Morphological and Histological Prenatal Studies on Some Structures of the Developing Human Knee Joint

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Abstract: The human knee joint has been studied widely. However morphogenesis and histogenesis of some intra articular structures in the developing human knee were insufficiently studied. The present work studied the morphological and histological changes of the intra articular septum in the developing human knee and its differentiation and emerging of the crutiate and meniscofemoral ligaments from that septum. The morphogenesis and histogenesis of the developing menisci were observed. The results of this work present new data about differentiation of the developing intra articular septum and emerging of the crutiate and meniscofemoral ligaments from it as well as the morphogenesis and histogenesis of the developing menisci in human knee joint. The study provides the basis for further investigations on anatomical pathology, comparative morphology and evolutionary anthropology. Thirty three human fetuses of different sexes and ages (3- 9 months) from (12-13wks-CRL 8- 9cm) to full-term: (33-36 weeks) CRL 31-34cm) and newborn infant (37-38 weeks; CRL 35-36cm) were used in this study, besides 4 adult knee joints. Morphological study of the developing knees revealed that early, in 3-5 months old fetuses (12-13wks, CRL 8- 9cm and 17 -20weeks, CRL 15-19cm)., the joints cavity was divided by a broad intra-articular septum into two cavities. This septum with age progressing became absorbed and differentiated into 3 bands: the menisco-femoral ligament and the anterior and posterior cruciate ligaments. The lower end of the femur from 6 months: (21 -24weeks) CRL 20-23cm had also changed progressively with age. With the exception of ligamentum patellea which had appeared early, the other ligament started to be observed from 6 months: (21 -24weeks) CRL 20-23cm. They became well developed at birth. The menisci were ill defined at 5 months old fetus, with flat upper surface, their horns started to appear at the age of 6 months old fetus and upper surface was still flat. At the age of 7 months, the outer edges started to thicken and elevated, at full term, the outer edges of the menisci were thicker more elevated and their inner edges were thinner than previous ages, to form concave upper surface to deepen the articular surface of the tibia preparing it to receive femoral condyles. The lateral meniscal upper surface concavity was more than the medial meniscus. The concavity of the upper meniscal surface increased with age progress. The femoral intercodyler fossa was shallow in young ages similar to inverted U when seen in anterior view flexion position, and increased in depth and length with age progress and became similar to inverted V in adult.

Histological examination of the developing menisci showed that they were initially formed of cartilaginous tissue then with age progress they became formed of fibro cartilage tissue. The cruciate ligament were initially formed of fibrous tissue contained few fibroblasts and loosely packed short collagen bundles, then with age progress those bundles became longer, parallel, wavy and more packed intermingled with few fibroblasts arranged in linear manner.

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Introduction

The review of literature showed that most of the articles referred that skeletal elements became defined from the continuous mesenchyme masses. between adjacent elements some regions were found which did not progress into cartilage or bone but remained as plates of inter-zonal mesenchyme. These were the sites of future joints. The development of synovial joints in the skeletal mesenchyme appeared as a general condensed mass not demarcated from the surrounding myogenic tissue. Further on, centres of chondrifications and, ossifications appeared in the mesenchymal core and rapidly extended to delineate the individual skeletal elements in the form of laminae. The laminae became demarcated from the underlying cartilage or bone thus forming the perichondrium or periosteum. (**Hanies, 1947 and Streator, 1949**)

In the synovial joints the interzonal mesenchyme became trilaminar namely two dense-strata next to the cartilaginous ends of the skeletal elements and a more tenuous intermediate zone. The intermediate stratum merged with the general mesenchyme of the limb which was vascularized. From this a cuff condensed as the fibrous capsule of the joint. A thinner layer of vascular mesenchyme was enclosed within this as the precursor of synovial capsule. The synovial mesenchyme formed the synovial membrane and probably gave rise to all other intra-articular structures such as tendons, ligaments, discs and menisci. As the skeletal elements chondrified and in part ossified, the dense strata of the interzonal mesenchyme also became cartilaginous. Cavitation of the intermediate zone establishes the cavity. (**Garder and Gray, 1950 and 1953**).

In joints containing discs and menisci more than one cavity might appear, merging, later into a complex single one. As development proceeded thickening of the fibrous capsule could be recognized. In some joints, thickening of the capsule were derived from neighboring tendons. (**Gardner and O'rahilly,1968 and Williams et at, 198**9).

Mérida-Velasco *et al.* (1997) mentioned that many studies had been published on the development of the human knee joint, but different investigators disagreed on its morphogenetic time table. Most discrepancies centered on the cavitation of the knee joint and the participation of the superior tibiofibular joint in the joint knee system. They summarized their observations of the development of the knee joint in 50 serially sectioned human embryonic and fetal lower limbs (26 embryos and 24 fetuses). They established the morphogenetic time table of the human knee joint. They reported that epiphysis of the femur and tibia became condryfied from O'Rahilly stage 18, and ossification begins during the 13th week of development. The patella appeared as a dense blastema during O'Rahilly stage 19, became condryfied during O'Rahilly stage 22, and began its ossification during the 14th week of development. The knee joint cavity appeared during O'Rahilly stage 22, initially as the femoropatellar joint. That process began at the periphery of the articular interzone. The superior tibiofibular joint communicates with the lateral meniscotibial joint between 10 and 11 weeks of development and became separated from the 13 week on. The menisci arised from the eccentric portions of the articular interzone during O'Rahilly stage 22; however, until week 9 of development, they were not easily distinguishable.

Ratajczak (2000) investigated 43 serially sectioned human embryos of developmental stages 18 to 23. They observed the homogeneous interzone of the future knee joint in embryos at stage 18. They mentioned that during stage 19 that interzone was differentiated into dense, intensively stained, peripheral parts, which were the primordia of menisci and the medial portion, in which the cruciate ligaments are formed. All structures of the interior of the knee joint were more clearly delineated during stage 20, and they were well developed during the last embryonic week (stages 21-23).

Anatomical and histological studies on the development of the human knee joint are insufficiently reported in the literature. Further studies are needed to attain an accurate knowledge about the morphogenesis and histogenesis of the developing knee joint. The current study aims to study the morphological and histological prenatal Studies on some structures of the developing human knee joint.

This is critical in understanding the knee biomechanics which is fundamental in correction and treatment of knee lesions. It is also important in reconstruction and graft placement.

2. Material & Methods:

A total of 33 human Human (male and female) fresh fetuses aged 3, 4, 5, 6, 7, and 9 months (full term) and of 3-9 months old fetuses from (12-13wks-CRL 8- 9cm) to full-term: (33-36 weeks) CRL 31-34cm) new born infant) 37-38 weeks) CRL 35-36cm) were used in this investigation. The fetuses were obtained from the miscarriage and spontaneous abortion obtained from Gynecology and Obstetric Department Al-Zharaa hospital-Cairo -Egypt (according to medical ethics). They were used in the studying of the normal morphogenesis and histogenesis of the developing knee joint.

Four adult adult knee joints from new cadavers (male and female) were also used in this work for reason of comparison. The cadavers were obtained from the Dissection room at the – Anatomy Department -Al Azhar University -Cairo -Egypt. Dissection of both sides of the developing and adult knees was done Dissection was held according to **Romanes (1992)** in three stages: a) To expose the outer most structures of the joint's cavity, by cutting across the quadriceps tendon immediately proximal to patella. Then the latter was turned downwards. followed by displacement of the capsule; b) A deeper dissection was done to expose the intra-articular structures, by removing the infra-patellar synovial fold and fat, then the infra-patellar bursa was opened. c) A clear view of the upper surface of the tibia was obtained after cutting across the fibular and tibial collateral ligaments, the arcuate ligament, tendon of popliteus and the remains of the fibrous capsule. Followed by cutting across the crutiate ligaments.

Finally the femur was removed. Then specimens were fixed in formalin.

To illustrate the morphology of the developing knee joints, photos were photographed by Canon camera zoom. (The anterior aspect in full flexion position and the quadriceps tendon in each joint is sectioned and the patellar flap retracted distally). (Adult knee photos were photographed by Yashica T3 Super D-Carl Zeiss T –Tessar 2-8/35).

For histological study, specimens from the crutiate ligaments or its primordial and the menisci of the knees, as well as the capsule and the synovial membrane of 4 months fetuses: (33-36 weeks) CRL 31-34cm) and: (33-36 weeks) CRL 31-34cm) full term were collected freshly and fixed in 10% formal saline solution for 10 days, then dehydrated, cleared in benzene, embedded in paraffin wax, cut serially at 7 microns thickness and stained with haematoxylin and eosin stain for detection of general histological structures, Mallory's stain to investigate collagenous tissue and Masson trichrome stain for evaluation of collagenous tissue and Van Gieson stain for the collagen and elastic (yellow fibres) *(***Drury & Walington, 1980***)*.

The CRL of each fetus was obtained and then converted into weeks of menstrual prenatal ages according to tables of Streeter **(1920), Langman (1975) and Sadler (2012**) Table (1).

Table (1) prenatal ages according **Sadler (2012)**

Table (1): Growth in Length and Weight During the fetal Period

Proposed Age (months)	Age (wks)	CRL (cm)	Weight (g)
2-3	9-12	5-8	10-45
3-4	13-16	9-14	60-200
4-5	17-20	15-19	250-450
5-6	21-24	20-23	500-820
6-7	25-28	24-27	900-1,300
7-8	29-32	28-30	1,400-2,100
8-9	33-36	31-34	2,200-2,900
9-10	37-38	35-36	3000-3.400

Results

I — Morphological Results

1-Knee joints of 3 -4 months old fetuses:

In 3(12-13wks-CRL 8- 9cm) and 4 months (13-16wks-CRL 9-14cm) old fetuses (Fig.1) and (Figs. 1a & b) the sizes of the knee joints were small especially in 3 months old fetuses, However in these ages, a middle intra-articular broad septum was detected, separating the joint's cavity into medial and lateral halves, Two condylar joints were resulted between the medial and lateral condyles of the femur and the corresponding condyles of the tibia.

Another gliding joint was noticed in front between the patella and the patellar surface of the femur. The ligamentum patellae and quadriceps tendon were observed. (Fig.1).

In 5—months old fetuses,: (17 -20weeks) CRL 15-19cm the lateral surface of the lateral condyle of the femur was convex. Extension of the two condyles distally was nearly to the same extent. The inter-condylar fossa and the patellar fossa in the lower end of the femur were shallow (Fig. 2-a). The previously detected middle intra-articular septum was also observed in this age. It was broad and presented a medial foramen and a lateral depression or pit. (Fig. 2-b) The capsule of the joint was extensively thin especially at its lower part (Fig. 2-b) The inter condylar fossa in youg ages was wide short in length, shallow similar to inverted U and becoming deeper and narrower longer when seen in anterior view with full flexion position.

The upper surface of the tibia bearing an almost primitive thin medial and lateral menisci, as their horns were not defined. (Fig. 2-c)

II- Knee joint of 6-months old fetus: (21 -24weeks) CRL 20-23cm.

The size of the joint as a whole was increased as well as the joint s cavity than the previous ages (Fig. 1). The lateral surface of the lateral condyle of the femur was more flat (Fig. 3-a) than the previous age (Fig.2-a) However the distal extension of both condyles was nearly the same (Fig. 3-a). Distal to the patella the synovial membrane was folded into 3 folds in which some fat was accumulated to form a middle infra-patellar fold, and two lateral alar folds (Fig. 3-a).

