European Journal of Molecular & Clinical Medicine (EJMCM)
ISSN: 2515-8260 Volume 09, Issue 09, 2022

HISTOLOGICAL DEVELOPMENT OF VASCULARITY AROUND HUMAN FOETAL SHOULDER JOINT

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ABSTRACT

Shoulder joint is a diarthrodial joint of ball and socket variety. Various components of shoulder joint start developing in early embryonic and foetal life at around 8 to 10 weeks. The present study aims to highlight the development of vascularity and cartilage canals around shoulder joint. Shoulder joint of 32 foetuses collected from areas in and around Jammu were dissected properly and decalcified in Gooding and Stewart's solution. Sections were cut after obtaining blocks by paraffin wax embedding method. Slides were stained using Haematoxylin and Eosin and Masson's trichrome and important findings were documented. Head of humerus is vascularised by cartilage canals by 10 weeks which arise from perichondrial vessels. In scapula, they develop around 12 weeks. Branching of cartilage canals is seen by 14 weeks. Synovial villi appear by 14 weeks and are vascularised by 16 weeks. Blood vessels enter joint in subcoracoid region. Epiphyseal vessels are seen to communicate with diaphyseal vessels at 17 weeks. Capillaries are seen in free margin of glenoid labrum by 12 to 12-1/2 weeks. Blood vessels are seen to develop in tendon of various muscles from 16 to 18 weeks.

Key Words: Shoulder joint, Cartilage canals, Glenoid fossa, Head of humerus

I. INTRODUCTION

The skeletal framework of human body comprises of numerous bones of varying shapes and sizes. These bones are united to one another by connective tissue structures constituting joints. Shoulder joint is a multi-axial, diarthrodial joint of ball and socket variety. Diarthrodial joints represent important constituents of musculoskeletal system and they enable individuals to maintain posture, to position their body relative to surroundings and to move and manipulate objects around them[1]. It is a simple joint having head of humerus and glenoid fossa of scapula as articulating surfaces. Humeral head is about four times the size of glenoid fossa[2]. By 6th week of development, first

hyaline cartilage models of bones of shoulder joint are formed by chondrocytes[3]. Areas in between skeletal elements do not undergo any change and persist as joint inter zones which further develop into joint cavity.

Bone is a living dynamic tissue with an abundant blood supply[4]. Humerus and scapula forming shoulder joint are cartilagenous bones and develop as a result of endochondral ossification in which mesenchymal cells first differentiate to form chondrocytes. The cartilaginous model laid down undergoes calcification followed by degeneration and then cartilage is replaced by bone. Humerus ossifies from one primary centre which appears during 8th week of intra uterine life in region of middle of shaft[3]. Epiphyseal ends where ossification has not extended are formed of hyaline cartilage. The cartilagenous substance is penetrated by cartilage canals. Cartilage canals augment nutrition of cartilaginous epiphysis. They are also involved in forming secondary centres of ossification. Each cartilage canal contains a small central artery or arteriole surrounded by numerous venules and perivascular capillaries[4]. These vessels arise from centripetal rami of perichondrial artery and vein. Cartilage canals appear by 12th week in both humerus and scapula[3]. Bertrant[5] states that epiphyseal vessels are terminal and there is no communication between them and diaphyseal vessels. But a definite communication occurs between these vessels after 17th week[3].

Only few studies related to development of shoulder joint have been devoted to its vascularity. Therefore, present study concentrates on development of cartilage canals and vascularity of shoulder joint. This on applied front will help in correction and treatment of shoulder lesions as well as in reconstruction and graft replacement.

II. MATERIAL AND METHODS

The study was conducted on 32 foetuses of varying gestational age obtained for a period of 1 year in Jammu (India) and areas surrounding it. The foetuses were obtained as products of abortions, still births and hysterotomy procedures. They were preserved in 10% formalin. The crown rump (CR) length of foetuses was measured with vernier calliper to determine their gestational age as per rule described by Hamilton, Boyd and Mossman[6].

The sex of foetus was determined and pectoral girdle was separated from trunk. The area was dissected properly and dissected specimen was kept inside tissue capsule. Tissue capsule is a small container having holes in it which allows fixative to enter inside when tissue is placed inside. This prevents loss of specimen during processing. Specimen was fixed by 10% formalin solution to impart firm consistency for period of 48 hours to 1 week – depending upon size of specimen. The specimen was decalcified by placing in Gooding and Stewart's 5% solution[7] for 4-5 days. Bigger specimen was decalcified by treating with 5% nitric acid. The tissue was prepared for sectioning by using paraffin wax embedding method. After trimming paraffin wax block, sections of 7 microns thickness were cut with rotary microtome. Both coronal and transverse sections were taken. Sections were transferred to water bath to remove wrinkles. Sections were fixed on slides

smeared with drop of Mayer's egg albumin. Then slides were stained with Haematoxylin and Eosin and Masson's trichrome. Slides were examined under light microscope and photographic documentation of important findings was done.

