head has increased in size and there is also increase in the depth of acetabular cavity (fig.6)



Fig 5

Fig 6

Group-IV

140mm-146 mm CR Length (18½ to 19 weeks)

The head of femur is more spheroidal and the neck has increased in length. The hip joint cavity can be seen as a symmetrical gap between the hip bone and the head of femur. There is increase in the concavity of the acetabulum. The acetabular labrum can be easily demarcated from the adjoining hyaline acetabular cartilage

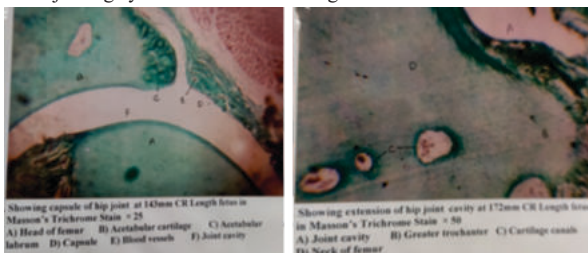


Fig 7

Fig 8

Group-V:

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

There is much clear demarcation between the head and neck of femur. Neck has gained length and is more constricted. Both lesser and greater trochanter can be seen clearly (fig.8). The cavity has increased in size

and has extended to the zone of diaphyseal ossification (fig.9).The extension of the cavity continues to be the same and there is deepening of the concavity of the acetabulum.

DISCUSSION

The present work was undertaken chiefly to gain insight into the pattern of development of cavity of hip joint along with change in the shape of head and neck of femur and acetabulum. The histological findings show that at 53 mm CR Length fetus, the head and neck of femur have already been established though the neck is still short and thick. These findings are well in accordance with some of the authors^{3,4,5,6}. At this stage, similar observations have been made by one author⁷ who claimed that shaped are developed before the fetal movements are possible. However, the head and neck of femur have become distinct in 75 mm stage and with advancement in development, more definite shapes are attained in the later fetal stages similar to those observed by one author⁸. Our findings are not in conformity⁹ that femoral head is club shaped and not well differentiated until 93 mm CR Length fetus. As a result of their studies on the development of joints, several investigators attempted to relate these developmental changes to either genetic or mechanical factors. It was discovered that movement induced by muscles and tendons is the factor which determines the form of articular structure. This was also later supported^{10,11}. But it is difficult to account these changes to the mechanical factor at 53mm CR Length fetus. We are in agreement with the views who held the opinion that their general form and major components resemble that of adult before cavity formation begins and any muscle activity is possible^{12,13,14}. So these processes may be genetically determined as is also reported¹⁵.

The presence of cavity around the periphery of the joint was noted at 30-33 mm stages⁶ and it was obliterated in the centre. Extension of this cavity over the femoral neck was noticed by them at 73-75 mm and at 180 mm CR Length, it extended almost to the level of diaphyseal ossification of the femur. In the present study, the cavity of the hip joint is present laterally at 53 mm stage though it is ill- defined in the medial part. It has also extended along the femoral neck for a short distance. There is increase in the extension of the cavity as the size of the fetus increases and extends upto the zone of diaphyseal ossification but at a slightly later stage that is 195 mm CR Length fetus. It was observed¹⁶ that hip joint cavity becomes obliterated for a time by secondary cartilaginous continuity but this is not in accordance with the present study. We also confirm the findings⁶ that there is progressive increase in the dimensions of femoral head and the acetabular depth and size appears normal. This has tallied with our observations. This is somewhat different from that was claimed¹⁸ that acetabulum is flat in the newborn as no specimen in our study gives evidence of defective development of the acetabulum. Regarding the vascularity of the acetabular fossa, the blood vessels were noticed⁶ at 30mm and 33 mm CR Length fetuses which were more pronounced at 106-107 mm stage. In the present study, blood vessels are noticed in the acetabular fossa for the first time at 77 mm CR Length which is slightly later and they become pronounced from 98 mm stage till later stages. They also extend into nearby acetabular cartilage by 120 mm stage.

Acetabular labrum was found to be present as a fibrocellular structure⁶ at 49-50 mm stage. It is noticed as a similar structure in our studies at 53 mm stage. Therefore claim¹⁹ that acetabular labrum is cartilaginous at birth must be heavily discounted.

CONCLUSION

The femoral head and neck are established at 53mm CR length fetuses. Neck is thick and short. These are avascular at this stage. Vascularization of the epiphyseal cartilages begins at 75mm CR Length and blood vessels enter through perichondrium and trochanteric fossa at 75mm CR Length. Whereas through the ligamentum teres, blood vessels enter femoral head at 143mm CR Length. Anastomosis between cartilage canals is seen at 135mm and 172mm CR Length. There is gradual increase in the length of femoral neck and the shape of head & neck of femur are more definite in older fetuses. Neck is much constricted at 190mm CR Length. The cavity of the hip joint is already present in 53mm CR Length fetus though it is ill-defined medially and is wider in the lateral part. It is symmetrical at 58mm CR Length. There is further extension of this cavity along the neck of the femur and it reaches to the level of diaphyseal ossification in 195mm CR Length fetus. There is increase in the depth of the acetabulum from 53mm stage till 240mm stage. Blood vessels appear in the acetabular fossa at 77mm CR Length and it is collagenous at 112

mm CR Length. Extension of the blood vessels from the acetabular fossa into adjacent acetabular cartilage is also seen as 120mm CR Length. Fat appears in the acetabular fossa.

DECLARATIONS

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Conflict of interest: None declared

Ethical approval: The study was undertaken after taking due consent of the concerned parents.

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