The septum that separated the joints cavity was still broad in this age but modified than the previous age (Fig. 2-a) as its medial foremen became longer and an additional depression or pit was added to its lateral side. (Fig.3-b). Deeper inter-condylar fossa and thin capsule were also noted (Fig.3-b).

The menisci became more prominent and their horns were noticed. Transverse ligament appeared between the anterior horns of both menisci (Fig.3-c).

III-Knee joint of 7 months fetus: (25-28weeks) CRL 24-27cm

The size of the joint was increased and the joint features were more prominent in this age than the previous ages (Fig. I).

In this age, lateral surface of the lateral condyle was more flat than the previous age (Fig. 3-a), but downward extension of both condyles was the same. Prominent infra-patellar and alar folds were noticed (Fig. 4-a).

The middle intra-articular septum became narrower especially in its middle part (Fig. 4-b). The concavity of the patellar fossa became deeper but its edges were at same level (Fig. 4—b). The inter-condylar fossa was also deep. Beside the ligaments seen in the previous ages, the fibular and tibial collateral ligaments and the arcuate ligament also could be recognized (Fig. 4-b). The fibular ligament appeared as a cord-like thickening- of the lateral part of the capsule just anterior to the arcuate ligament (Fig. 4-b). The medial collateral ligament appeared as a band in the medial side of the capsule (Fig. 4-b).

The medial meniscus was larger than the lateral one. They were fixed anteriorly and posteriorly by fibrous tissue to the capsule (Fig. 4-c).

IV—Knee joint of 8 months old fetus: (29-32 weeks) CRL 28-30cm) -

A notable increase in the joint's size and cavity were noticed in this age than he previous age (Fig.1).

The distal end of the femur showed a more laterally compressed lateral surface of the lateral condyle and a larger medial condyle. The latter bulged slightly downward more than the lateral one, (Fig. 5-a) More fat deposition was noted in the prominent infra-patellar and alar folds (Fig. 5-a).

Two small cord-like bands became slightly differentiated from the middle part of the intra-articular septum which became narrow In addition three tiny small thickenings were seen in the septum. (Fig.5-b). The patellar and inter-condylar fossae became more deeper. The ligament which had appeared before became well developed, besides the newly observed coronary ligament in the lateral side of the capsule (Fig.5-b).

The menisci became well-developed. The medial mieniscus was larger than the lateral one. Its open curve enclosed inside its concavity the curve of the lateral meniscus (Fig. 5-c).

Morphological examination of the Articular Capsule (*capsula articularis; capsular ligament*) (Figs 1 & 2-6 a & b).

Morphological examination of the articular Capsule of the developing knee joint at the age 5-8 months old fetuses (17 -20weeks) CRL 15-19cm.-: (29-32 weeks) CRL 28-30cm) fetus showed that it was thin membrane which was strengthened in almost its entire extent by bands inseparably connected with it. Above and in front, beneath the tendon of the Quadriceps femoris, it is represented only by the synovial membrane. Its chief strengthening bands are derived from the fascia lata and from the tendons surrounding the joint. In front, expansions from the Vasti and from the fascia lata and its iliotibial band fill in the intervals between the anterior and primitive collateral ligaments, constituting the medial and lateral patellar retinacula. Behind the capsule consisted of vertical fibers which arose from the condyles and from the sides of the intercondyloid fossa of the femur; the posterior part of the capsule was therefore situated on the sides of and in front of the intra articular septum (cruciate ligaments premordium), which were thus excluded from the joint cavity. Behind the intra articular septum (cruciate ligaments premordium), was the oblique popliteal ligament which was augmented by fibers derived from the tendon of the Semimembranosus. Laterally, a prolongation from the iliotibial band filled in the interval between the oblique popliteal and the fibular collateral ligaments, and partly covered the latter. Medially, expansions from the Sartorius and Semimembranosus passed upward to the tibial collateral ligament and strengthened the capsule.

V -Knee joint of human full-term: (33-36 weeks) CRL 31-34cm) and newborn infant (37-38 weeks) CRL 35-36cm) figs.1, (figs 6. a & b) and - figs.6- A & B -

In this age, the size of the joint was greatly increased. Its cavity also had increased and became a single cavity contained intra-articular structures (cruciate and menisco-femoral ligaments) and continued inferiorly through the patellar surface of the femur (Fig.1).

The lateral surface of the lateral condyle was completely flat and compressed. The medial condyle was large. convex and bulging downwards. The inter-condyler fossa was deep. Prominent infra-patellar and alar folds were well observed (Figs.6. a & b).

The intra-articular septum was extremely narrow in its middle part. Two cruciate (anterior and posterior) and menisco-femoral ligaments were completely differentiated from this septum, at this age. (Fig. 6-b).

The capsule was reinforced by ligaments, mainly the tibial and fibular collateral ligaments (Fig. 6-b). The anterior cruciate ligament was attached to the anterior inter-condylar area of the tibia and passed upward. backward, and laterally. to be attached to the posterior part of the medial surface of the lateral femoral condyle (Fig. 6 -b) The posterior cruciate ligament was attached to the posterior inter-condylar area of the tibia and passed upward, forward, and medial to be attached to the anterior part of the lateral surface of the medial femoral condyle. (Fig. 6 - b). The menisco-femoral ligament was attached above to the posterior surface of the lateral condyle of the femur. The patellar fossa became more deeper with slight projection of its lateral edge (Fig. 6-b). The definite capsular attachment was observed. The menisci were similar to previous ages.

The menisci full term and newborn infant (Figs.6- b & A & B The menisci increased in size in this age and were cresentic, intracapsular, fibrocartilage laminae. They deepened, and widened tibial articular surfaces and prepared them to received the femoral condyles. Their peripheral attached borders in this age were more thick and covex than the previous ages, and their free inner borders were more thin and concave. The proximal surface was smooth and concave, and in contact with the articular cartilage on the femoral condyles. The distal surfaces were smooth and flat, resting on the tibial articular, cartilage. Each covered approximately two third of its tibial articular surface.

The medial meniscus (Figs.6- A & B) increased in size than the previous ages and was almost a semicircle in shape broader posteriorly. It was attached by its anterior horn to the anterior tibial intercondyler area in front of the anterior cruciate ligament; the posterior fibers of the anterior horn were continuous with the transverse ligament of the knee. (when present). The anterior horn was medial to the upper part of the patellar ligament. The poterior horn was fixed to the posterior tibial intercondyler area, between attachment of the lateral meniscus and posterior cruciate ligament. Its peripheral border was attached to the fibrous capsule and the deep surface of the tibial collateral ligament the lateral meniscus (Figs.6- A & B) formed approximately four- faith of a circle and covered a large area than the medial meniscus. Its breadths was apparently uniform except its short tapering horns. Its anterior horn was attached to n front of the intercondyler eminence, posterolateral to the anterior cruciate ligament. Its posterior horn was attached behind that eminence in front of the posterior horn of the medial meniscus. Its anterior attachment was contored so that the free margin faced postersuperiorly and the anterior horn rested on the anterior slope of the latertal intercondyler tubercle. Near its posterior attachment a posterior meniscofemoral ligament asended superiorly toattach to the femoral condyle (Fig. 6-b & A & B).

the outer edges of the menisci were thicker more elevated and their inner edges were thinner than previous ages, to form concave upper surface to deepen the articular surface of the tibia preparing it to receive femoral condyles. The lateral meniscal upper er surface concavity was more than the medial meniscus.

Tibiofemoral congruence was improved by the menisci which were shaped to produce concavity of the surfaces presented to the femur; the combined lateral tibiomeniscal surface was deeper. (Figs.6-b & A-B)

Morphology of the Capsule and retinacula of full term human term: (33-36 weeks) CRL 31-34cm) (Figs.1,6-a & b) and newborn infant (37-38 weeks) CRL 35-36cm) (figs A & B).

Morphological examination of the capsule of full term human infant (Figs. 1,6-a & b and figs. A & B) showed that Capsule (Fig. A) membrane was of variable thickness. Anteriorly it was replaced by the Patellar tendon and does not pass proximal to the patellar area. Else were it lied deep to expansion from vasti medialis and lateralis separated from them by a plane of vascularized loose connective tissue. The expansion were attached to the Patellar margins and patellar tendon, extending back to corresponding collateral ligaments and distally to tibial condyles. They formed medial and lateral patellar retinacula., the lateral being reinforced by the iliotibial tract. Posteriorly the Capsule contained vertical fibers that aroused from the articular margin s of the femoral condyles and inter condyler notch and from the proximal tibia. The fibers mainly passed downwards and somewhat medially. The oblique popleteal ligament was well defined thickness across the posteromedial aspect of the capsule, and was essentially an extension from the tendon of insertion of semimembranosus.

Morphological examination of the synovial membrane at the age 5-8 months old fetuses: (17 -20 weeks) CRL 15-19cm.-: (29-32 weeks) CRL 28-30cm) fetus (Figs. 1 & 2-6 a & b): showed that various forms of membranous extensions of the synovial membrane were noted. At the age of 5months (Figs.2 a & b), two cord like structures in the infra patellar area were seen. At the age of 6.7 and 8 months (Figs. 4 & 5 a). A synovial reflections on the medial and lateral femoral condyles (Figs. 3,4 & 5 b) were seen.

VI- Adult Knee Joint

Comparing the adult knee joint to those of the previous ages and stressing on the full term joint, it was found that their structures were almost completely similar but in adult they had greatly increased in size. However the postmatal development resulted in more development of these structures, as the lower end of the medial condyle of the femur became narrower, longer and more curved than the lateral condyle. So, asymmetry of the condyles were more evident in adult than developing knees (Figs. 7-a, b). A faint groove on the anterior surface of each femoral condyles that were not noted in the previous fetal ages. (Fig. 7-b)

The patellar surface of the femur in adult had very prominent lateral edge. The menisci became thicker (Figs. 7 a, b).

The inter condylar fossa is deeper longer than the previous ages and was similar to inverted (V) when seen in anterior view fullflexed knee.

I —Histological Results:

A: The menisci:

Microscopic examination of longitudinal section (L. S). of a part of the meniscus of 5 months old fetus: (17 -20weeks) CRL 15-19cm stained with Mallory stain showed that the tissue of the meniscus was formed of cartilaginous and mesenchymal elements. The latter was peripherally placed in contact with the synovial membrane It was rich of blood vessels. Few large fibroblasts were seen in the mesenchymal tissue in contact with these vessels. While the cartilaginous tissue was placed centrally. It showed two different strata: (Fig. 8 -a): an outer deeply stained stratum with highly packed large chondroblasts and an inner lightly stained stratum with loosely packed small cartilage cells. (Figs.8 –a, b & c). The newly formed chondroblasts in the deeply stained stratum were flat or oval in shape placed close to the mesenchyme, but as they become well developed they moved internally and became rounded in shape with clear cytoplasm and red rounde nuclei. Some twins appearance between these cells could be seen. (Fig.8 –b). The chondrocytes in the inner loosely packed stratum were small rounded cells with clear cytoplasm, and red nuclei. Few very fine fibers were seen in this stratum between the cells (Fig.8 –c).