III. RESULTS

The foetuses were divided into six groups based on their stage of histological development as shown in table

Group No	CR length(mm)	Age (weeks)	No. Of foetuses
1	53-58mm	10 to 11	2
2	75-98mm	12 to 14	4
3	110-128mm	15 to 17-1/2	8
4	132-142mm	18 to 18-1/2	8
5	143-168mm	19 to 21	5
6	172-240mm	22 to 28	5

GROUP 1:53 to 58mm CR length (10 – 11weeks)

Coronal section of foetus of 10 weeks shows vessels entering the joint are more numerous near coracoid process. Few capillaries are seen in free margin of glenoid labrum (Fig 1) and are abundant in loose tissue between glenoid labrum and capsule. Vessels penetrating proximal humeral epiphysis are seen in area of bicipital sulcus. Most of cartilage canals are quite superficial and no cartilage canals are seen in glenoid fossa of scapula yet.

GROUP 2: 75 to 98mm CR length (12 -14 weeks)

Transverse section of foetus of 12weeks reveals head of humerus is cartilagenous with cartilage canals penetrating deeper into interior. Blood vessels enter head around bicipital sulcus from perichondrium. Cartilage canals are seen in scapula but do not extend in glenoid fossa of scapula. Margins of glenoid labrum are vascular. Blood vessels extend only Upto margins.

Coronal section of 14weeks foetus shows cartilaginous head of humerus which is filled with cartilage canals up to its interior. Greater and lesser tubercles are well distinguished. Branching of cartilage canals can be seen (Fig 2). Cartilage canals can be seen in greater tubercle (Fig 3). Cartilage canals are seen in glenoid fossa of scapula also. They are more numerous near neck of scapula. Blood vessels enter scapula near neck (Fig 4).

GROUP 3: 110 -128mm CR length (15 to 17-1/2 weeks)

Coronal section of foetus of 15 weeks shows head of humerus being penetrated by cartilage canals which are extending into its interior. There is increase in number of cartilage canals. The number of cartilage canals in glenoid fossa of scapula has increased. Transverse section of same foetus shows well developed greater and lesser tubercles permeated by cartilage canals.

Coronal section of foetus of 15-1/2 weeks CR length shows joint cavity with increased vascularity in subcoracoid region. Blood vessels can be seen entering joint cavity at this site. Head of humerus contains many cartilage canals which have increased in number and size with progressive stages.

Coronal section of foetus of 16weeks shows vasculaization of synovial folds at their margins (Fig 5). Blood vessels enter scapula along its neck and these are quite prominent. Transverse section of same foetus shows mesotendon of long head of biceps brachii to be quite vascular.

Coronal section of foetus of 17 weeks shows communication between epiphyseal vessels of head of humerus with diaphyseal vessels in shaft of humerus (Fig6).

Transverse section of foetus of 17-1/2 weeks reveals that synovial membrane lining joint cavity shows numerous synovial villi. Branching of these synovial villi is also seen and these are highly vascular.

GROUP 4:132 to 142mm CR length (18 to 18-1/2 weeks)

Coronal section of foetus of 18 weeks shows head of humerus is completely permeated with cartilage canals.

Vascularity has extended deeper down in glenoid labrum (Fig 7). Tendon of supraspinatus and infraspinatus muscles have become vascularised.

GROUP 5: 143 to 168mm CR length (19 to 21 weeks)

Transverse section of foetus of 19 weeks shows transverse humeral ligament extending between two tubercles of humerus (Fig8). The amount of collagen fibres in tendon has increased and it has become more vascular. Head of humerus and glenoid fossa of scapula contain numerous cartilage canals. Branching of cartilage canals is also seen.

GROUP 6: 172 to 240mm CR length (22 to 28 weeks)

Coronal section of foetus of 22 weeks shows increase in thickness and vascularity of synovial membrane. Blood vessels supply both synovial membrane and capsular ligament (Fig9). Transverse section of same foetus shows head of humerus filled with multiple branched cartilage canals. Perichondrial vessels are seen entering head of humerus (Fig 10).