Microscopic examination of longitudinal section (L. S). of a part of the meniscus of of full term fetus: (33-36 weeks) CRL 31-34) cm and newborn infant (37-38 weeks) CRL 35-36) cm of knee joint stained with heamatoxylin and eosin showed that it did not have a unique structure, as it was formed of fibrocartilage tissue which consisted of large amount of chondrocytes encircled by a large amount of thin collagen bundles of arranged in different directions. (Fig. 9 -a). In sections stained with Masson trichrome stain this tissue was formed of large amount of chondrocytes scattered between collagen bundles. Some of these bundles were closely packed, wavy, and branched. (Fig. 9 -b).

Microscopic examination of longitudinal section (L. S). of a part of the meniscus of adult knee joint stained with haematoxylin and eosin showed that they were formed of fibrocartrilage tissue. It contained few large oval chondrocytes with oval nuclei and clear cytoplasm, scattered widely in –between excessive amount of thick, highly packed and branched collagen bundles. These bundles were arranged in different directions either in parallel, radial, or circumferential manner (Figs.10a & b).

B-Cruciate Ligaments:

1- Microscopic examination of longitudinal section (L.S). of a part of the primordium of the cruciate ligament (the intra-articular septum) of 5-month old foetuses: (17 -20weeks) CRL 15-19cm stained with Masson trichrome stain revealed that it was formed of few, small fibroblasts dispersed in between thin, short collagen bundles, Most of these bundles were straight and loosely packed, (Fig. 11-a).

11- Microscopic examination of longitudinal section (L. S). of a part of the anterior cruciate ligament of full term fetus: (33-36 weeks) CRL 31-34) cm and newborn infant (37-38 weeks) CRL 35-36) cm: stained with Masson trichrome stain showed that it was formed of few. large spindle-shaped fibroblasts sandwiched in between different sized long collagen bundles. Most of these bundles were long, wavy, and loosely packed. (Fig.11-b).

111- Microscopic examination of longitudinal section (L. S). of a part of the anterior cruciate ligament of adult knee joint stained with heamatoxylin and eosin and Masson trichrome stain showed that it was formed of few, large, spindle shaped fibroblasts with flat or oval nuclei arranged in a linear manner, intermingled with massive amount of thick, very long and highly packed collagen bundles. These bundles were wavy and run parallel. Some of them branched with each other (Figs.11-c & d).

C-The Capsule

Histological examination of the c apsule of 4 months fetus (Figs 1 & 1-b): Histological examination of part of LS of serial sections of part of the posterior capsule of 4 months fetus stained by Van Gieson stain showed that the capsule was formed of interlacing wavy collagen bundles. Free thin fibers were seen. The collagen bundles were of different length, size and directions. The fibres sometimes gathered to form bundles of collagen, which frequently branched and united with other fibres.

Histological examination of the capsule of full term human infant (Figs. 12 b & c).

Histological examination part of LS of serial sections of the capsule of full term human infant stained by Van Gin stain (Fig.12 -b) showed that the capsule was formed of wavy parallel more dense and longer thicker collagen bundles than the previous age. Some bundles branched. Numerous blood vessels were seen at the peripheral part.

Histological examination part of LS of serial sections of the capsule of full term human infant stained by Van Gin stain (Fig.12-c). anteriorly close to the patella (retinacula -ligamentum patelle?) showed that the capsule was formed of thin and thick collagen bundles oriented parallelly, Some bundles were vertical interlacing regularly arranged in different directions.

Histological examination of Synovial membrane D

Histological examination of Synovial membrane of 4 months fetus (Figs. 12-d & e)

Histological examination of serial sections of L.S of part of the Synovial membrane of 4 months fetus stained with heamatoxylin and eosin **(Figs. 12-d & e)** showed that the synovial membrane was formed of discontinuous intimal layer and was formed of synoviocytes with different size and shape. The synoviocytes were arranged in 2-5 cell layers. The subintimal layer was full of fibroblasts and fine collagen fibers present in ground substance. There was no basement membrane between the intimal and subintimal layer. Some villi were formed from the synoviocytes were seen. Synovial intima consisted of pleomorphic synoviocytes embeded in a granular amorphous, few fibres and numerous cellular matrix. Villi were seen with considerable regional variation in synoviocyte morphology and numbers which appeared to be dependent on the underlying subintimal tissue. The synoviocyte layer was 2-5 in number. The synoviocyte layer was not separated from the subintima by a basement membrane. Some synoviocytes were flattened others were elliptical.

Histological examination of Synovial membrane of (Figs. 12-f).

Histological examination of serial sections stained with Heamatoxylin & Eosin of L.S of part of the Synovial membrane of full term human infant showed that the synovial intima consisted of polymorphic synoviocytes embeded in a granular amorphous, with few fibres in intercellular matrix. There was considerable regional variation in synoviocyte morphology and numbers, which appeared to be dependent on the underlying subintimal tissue. Synoviocyte were arranged in 2-3 layers. The synoviocyte layer was not separated from the subintima by a basement membrane. Some synoviocytes were flattened others were elliptical. The subintimal layer was formed of less areolar tissue and was less vascular than the previous age. Interlacing collagen bundles were seen as well as free fibres.

Discussion:

Development of the fetus:

In the present work fetal ages were calculated by months and weeks after measuring the CRL. according to **Sadler, 2012**. The month calculation was proposed and was not cited in Sadler, 2012. However the age calculation on the present work agreed with **Streeter (1920) and Langman (1975)**.

In the present work, in 3-5 months old fetuses (12-13wks-CRL 8- 9cm) to full-term: (33-36 weeks) CRL 31-34cm), an intra-articular septum was noted in the middle of knee joint's cavity dividing it into two parts, medial and lateral. Differentiation of that septum was noted at the age of 5 monthes< That agreed with **Sadler, 2012.**

Sadler, 2012. mentioned that in development of the fetus the period from the beginning of the ninth week to birth was known as the fetal period. It was charachterised by maturation of tissues and organs and rapid growth of the body. The length of the fetus was usually indicated in the crown –rump length (CRL) (sitting height) or as the crown –heel length (CHL), the measurement from the vertex of the skull to the heel (standing height). These measurement, expressed in centimeters, were correlated with the age of the fetus in weeks or months. Growth in length was particularly striking during the third, fourth, and fifth month, while an increase in weight was most striking during the last two months of gestation. In general, the length of pregnancy was considered to the 280days, or 40weeks after the onset of the last normal menstrual [period (LNMP) or, more accurately,266 days or 38 weeks after fertilization. He added that at the beginning of the third month, the head constituted approximately half of the (CRL). By 6.5 to 7 months, the fetus had a CRL of about 25 cm and weights approximately 1.1 gm.

In the present work, in 3-5 months old fetuses (12-13wks-CRL 8- 9cm) to full-term: (33-36 weeks) CRL 31-34cm), an intra-articular septum was noted in the middle of knee joint's cavity dividing it into two parts, medial and lateral. That result was in agreement with **Gander and Orahilly (1968) and Williams *et al.*, (1989)** who mentioned that in joint containing discs or menisci and in compound articulation, more than the one cavity might appear initially. Sometimes merging later into complex one. This result was also recorded by **Doskoil (1984)**. who studied the human knee joint during the period in which the joint gap developed. He found that the knee joint contained a high broad septum which he called (The mediastinum genus) in which there were many blood vessels. Those vessels fed the cruciate ligaments analogs, the meniscus analogs, the cartilaginous and the adjacent bone analogs. In the human embryo the mediastinum genus had splitted the knee joint into a lateral and a medial halves. Communication between these two halves was between the small contact surface of the patella and femur analogs. However, further differentiation of that mediastinum genus had not reported sufficiently in the literature.

In the present work, in the developing human knee in 5 months old fetuses: (17 -20weeks) CRL 15-19cm, it was found that the intra articular septum had a depression or pit in its lateral side and a foramen in its medial side. Later on, in 6-mouths old fetuses: (21 -24weeks) CRL 20-23cm, an additional pit was added to the lateral side of the septum, while the medial foramen became larger. Small tiny cord like thickening developed in that septum. In 7-months old fetuses,: (25-28weeks) CRL 24-27cm, the middle part of the septum became narrow, In 8-months old fetuses: (29-32 weeks) CRL 28-30cm), two small bands were differentiated downward from the middle part of the septum in addition to two smaller shorter tiny thickening above those bands. In human full-term: (33-36 weeks) CRL 31-34cm) and newborn infant (37-38 weeks) CRL 35-36cm), morphogenesis of the septum was nearly completed by differentiating and merging of the menisco-femoral ligament and the anterior as well as posterior cruciate ligaments from that septum. In human adult knee, the menisco-femoral ligament and the anterior and posterior cruciate ligaments were thick taut bands seen attached to the lower end of femur and upper surface of tibia.

The results of the present work in 8-months old fetuses: (29-32 weeks) CRL 28-30cm), two small bands were differentiated from the middle part of the septum in addition to two smaller shorter tiny thickening above the bands, these thickenings might establishing for be the developing of different functional bands of the cruciate ligaments that were described in adult knee by Standring *et al.,*2016.

Standring *et al.,* 2016 mentioned that the anterior crutiate ligament was attached to the anterior intercondyler area of the tibia just anterior and slightly lateral to the medial intercondyler tubercle, partly blending posterolaterally, twisting on itself and fanning out to attach high on the posteromedial aspect of the lateral condyle (**Girgis *et al.,* 1975**) The average length and width of an adult anterior crutiate ligaments were 38mm and 11mm, respectively. It was formed of two or possibly three functional bands that were not apparent to the naked eye but could be demonstrated by microdessection techniques, The bundles were named antero medial, intermediate and posterolateral, according to their tibial attachment. (**Amis and Dawkins, 1991**)

The posterior crutiate ligament was thicker and stronger than the anterior crutiate ligament. The average length and width of an adult posterior crutiate ligaments were 38mmand 13mm, respectively. It was attached to the lateral surface of the medial femoral condyle and extended up on to the anterior part of the root of the intercondylar fossa, where its attachment was extensive in the anteroposterior direction, Its fibers were adjacent to the articular surface. They passed distally and posteriorly to a fairly compact attachment posteriorly in the intercondylar region and in a depression on the adjacent posterior tibia, That gave a fan like structure in which fibre orientation was variable,. Anterolateral and posteromedial bundles had been defined; they were named (against convention) according to their femoral attachment. The anterolateral bundle tightens in flexion while the posteromedial bundle was tight in extention of the knee. Each bundles slackens as the other tightens. Unlike the anterior crutiate ligament, it was not isometric during knee motion, i.e the distance between attachment varied with knee position. The posterior crutiate ligament ruptured less commonly than the anterior crutiate ligament and rupture was usually better tolerated by patients than rupture of the anterior crutiate ligament.

These results were in agreement with **Fredich *et al.* (1992)** who studied the functional anatomy of the knee joint of 130 fresh frozen adult cadavers, They found evidence to support the two-bundle and three bundle theories of cruciate ligament fibre patterns. **Dodds and Arnoczky (1994)** stated that anterior cruciate ligament was a complex, structure whose orientation, construction, and biology were related to its function as a constraint of knee motion, while the complexity of its design allowed the ligament to function through the normal range of movement as a static stabilizer of the knee, it also made the exact duplication of that structure very difficult in surgical treatment.

The results of the present work describing adult knee joint results agreed with **Standring *et al.*, 2016** who mentioned that the crutiate ligaments so named because they crossed each other, were very strong richly innervated intracapsular structures, The point of crossing was located a little posterior to the articular centre. They were named anterior and posterior with reference to their tibial attachments. synovial membrane almost surrounded the ligaments but was reflected posteriorly from posterior cruciate ligament to adjoining parts of the capsule; the intercondyler part of the posterior region of the fibrous capsules therefore had no synovial covering.

Some other ligaments could be traced in this work, The ligamentum patellae had been found early in 3 months old fetuses (12-13wks-CRL 8- 9cm). The transverse ligament appeared in 6 months old fetuses: (21 -24weeks) CRL 20-23cm, when the horns of the menisci had developed. It connected the two anterior horns. The tibial and fibular collateral ligaments and the arcuate ligament were observed in 7-months old fetuses: (25-28weeks) CRL 24-27cm. In 8- months old fetuses: (29-32 weeks) CRL 28-30cm)., the coronary ligaments was recognized. In full-term fetuses: (33-36 weeks) CRL 31-34cm) and newborn infant (37-38 weeks) CRL 35-36cm), the capsule was well-developed and thickened and strengthened by ligaments, and its definite attachment was observed.

The results of the present work coincided with **Putz *et al.*, 2007** mentioned that the ligaments of the knee could be divided into four groups. Ventral reinforcements were the patellar retinaculae. The posteromedial complex stabilizes the valgus stress. It consisted of the medial collateral ligament, the thickened posteromedial capsule and a branch of the tendon of the semimembranosus muscle as well as the oblique popliteal ligament. On the lateral side the posterolateral complex protected the knee against varus stress. Here the lateral collateral ligament, the tendon of the popliteus muscle and the so-called popliteofibular fibres work together. The cruciate ligaments controlled the contact between femoral condyles and tibial plateau during flexion-extension of the knee. They course between the two layers of the capsule, the membranous and the synovial layer.

Morphological examination of the articular Capsule of the developing knee joint at the age 5-8 months old fetuses (17 -20weeks) CRL 15-19cm.-: (29-32 weeks) CRL 28-30cm) fetus showed that it was thin membrane increased in thickening and reinforcement with age progress. The capsule was strengthened in almost its entire extent by bands inseparably connected with it. Above and in front, beneath the tendon of the Quadriceps femoris, it is represented only by the synovial membrane. Its chief strengthening bands are derived from the fascia lata and from the tendons surrounding the joint. In front, expansions from the Vasti and from the fascia lata and its iliotibial band fill in the intervals between the anterior and primitive collateral ligaments, constituting the medial and lateral patellar retinacula. Behind the capsule consistsed of vertical fibers which arose from the condyles and from the sides of the intercondyloid fossa of the femur; the posterior part of the capsule was therefore situated on the sides of and in front of the intra articular septum (cruciate ligaments premordium), which were thus excluded from the joint cavity. Behind the intra articular septum (cruciate ligaments premordium) at the ages5-8 months old fetuses (17 -20weeks) CRL 15-19cm.-: (29-32 weeks) CRL 28-30cm), was the oblique popliteal ligament which was augmented by fibers derived from the tendon of the Semimembranosus. Laterally, a prolongation from the iliotibial band filled in the interval between the oblique popliteal and the fibular collateral ligaments, and partly covered the latter. Medially, expansions from the Sartorius and Semimembranosus passed upward to the tibial collateral ligament and strengthened the capsule.

The ligamentum patellæs (anterior ligament) at the age 5-8 months old fetuses): was the central portion of the common tendon of the Quadriceps femoris, which was continued from the patella to the tuberosity of the tibia. It was a strong, flat, ligamentous band, increased. in length with age progress,

Morphological examination of the synovial membrane at the age 5-8 months old fetuses): showed that various forms of membranous extensions of the synovial membrane were noted. At the age of 5months two cord like structures in the infra patellar area were seen. At the age of 6.7 and 8 months. A synovial reflections on the medial and lateral femoral condyles were seen.

The results of the present study agreed with **Schindler, 2014** who studied morphology, pathophysiology and treatment of synovial plicae of the knee. The worker aimed to comprise current knowledge on morphology, embryology and pathophysiology of synovial plicae as well as on clinical and therapeutic aspects of the plica syndrome.

The worker review the literature combined with a meta-analysis of studies assessing the outcome of open or arthroscopic plica excision including the author's own series. The investigator mentioned that the term synovial plica had been devised to describe a number of intra-capsular folds thought to represent remnants of a membranous knee joint partition present during foetal development. Although four such folds had been defined, it was mainly the medial patellar plica which was implicated in carrying clinical significance as a potential cause of anteromedial knee pain particularly in adolescents. Blunt trauma, a sudden increase in athletic activity or any form of transient synovitis were associated with plica inflammation leading to tissue fibrosis and subsequent loss of elasticity. A plica affected in this way might impinge against intra-articular structures in its proximity, often creating localised chondromalacia particularly of the patello-femoral joint. The diagnosis was based on history and clinical examination although MRI could be of value. Twenty-three studies assessing the clinical out-come of 969 patients following open or arthroscopic plica excision were identified. The average age was 25 years with equal male-to-female ratio. Trauma was considered the cause in 57 %. At a mean follow-up of 27.5 months, 64 % of patients were symptom free, 26 % improved and 10 % considered failures. The auther added that Symptomatic plicae might initially be treated with physiotherapeutic measures and structured exercise regimes but success rates are generally low. Intra-plical or intra-articular corticosteroid injections might be beneficial if administered early in the disease process. Arthroscopic excision of the entire plical fold became indicated in recalcitrant cases and once a plica had undergone irrevocable morphological changes. The procedure carried low morbidity, and results were universally good especially if the plica was the sole pathology. Factors associated with a favourable outcome were young patient age, localised symptoms of short duration and absence of plica induced chondromalacia.

The capsule of full term infant was formed of collagen fibres arranged parallelly. They were longer, thicker and more inter lacing than the previous age.

Light microscopic examination using suitable stains showed that the synovial membrane of4 months fetus was formed of a intimal synovial layer of squamous or cuboidal cells arranged in 2-5 layers. The synovial cell layer was discontinuous and separated from each other by a small amount of connective tissue. Underneath these cells was a layer of loose or dense connective tissue full of undifferentiated cells and ground substance. There was no basemembrane separating the initial cells from the sub intimal tissue. The synovial membrane formed villi of different size. The synovial membrane of full term infant was formed of synoviocytes forming a discontinuous pleomorphic cell layer. The cells were arranged in 2-3 layers. The cells formed longer villi thinner than the previous age. The sub intimal tissue was full of denser, longer, thicker collagen fibres, with less cellular and vascular appearance.

It was concluded that age associated changes in the developing pre - natal human capsule was accompanied with increased collagen thickness and more parallel arrangement. and synovial membrane changes included decrease cellularity and vascularity, meanwhile increased collagen fibers.

That was in agreement with **Standring *et al.* (2013**) 6 mentioned that the Synovial membrane of the Knee was the most extensive and complex in the body. It formed a large supera patellar bursa between quadriceps femoris and the lower femoral shaft proximal to the superior patellar border The folds converge posterioly to form infrapatellar fold (ligamentum mucosum), which curved posteriorly to its attachment in the femoral inter condyler fossa. Distal to the Patella the Synovial membrane is separated from the patellar tendon by an infra patellar fat pad. Where it lied beneath the fat pad the memdrane projected in the joint as fingers, alar folds, which beared villi. The folds converge posterioly to form infrapatellar fold (ligamentum mucosum), which curved posteriorly to its attachment in the femoral inter condyler fossa. **Standring *et al.*, 2013**, mentioned that the fold might be a vestige of inferior boundry of an originally separate femoropatellar joint. The extent of the infra patellar plica ranged from a thin cord to complete sheet. When sustained it had been mistaken for the anterior cruciate ligament, which was directly posterior to it. The supra patellar plicae were remnant of an embryonic septum that completely separated the suprapatellar pouch from the knee joint. Occasionally a septum persists, rather in its entirety or perforated by a small peripheral opening.

The results of the present work agreed with **Standring *et al.*, 2016** who mentioned that recent advances in imaging and surgery of knee ligaments had contributed to an improved understanding of the anatomy of the medial and lateral soft tissues of the Knee. Medial soft tissues: were arranged in three layers (**Warren and Marshall, 1979**). Layer 1 was the most superficial and was deep fascia that invested sartorious. The saphenous nerve and its infrapatellar branch were superficial to deep fascia of the leg. Posteriorly, layer 1 overlied the tendons of gastrocnemius and the structures of popliteal fossa. Anteriorly, layer 1 blended with the anterior limit of layer 2 and the medial patellar retinaculum. More inferiorly, layer 1 blended with the periosteum. A condensation of tissue passed from the medial border of the patella to the medial epicondyle of the femur (the medial patellofemoral ligament).

Layer 2 was the plane of the superficial part of the tibial collateral ligament, which meant that the tendons of gracilis and semi tendinosus lied between layers 1 and 2. The superficial part of the tibial collateral ligament had vertical and oblique portions.

Layers 3 was the capsule of the Knee Joint and could be separated from layer 2 to the every where except anteriorly close to the patella, where it blended with the more superficial layers. Deep to the superficial tibial collateral ligament. It was thick and had vertically oriented fibres that made up the deep medial part of the tibial collateral ligament. It sent fibres to the medial meniscus. Anteriorly, the separation of the superficial and deep parts of the tibial collateral ligament was distint. Posteriorly, layers 2 and 3 blended to form a conjoint postero-medial capsule.

The lateral soft tissues: were also arranged in three layers (**Seebacher *et al.*, 1982**) which collectively had been referred to as the lateral collateral ligamentous complex (**Nissan *et al.*, 2008**). The most superficial layer was the lateral patellar retinaculum. The middle layer consisted of the fibular collateral popliteofibular, fabellofibular and arcuate ligaments. The recenty described anterolateral ligament of the knee might exist in that layer (**Claes *et al.,* 2013**). The deep layer was the lateral part of the capsule.

In the preset study the lateral surface of the lateral condyle of the femur was convex early until the 6month, when it started to be compressed laterally. This compression was increased with progress of age and in 8-months old fetuses (29-32 weeks) CRL 28-30cm). this surface become nearly flat. Before this age the downwards extension of both condyle was the same, but in this month the medial condyle started to protrude dowards more than the lateral one. Comparing with adult one which showed evident protrusion of the medial condyle, it showed also complete asymmetry of both condyles. The lower end of the medial condyle became more narrower and convex. The intercondylar fossa in 3 -5 months (12-13wks-CRL 8- 9cm)-: (17 -20weeks) CRL 15-19cm old fetuses was shallow then it had increased in depth with progress of age.

In the preset study asymmetry of developing femoral condyles was noted; in addition to increased size changes, presence of faint groove on the anterior surface of each femoral condyles in adult knee were noted. Those faint groves differed in lenght and were not present in fetuses nor in full term human knee joint. Those faint groves might have a role in controlling, accommodating and fitting for the optimum articulation of the developed concave menisci in adults. That was to suit the functions of the joint movements, and to tolerate strain and compression.

In the present work the patellar surface of the femur was concave early in 3-months old fetuses (12-13wks-CRL 8- 9cm). It became also more deep with progress of age. In 7-months old fetuses: (25-28weeks) CRL 24-27cm, the lateral edge of the patellar concavity started to be elevated. In adult this edge became highly elevated. Early the synovial membrane sent inside the cavity of the knee joint a middle fold called the infra-patellar fold. It extended laterally to form two alar folds. In 3-5 months (12-13wks-CRL 8- 9cm)-: (17 -20weeks) CRL 15-19cm. old fetuses, theses folds were thin but with progressing of age, fat deposited inside them, resulting in increase of their size.

The results of the present work agreed with **Standring *et al.*, 2016** who pointed out that the femoral condyles, bearing articular cartilage were almost wholly convex. Opinion as to the contours of their sagittal profiles tended to vary. One view was that were spiral with a curvature increasing posteriorly (a closing helix), that of lateral condyle being greater. An alternative view was that articular surface for contact with the tibia on the medial femoral condyle described the arcs of two circles. According to that view the anterior arc made contact with the tibia near extension and was part of a virtual circle of larger radius than the near posterior arc, which made contact during flexion. The lateral femoral condyle was believed to describe a single arc thus to possess a single radius of curvature.

Tibiofemoral congruence was improved by the menisci which were shaped to produce concavity of the surfaces presented to the femur; the combined lateral tibiomeniscal surface was deeper. The lateral femoral condyle had a faint groove anteriorly, which rested on the peripheral edge of the lateral meniscus in full extension. A similar groove appeared on the medial condyle but did not reach its lateral border, where a narrow strip contacted the medial patellar articular surface in full flexion. Those grooves demarcated the femoral patellar and condylar surfaces. The differences between the shapes of the articular surfaces correlated with the movements of the knee joint.

That agreed with **Standring *et al.* (2016)** who mentioned that movements of the knee were described as flexion, extension, medial (internal), and lateral (external) rotation Flexion and extension differed from true hingeing, in that the articular surface profiles of the femoral and tibial articular surfaces or produced a variably placed axis of rotation during the flexion arc and when the foot was fixed, flexion entailed corresponding conjunct coupled) lateral rotation. These conjunct rotations were a product of the complex geometry of the articular surfaces, and to an extent the disposition of the associated ligaments. There was differential motion in the medial and lateral tibiofemeral compartments, Laterally there was considerable displacement of the femur on the tibia with the rolling as well as sliding at the joint surface, In contrast, medially for most of the flexion were there was minimal relative motion of the femur and tibia, and the motion almost exclusively involved one joint surface sliding on the other. In full flexion, the lateral femoral condyle was close to posterior sublaxation off the lateral tibial articular surface. Medially significant posterior femoral displacement only occurred when flexion exceeded 120 degrees. The menisci moved with the femoral condyles. the anterior horns more than the posterior, and the lateral menisci considerably more than the medial.

The axial rotation had a smaller range than the arc of the flexion and extension. These rotations were conjunct and integral with flexion and extension.i,e they were obligatory. They could be also adjunct and independent i.e voluntary, and were best demonstrated with the knee semi flexed. The degeree of axial rotation therefore varied with flexion and extension **Standring *et al.*, 2016** added that the range of extention was 5-10 degrees beyond the "straight position". Active flexion was approximately 120with the hip extended,140 degrees when the hip was flexed, and 160 when aided by passive element, e.g when sitting on the heels. Voluntary rotation is 60-70 but conjunct rotation only 20. Congunct medial rotation of the femur on the tibia in the later stage s of extension was part of locking mechanism, the so called screw – home movement, which was in assest when the fully extended knees were subjected to strain, Full extension resulted in the close-packed position, with maximal spiralization and tightening of the ligaments. The roles of the articular surfaces, musculature and ligaments in generating conjunct rotation remained controversial. (**Girgis *et al.*, 1975**, **Rajendran 1985)**

In the present work, the menisci were noticed in in 3-5 months old fetuses (12-13wks-CRL 8- 9cm)-(17 -20weeks) CRL 15-19cm. They were thin and their horns were not yet developed. In 6-months old fetuses: (21 -24weeks) CRL 20-23cm., the horns started to appear and their anterior ends became connected together by the transverse ligament. In 8-months old fetuses: (29-32 weeks) CRL 28-30cm) and human full-term: (33-36 weeks) CRL 31-34cm) and newborn infant (37-38 weeks) CRL 35-36cm) the medial meniscus was larger than the lateral one. It enclosed the two horns of the lateral meniscus inside its curve. They became attached to the capsule by fibrous tissue. the outer edges of the mensci were thick elevated and the inner edges were thin and the upper surfaces were concave to increase and deepen the upper articular tibial surface to fit with the articulating femoral condyles.

In the present work, the developing menisci of each age differed in shape and size: the medial meniscus was broader posteriorly and was almost a semicircle in shape, and lateral meniscus formed approximately four- fith of a circle and covered a large area than the medial meniscus. The upper surfaces of the developimg menisci at the fetal age of 5months were flat and increased in concavity with age progress, In full term, the concavity of the upper meniscal surfaces increased than previous ages and were sloping towards the inter condyler area. The meniscofemoral ligament were often the sole attachment of the posterior horn of the lateral meniscus.

That agreed with **Standring *et al.* (2016)** who mentioned that that the menisci (semi lunar cartilages) were cresentic, intracapsular, fibrocartilage laminaeb served widen deepened, and prepared the tibial articular surfaces that received the femoral condyles. Their peripheral attached borders were thick and convex, and their free inner borders were thin and concave Their peripheries were their vascularized by capillary loops from the fibrous capsule and synovial membrane, while their inner regions were less vascular. Tears of the menisci were common. Peripheral tears.g. in the vascularized zone had the potential to heal satisfactory, especially with surgical intervention. Tears in the less vascularized or inner zone seldom healed spontaneously, if surgery was indicated, those menisci were often resected. The meniscal horns were richly innervated copared with the remained er of the meniscus. The central one third was devoid of innervations (**Gronblad *et al.,* 1985**). The proximal surface was smooth and concave, and in contact with the articular cartilage on the femoral condyles. The distal surfaces were smooth and flat, resting on the tibial articular, cartilage. Each covered approximately two third of its tibial articular surface. Canal like structures opened on the surface of the menisci in infants and young children and might transport nutrients to deeper less vascular areas.

Standring *et al.,* 2016 added that medial meniscus was broader posteriorly and was almost a semicircle in shape. It was attached by its anterior horn to the anterior tibial intercondyler area in front of the anterior cruciate ligament; the posterior fibers of the anterior horn were continuous with the transverse ligament of the knee (when present). The anterior horn was in the floor of a depression medial to the upper part of the patellar ligament. The poterior horn was fixed to the posterior tibial intercondyler area, between attachment of the lateral meniscus and posterior cruciate ligament. Its peripheral border was attached to the fibrous capsule and the deep surface of the tibial collateral ligament. The tibial attachment of the meniscus was known as the coronary or the meniscotibial ligament. Collectivelly those attachments ensured that the medial meniscus was relatively fixed and moved much less than the lateral meniscus.

However **Standring *et al.,* 2016** pointed out that lateral meniscus formed approximately four- fith of a circle and covered a large area than the medial meniscus. Its breads except its short tapering horns was more or less uniform. It was grooved posteriorly by the tendon of popliteus, which separated it from the fibular collateral ligament. Its anterior horn was attached to in front of the intercondyler eminence, posterolateral to the anterior cruciate ligament Its posterior horn was attached behind that eminence in front of the posterior horn of the medial meniscus. Its anterior attachment was contored so that the free margin faced postersuperiorly and the anterior horn rested on the anterior slope of the *latertal* intercondyler tubercle. Near its posterior attachment it commonly sent a posterior meniscofemoral ligament superiorly behind the posterior cruciate ligament to the medial femoral condyle An anterior meniscofemoral ligament might also connect the posterior horn to the medial femoral condyle anterior to the posterior cruciate ligament. The meniscofemoral ligamen were often the sole attachment of the posterior horn of the lateral meniscus.

In the present work, microscopic examination of longitudinal section (L.S). of parts of the menisci of 5 months old fetuses (17 -20weeks) CRL 15-19cm revealed that they were formed mainly of cartilaginous tissue internally and mesenchymal tissue peripherally. The mesenchymal tissue contained blood vessels and few large fibroblasts which will form later the collagen fibres. The cartilaginous tissue appeared in two different strata: the outer one was deeply stained stratum and contained highly packed large chondroblasts. These cells were the stem cells that will produce chondrocytes which were forming the inner or next loosely packed layer, lightly stained inner. This layer contained also very fine few fibers. In full term fetus: (33-36 weeks) CRL 31-34) cm and newborn infant (37-38 weeks) CRL 35-36) cm knee joint, the menisci were formed of truly fibrocartilage tissue which consisted of large amount of chondrocytes intermingled with excess collagen fibres. Comparing to adult menisci, the collagen bundles were thick and highly packed and arranged in different directions encircling few large chondrocytes.

These results were in agreement with **Somer and Somer (1983), and Williams *et al.* (1989)** who mentioned that early in development, dense strata of interzonal mesenchyma became cartilaginous then later changed to fibrocartilage. It differed from other types of cartilaginous tissue in having type 1 collagen in its matrix. **Aspeden *et al.* (1985)** mentioned that x-ray diffraction showed that the collagen fibrils of dogs, pig, and human meniscus tended to be oriented circumferentially in bulk tissue and radially in the surface region. Individual fibrils were not all oriented in these directions. Polarized microscopy yielded result which was in consistent with x-ray diffraction. That technique showed that fibrils were aggregated into crimped fibres, resembling those of tendons and that some of these fibers passed from outer region of the meniscus into bulk tissue.

The results of the present work agreed with Standring ***et al.*, 2016** who mentioned that two different regions of the menisci had been identified. The inner two thirds of each meniscus consisted of radially organized collagen bundles, and the peripheral one third consisted of large circumferentially arranged bundles (**Ghadially *et al.*, 1983**). Thinner collagen bundles parallel to the surface of the articular surfaces of the inner part, while the outer portion was covered by synovium. That structural arrangement suggested specific biomechanical functions for the two regions, the inner portion of the meniscus was suited to resting compressive forces while the periphery was capable of resisting tentional forces. With ageing and degeneration, compositional changes occurred within the menisci, which reduced their ability to resist tensional forces. Out ward displacement of the menisci by the femoral condyles was resisred by firm anchoring of the peripheral circumferential fibers of the inter condyler bone of the meniscal horns. The menisci had spread load by increasing the congruity of the articulation, provided stability by their physical presence and proprioceptive feed back, and might cushioned the underlining bone from the considerable forces generated during extreme flexion and extension of the knee.

The results of the present work In microscopic examination of longitudinal section (L.S). of a part of the primordium of the cruciate ligament (the intra-articular septum) of 5- month old foetuses: (17 - 20weeks) CRL 15-19cm it was formed of few, small fibroblasts scattered in between thin, short fibers which were packed loosely in short parallel collagen bundles. In the anterior cruciate ligament of full term fetus: (33-36 weeks) CRL 31-34) cm and newborn infant (37-38 weeks) CRL 35-36) cm: the collagen bundles became longer and thicker, but still loosely packed, sandwiched between them in linear manner few fibroblasts. Comparing to adult anterior cruciate ligament, the collagen bundles formed became more thicher, longer. They were wavy, parallel and more regular. Few fibroblasts were arranged in linear manner between these collagen bundles.

The present work agreed with **Roberts et *al.*, 2007** who mentioned that The anterior and posterior cruciate ligaments were crucial stabilizers of the knee. These ligaments were named by the location of their tibial attachments. Each ligament was composed of separate functional bundles that differed in size but were equally important in function. MR imaging was accurate and sensitive, making it the imaging technique of choice for evaluating these ligaments. Acute and chronic injuries involving the cruciate ligaments had typical appearances and associated findings. MR imaging interpretation had taken into account atypical injuries and imaging pitfalls. They added that knowledge of normal ligament reconstruction techniques allowed differentiation of the normal postoperative appearance from reconstruction failure and complications. They reviewed ligament reconstruction techniques, complications, and appearances were in their article.

The results of the present work showed differentiation of the *Meniscofemoral ligaments* in full term and new born from the intra articular septum in the cavity of the knee joint

Standring S *et al.*, 2008 mentioned that the Meniscofemoral ligaments.

The two meniscofemoral ligaments (MFLs) connect the posterior horn of the lateral meniscus to the inner (lateral) aspect of' the medial femoral condyle (Figs 82.11, 82.12). The anterior MFL) a MFL (; ligament of HUMPHRY) passes anterior to the posterior cruciate ligament. The posterior meniscofemoral ligament l MFL (pMFL; ligament of Wrisberg) passes behind the posterior cruciate ligament and attaches proximal to the margin of attachment the posterior cruiate.

Anatomical studies found that at least one meniscofemoral ligament is present in in 92%~of Cadaveric knees examined, whilst both-coexisted 32% (**Gupte *et al.*, 2003**):-Biomecanical studies have revealed the 1igaments sectional area and strength of the meniscofemoral ligaments to comparable to those of the posterior fibre bundle of the posterior ligament.

The meniscofemoral ligaments are believed to act as secondary straints, supporting the_posterior cruciate ligament in minimizing displacement caused by posteriorly directed forces on the tibia. These ligaments are also involved- in controlling the motion of the lateral meniscus in conjuction with the tendon of popliteus during flexion.

Conclusion

Morphological study in this work, shows that the developing human knee joint began as two cavities medial and lateral ones, separated by a broad septum. This septum. with progressing of age became narrower due to increase in thc size of its medial foramen and the increase in the depth of pits in its lateral side. In full-term fetuses, this septum differentiated into two cruciate ligaments and the menisco-femoral ligament. The joints cavity changed to be a single one communicating across the patellar surface of the femur.

Histological examination in this work showed that the menisci of the knee joint were initially formed of cartilaginous tissue then transformed with age progress to fibrocartilaginous tissue due to deposition of the newly formed collagen fibers. The cruciate ligament were initially formed early (septum) of few fibroblasts and loosely packed short collagen bundles. Those bundles became more packed, longer, parallel, and wavy with age progress intermingled with linearly arranged few fibroblasts.

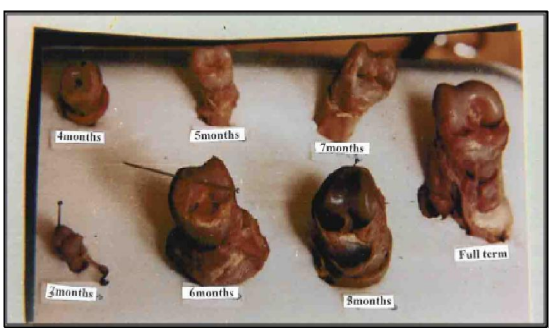

Fig. (1): A photograph of the developing knee joint of 3-9 months old fetuses from (12-13wks-CRL 8- 9cm) to full-term: (33-36 weeks) CRL 31-34cm), anterior aspect in full flexion position, showing besides the increase in the sizes of the knee joints with age progressing, the presence of a broad intra-articular septum was detected also specially in young ages. That septum became narrower in older ages. The quadriceps tendon in each joint is sectioned and the patellar flap retracted distally. Note that the inter condylar fossa in youg ages was wide shallow similar to inverted (U) and becoming deeper and narrower with age progress.

Fig. (1-a): Photograph of the knee joint of 3 months old fetus (12-13wks-CRL 8- 9cm) anterior aspect in full flexion position. A middle intra -articular broad septum is detected, separating the joint's cavity into medial and lateral halves, Two condylar joints were resulted between the medial and lateral condyles of the femur and the corresponding condyles of the tibia.

Fig. (1-b): Photograph of the anterior aspect in full flexion position of the knee joint of 4 months old fetus (13-16wks-CRL 9-14cm). The joint is small. A middle intra -articular broad septum is detected, separating the joint's cavity into medial and lateral parts, Two condylar joints were resulted between the medial and lateral condyles of the femur and the corresponding condyles of the tibia.

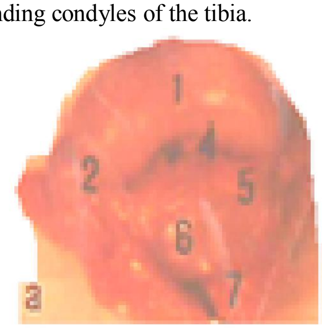

Fig. (2-a): A photograph of a left knee joint of 5 months old fetus: (17 -20weeks) CRL 15-19cm. anterior aspect in full flexion position showing convex lateral surface of the lateral condyle (10). The latter has the same level of downward extension as the medial condyle (9). Note the shallow inter-condylar fossa (4), the broad intra-articular septum (5), and small patella (6) attached to the quadriceps femoris tendon (7).

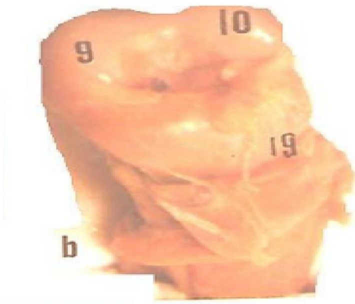

Fig. (2-b): A photograph of the same previous joint after further dissection showing the broad intra- articular septum (/) between the medial (9) andand lateral condyles (10). It shows large medial foramen and a lateral depression or pit. Notice the thin capsule (19). Note the two cord like structures thickening from the synovial membrane infra patellar.

Fig. (2-c): A photograph of the upper surface of the left tibia of the same joint showing the primitive lateral (14) and medial menisci (15). Note that the horns are not defined.

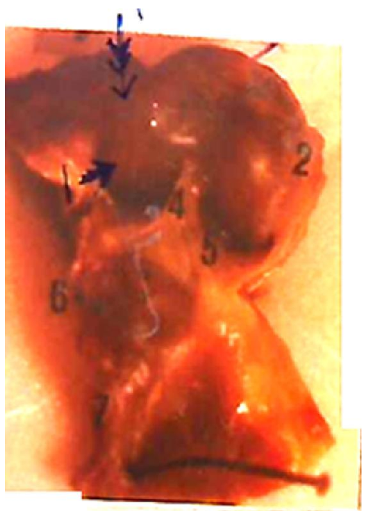

Fig. (3-a): A photograph of left knee of 6-months old fetus: (21 -24weeks) CRL 20-23cm anterior aspect in full flexion position showing that the medial condyle (10) is larger in size than the lateral condyle (9). The lateral surface of the lateral condyle is compressed laterally. Notice the prominent infra-patellar fold (4)and alar folds (5). Notice also the patella (6) is attached to the quadriceps tendon (7).

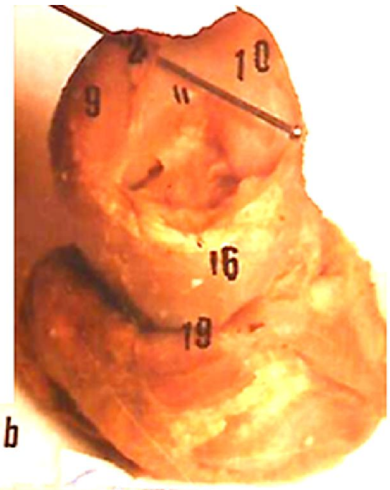

Fig. (3-b): A photograph of the left knee joint of 6 month old fetus: (21 -24weeks) CRL 20-23cm showing the thin capsule (2), and the large medial condyle (9), the compressed lateral surface of the lateral condyle (10) and the shallow inter -condylar fossa (11). Notice the broad intra-articular septum has two lateral pits and a medial large foramen. Notice also the transverse ligament (16) and the patella (19).

Fig. (3-c): A photograph of the upper surface of the tibia of the previous joint fig. (3-a) showing that the anterior horns of the medial (14) and lateral menisci (15) are well developed and connected with each other by the transverse ligament.

Fig. (4-a): A photograph of the right knee joint of 7-months old fetus: (25-28weeks) CRL 24-27cm anterior aspect in full flexion position. showing that the lateral surface of the lateral condyle of the femur (1) is more flat than the medial condyle (2). and the prominent infra-patellar fold (4). Note the reflection of synovial membrane on the femoral condyle.

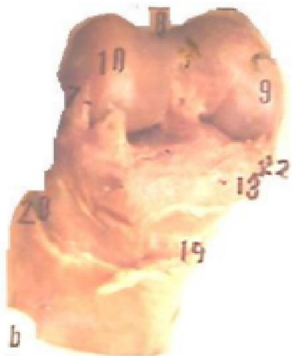

Fig. (4-b): A photograph of the right knee joint of 7-months old fetus: (25-28weeks) CRL 24-27cm. with further dissection showing a narrow intra-articular septum (/) and the downward extension of the medial condyle (9) appears at the same level of the lateral condyle (10) which becomes laterally flat. Notice the increase of concavity of the patellar fossa (8) and the appearance of fibular (20) and tibial (22) collateral ligaments. besides the previously appeared transverse ligament (13). Notice the ligamentum patellea (19).

Fig. (4-c): A photograph of the upper surface of the left tibia of the previous joint fig (4-a) showing the medial meniscus (4) is larger than the lateral meniscus (1 5).

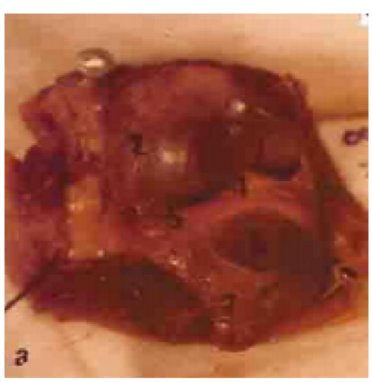

Fig. (5-a): A photograph of the left knee joint of 8 months old: (29-32 weeks) CRL 28-30cm) fetus anterior aspect in full flexion position showing the slight downward projection of the lower end of the medial condyle and reflection of the capsule on it (9) than the lateral condyle (l0) and the increase in the deposition of fat in the infra-patellar fold (4), and alar folds (5). Notice the patella (6) is attached to the quadriceps tendon (7).

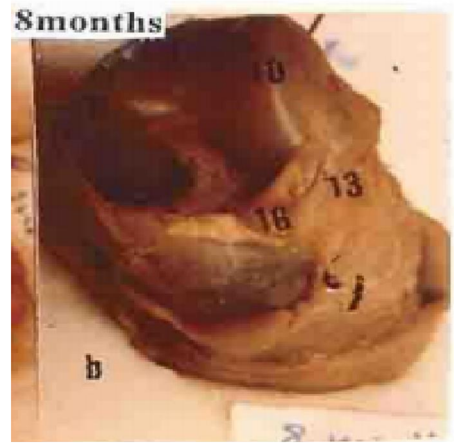

Fig. (5-b): A photograph of the same knee joint after further dissection to show the differentiation of two small bands from the middle part of the intra-articular septum which became narrower in size, Another small tiny three thickenings are seen appearing in the septum. Notice the increase in depth of the concavity of the patellar fossa (8), the downward projection of the medial condyle (9) than the lateral condyle (10), the coronary ligament (13) and the transverse ligament.

Fig. (5-c): A photograph of the upper surface of the left tibia of the same joint showing the well developed menisci, the medial one (14) is larger than the lateral meniscus and enclosed the latter into its curve.

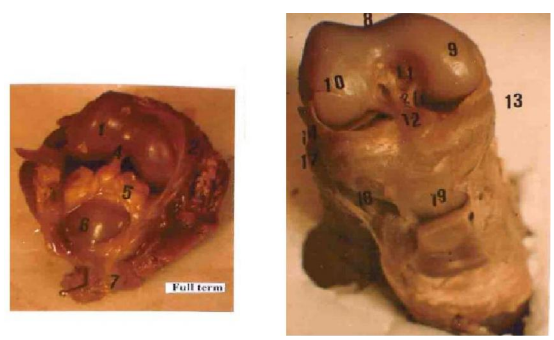

Fig. (6-a): A photograph of the right knee joint of human full term: (33-36 weeks) CRL 31-34cm) anterior aspect in full flexion position showing the lateral condyle (l0) projects less than the media condyle (9). Notice the presence of large amount of fat inside the infra patellar fold (4) and alar folds (5) and also the patella (6) is attached to quadriceps tendon (7).

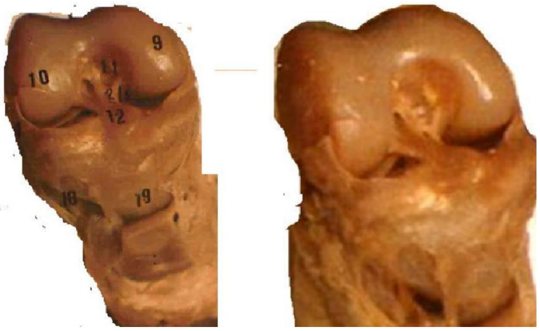

Fig. (6-b): A photograph of the same previous joint Fig. (6-a) after further dissection showing that the intra articular septum is between medial (9) and lateral condyle (10) and is differentiated into three bands, posterior (11) and anterior (12) cruciate ligaments and menisco femoral ligament (21). Notice the slight projection of lateral edge of the patellar fossa (8) and notice also the coronary ligament (13) the lateral meniscus (N), the fibular collateral ligament (17), and the well-developed capsule (18) as well as ligamentum patellae (19).

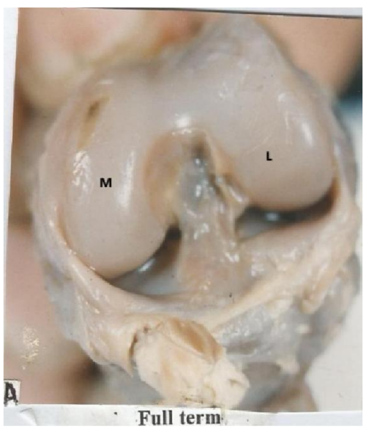

Fig. (6- A): A photograph of left knee of newborn infant (37-38 weeks) CRL 35-36cm), anterior aspect in full flexion position showing the medial condyle (M) and the lateral condyle (L) of the lower end of the femur and the more deep intercondyler fossa than the previous ages with intact diferentiated crutiate and menisco- femoral ligaments.

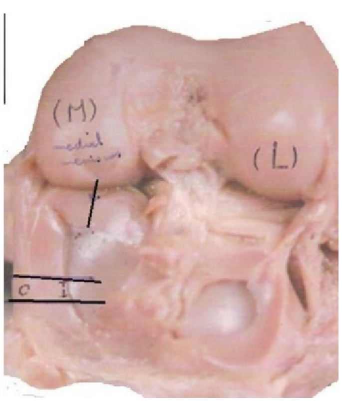

Fig. (6- B) A photograph of left knee of newborn infant (37-38 weeks) CRL 35-36cm) of the previous photo

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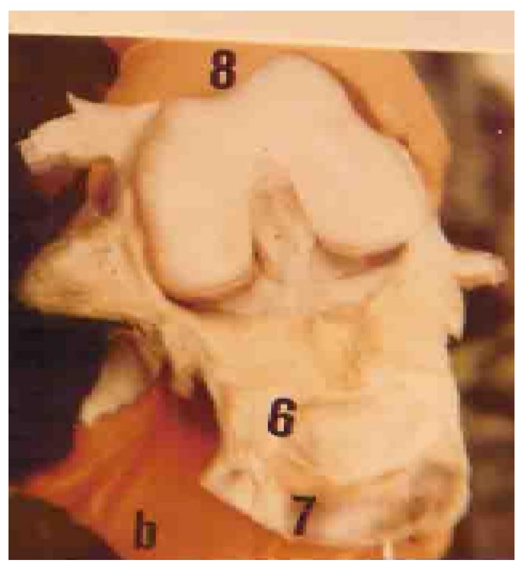


Fig. (7-b): A photograph of previous knee joint of Fig. (7-a) after further dissection showing the thick well developed lateral meniscus (3) and medial meniscus (4), the anterior cruciate (A) and posterior cruciate (5), the menisco femoral ligaments (M) and the patella (6) is attached to quadriceps tendon (7). Note the presence of faint grove on the anterior surface of femoral condyles that are not noted in the prevois fetal ages. Note that the inter condylar fossa is deep similar to inverted (V)

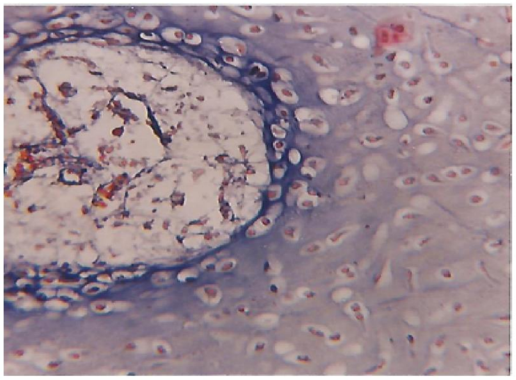


Fig. (8-a): A photomicrograph of L.S. of a part of the meniscus of of 5 months old: (17 -20weeks) CRL 15-19cm. showing peripheral mesenchymal tissue (M) containing blood vessels (v) and the next inner cartilaginous tissue is differentiated into two strata: an outer (O) deeply stained stratum and an inner lightly stained stratum (I) Mallory s stain x100**.**

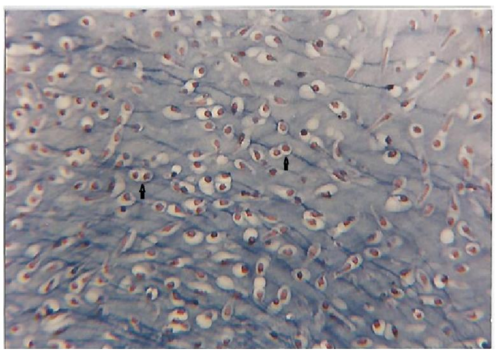


Fig. (8-b): A photomicrograph of L.S. of a part of the previous section Fig. (8-a): magnified to show an area of the mesenchymal tissue contained few fibroblasts (F) with red nuclei scattered in the embryonic connective tissue. It shows also part of the outer deeply stained stratum of the cartilaginous tissue which contain big number of chondroblasts (B) which appear flat peripherally (young) and rounded internally (more developed). Some times twin (/) appearance is observed. Mallory s stain x400.

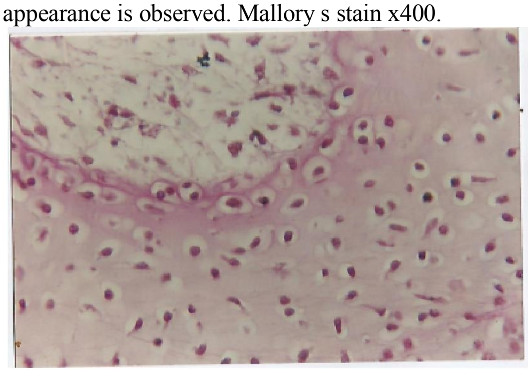


Fig. (8-c): A photomicrograph of L.S. of a part of the previous section Fig. (8-a): magnified to show the inner lightly stained stratum is formed of large amount of chondrocytes (C). They are small, round in shape with clear cytoplasm and red rounded nuclei. Some of them have twin appearance (/). Very few fine fibers (R) run parallel between the chondrocytes. Mallory s stain x400.

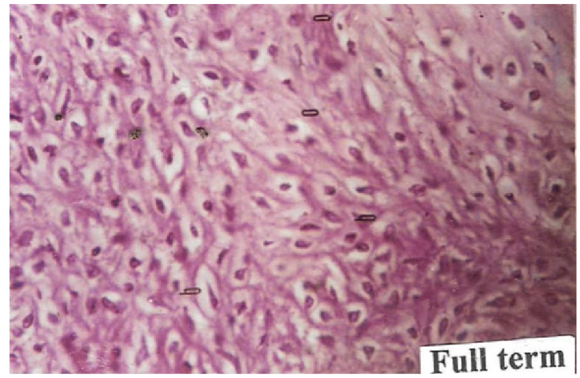
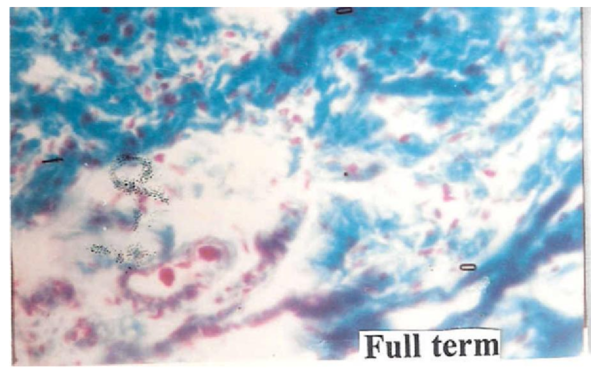


Fig. (9-a): A photomicrograph of L.S. of a part of the meniscus of the full term fetus: (33-36 weeks) CRL 31-34cm) showing lots of chondrocytes (C) intermingled with abundant collagen fibres (R). H x & E X 400.



(9-b): A photomicrograph of L.S. of a part of the meniscus of full tem fetus: (33-36 weeks) CRL 31-34cm) showing lot of chondrocytes (C) and large amount of collagen bundles (0). Some of these bundles are wavy and closely packed. Masson trichrome stain X 400.

Fig. (10-a): A photomicrograph of L.S. of a part of the meniscus of adult knee joint showing that it was formed of collagen bundles (o) running in different directions and in between few, large chondrocytes (/) with oval nuclei and clear cytoplasm can be observed. H x & E X 400 Fig. (10-b): photomicrograph of L. S. of a part of the meniscus of adult knee joint showing few, oval chondrocytes (c) with oval nuclei and clear cytoplasm, scattered in between large amount of highly packed collagen bundles (o) running in different directions. Masson trichrome stain X 400.

Fig. (11-a): Photomicrograph of L.S. of a part of the intra-articular septum (cruciate primordium) of 5 months old fetus: (17 -20weeks) CRL 15-19cm. showing very small fibroblasts with red nuclei (/) scattered in between large amount of thin collagen bundles (O). Most of the bundles are short and run parallel. Masson trichrome stain X 400.

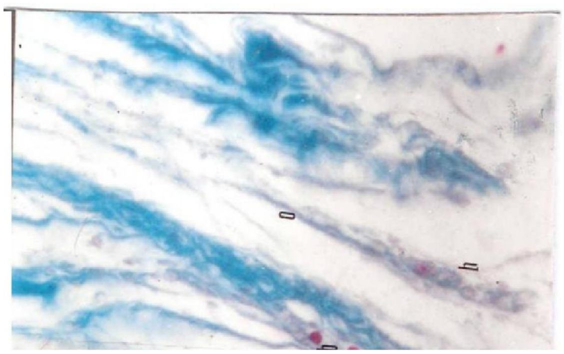


Fig. (11-b): Photomicrograph of L.S. of a part of the anterior cruciate ligament of full tem fetus: (33-36 weeks) CRL 31-34cm) showing few spindle shaped fibroblasts (F) with oval nuclei arranged in linear manner sandwiched between long in collagen bundles (O). Some of these bundles are loosely packed and branched. Masson trichrome stain X 400.

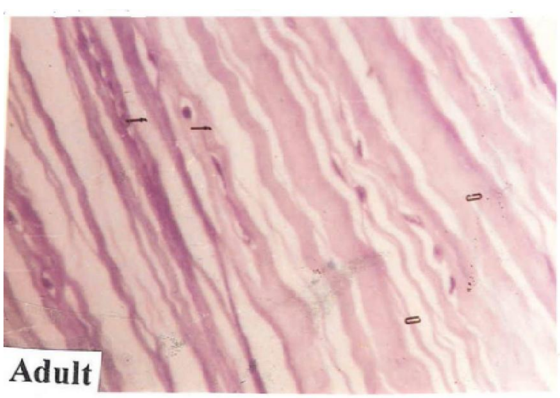


Fig. (11-c): Photomicrograph of L.S. of a part of the anterior cruciate ligament of adult knee joint showing that the collagen bundles are long, thick, and closely packed. They run parallel intermingled with oval or spindle –shaped fibroblasts (F) with flat nuclei arranged in linear manner between the collagen bundles (O) H x & E X 400.

Fig. (11-d): Photomicrograph of L.S. of a part of the anterior cruciate ligament of adult knee joint showing that the collagen bundles (O) are long thick, and closely packed. They run parallel and some of them are branched. Masson trichrome stain X 400

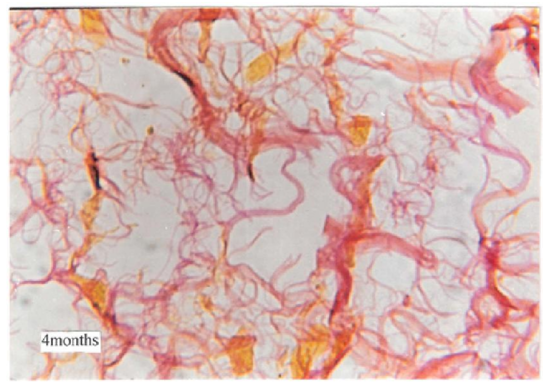


Fig (12-a): Photomicrograph of TS of part of 4 months old human fetus showing that the capsule is formed of white collagen fibres. The fibres are wavy and. different in size Note the vascularity of the tissue. Van Gieson x 1000.

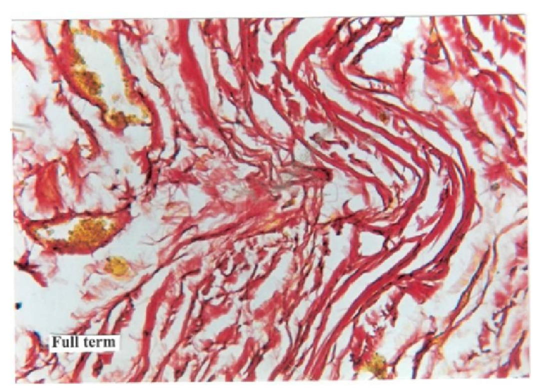


Fig (12-b): Photomicrograph of T.S of part of the capsule from the posterior part of full term human infant showing that is formed of more dense interlacing wavy parallel and longer thicker collagen bundles than the previous age. Van Gieson x 1000.

Fig (12-c): Photomicrograph of TS of part of the anterior part of the capsule near ligamentum patelle of the full term human infant showing long thin and thick collagen bundles parallel interlacing regularly arranged in different directions. Van Gieson x 1000

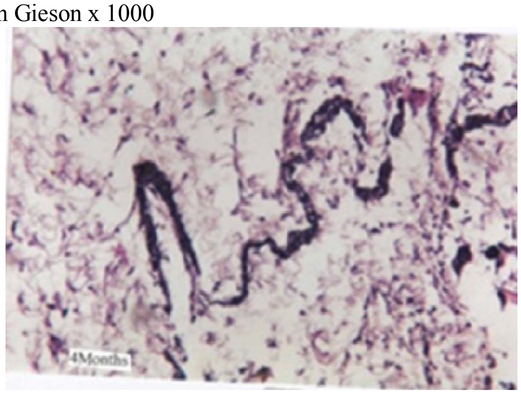


Fig (12-d): Photomicrograph of part of T.S of synovial membrane of 4 month fetus showing the discontinuous intimal layer of synoviocytes with different size and shape. The synoviocytes are arranged in 2-5 cell layers. The subintimal layer is full of fibroblasts and fine collagen fibers present in ground substance. Note that there is no basement membrane between the intimal and subintimal layer. Note that some villi formed from the synoviocytes are seen. H & E x l00.

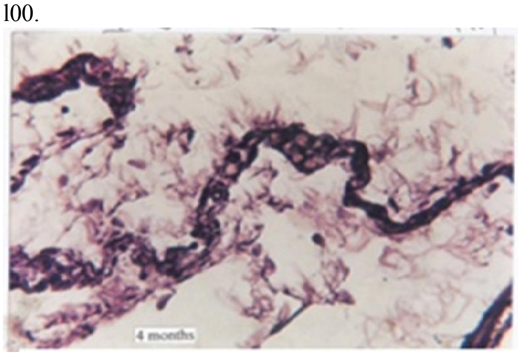


Fig (12-e): Higher magnification of part of the prevois photo showing Photomicrograph of part of T.S. of part of synovial membrane of 4 month fetus showing the discontinuous intimal layer of synoviocytes with different shapes. The subintimal layer is full of numerous fibrobasts and short collagen fibers. Note that there is no basement membrane between the intimal and subintimal layer. Note the villi formed from the synoviocytes. Note the pleomorphic synoviocytes arranged in 2-5 layers. H & Ex 1000.

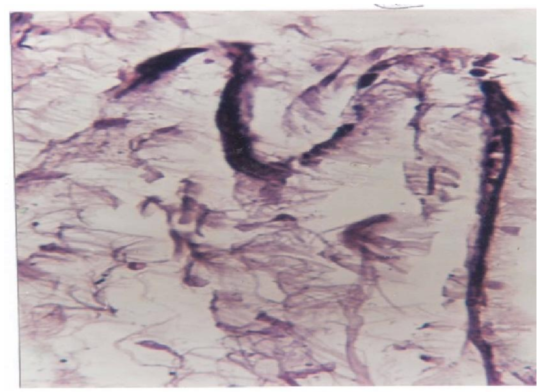


Fig (12-f): Photomicrograph of part of TS of part of the synovial membrane of part of full term human infant showing the subintimal areolar layer containing fat cells, collagen bundles and blood vessels. H & E x1000

Acknowledgement:

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اخر في بالانجليزي التالي التعليق الحاق يرجى
.الركبة مفصل عن البحث

للقب صادق ادسهير للأستاذ الترقية تم انه وإضافة
واستاذ، الازهر بنات طب التشريح بقسم استاذ
مجلة في ونشر الوهاب عبد جلال ادمنال وقتها مساعد
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2016عام الازهر مؤتمر في منه جزء نشر تم
وشكر.للقرآن العلمي الاعجاز بمشاركة بالزقازيق
العليا للدراسات العالي بالمعهد للمعيدة
.بالمؤتمر ألقته الذي مرزوق سارة للطفولة

Comment 1: The differentiation of ligaments, menisci, and other supporting of the body built by connecting the joints by these intra and extra articular structures was mentioned in Quraan in surat Al Insane 28. That was explained by Ibn Abbas the translator of Quraan and others (Mojhid, Katada, Mokatel, Abu hurira, Al Hassan and others. It was explained in the book of Asfahani the meanings of words of Quraan that (ASR-mentioned in surat Al Insane 28)) meant: connecting tightly with a strong tights. That tights could be translated scientifically by the Anatomy and embryology language as intra and extra articular ligaments, menisci, menbrans, septa. As in our research the crutiate ligaments, meniscofemoral ligaments, menisci, synovial membrane, plica, ligamentum patellea and extra articular ligaments were differentiated to tighten and strengthen the knee joint. However other membranes in other body places could be as interosuis menmbrane.

NB: The research work was submitted to fulfill the achievement of the scientific Position of Professor of Anatomy and embryology for Prof Dr Sohair Sadek, and associate professor of anatomy and embryology for Prof Dr Manal G Abdel wahab At the year 1995 and was accepted for publication in Al azhar medical journal.

NB2: The research work was presented by Sara M Marzouk the post graduate researcher in the High childhood institute for researches in Cairo EGYPT at the year 2016. by power point in the conference of AL AZHAR University with cooperation with the Islamic League - scientific signs of Quraan and sunna from KSA.

أسر

- الأسر: الشد بالقيد، من قولهم: أسرت القتب، وسمي الأسير بذلك، ثم قيل لكل مأخوذ ومقيد وإن لم يكن مشدودا ذلك (انظر: المجمل 1/97).

وقيل في جمعه: أسارى وأسارى وأسرى، وقال تعالى: {ويتيما وأسيرا} [الإنسان/8].

ويتجوز به فيقال: أنا أسير نعمتك، وأسرة الرجل: من يتقوى به. قال تعالى: {وشددنا أسرهم} [الإنسان/28] إشارة إلى حكمته تعالى في تراكيب الإنسان المأمور بتأملها وتدبرها في قوله تعالى: {وفي أنفسكم أفلا تبصرون} [الذريات/21].

والأسر: احتباس البول، ورجل مأسور: أصابه أسر، كأنه سد منفذ بوله، والأسر في البول كالحصر في الغائط.

وله تعالى: نحن خلقناهم من طين أي خلقناهم وشددنا أسرهم؛ قاله ابن عباس ومجاهد وقتادة ومقاتل وغيرهم. والأسر: الخلق؛ قال أبو عبيد: يقال فرس شديد الأسر أي الخلق. ويقال: أسره الله - جل ثناؤه - إذا شدد خلقه؛ قال لبيد:

ساهم الوجه شديد أسره مشرف الحارك محبوك الكتد

وقال الأخطل:

من كل مجتنب شديد أسره سلس القياد تخاله مختالا

وقال أبو هريرة والحسن والربيع: وشددنا مفاصلهم وأوصالهم بعضها إلى بعض بالعروق والعصب. وقال مجاهد في تفسير الأسر: هو الشرج، أي إذا خرج الغائط والبول تقبض الموضع. وقال ابن زيد: القوة. وقال ابن أحمر يصف فرسا

12/9/2018