Coronal section of foetus of 24 weeks show that cartilage canals have reached articular surface both in head of humerus and glenoid fossa of scapula. Vessels enter head of humerus from perichondrium. Entire glenoid labrum is vascular.

Coronal section of 28-week foetus shows blood vessels entering head of humerus along attachment of capsular ligament. Most of synovial villi are vascularised. Glenoid labrum is well vascularised. Multiple cartilage canals are seen near articular surface of head of humerus and margin of glenoid fossa.

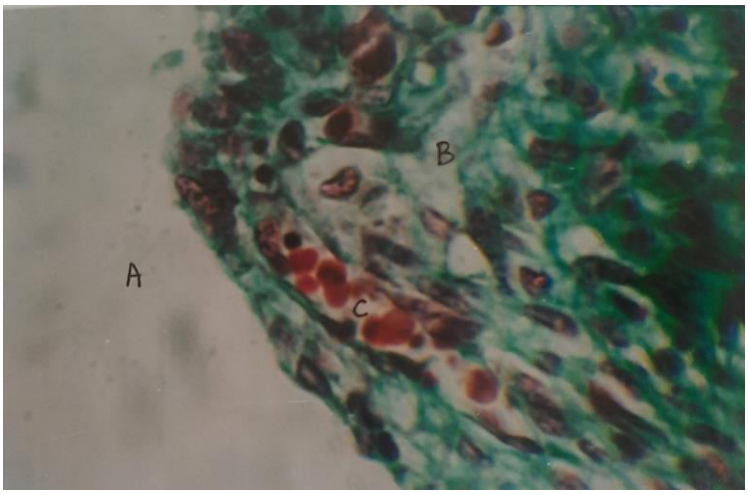

Fig 1: A) Joint cavity B) Glenoid labrum C) Blood vessels in foetus of 10 weeks in Masson's trichrome

Fig 2: A) Branched cartilage canal B) Head of humerus in foetus of 14 weeks in H and E

Fig 3: A) Greater tubercle B) Cartilage canal C) Perichondrial vessel in foetus of 14 weeks in H and E

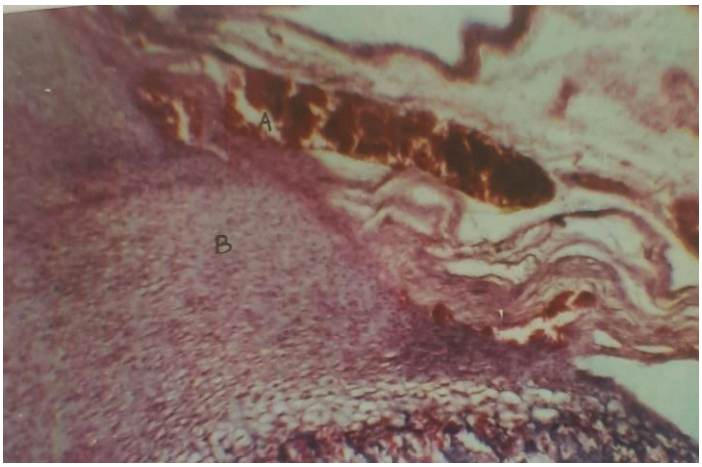

Fig 4: A) Blood vessel B) Neck of scapula in foetus of 14 weeks in H and E

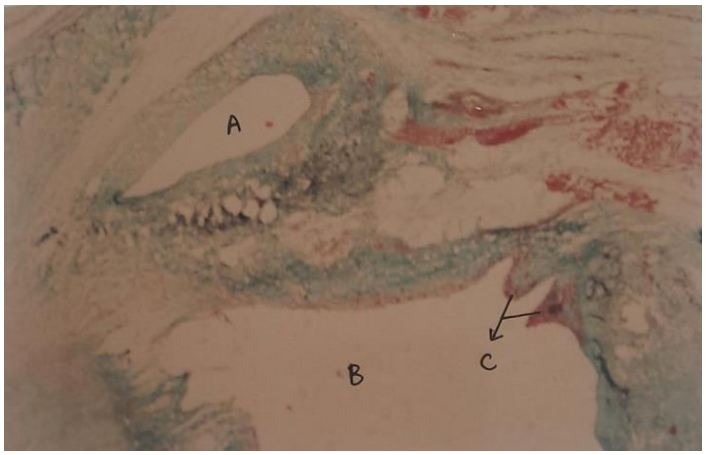

Fig 5: A) Subacromial bursa B) Joint cavity C) Synovial villi in foetus of 16 weeks in Masson's trichrome

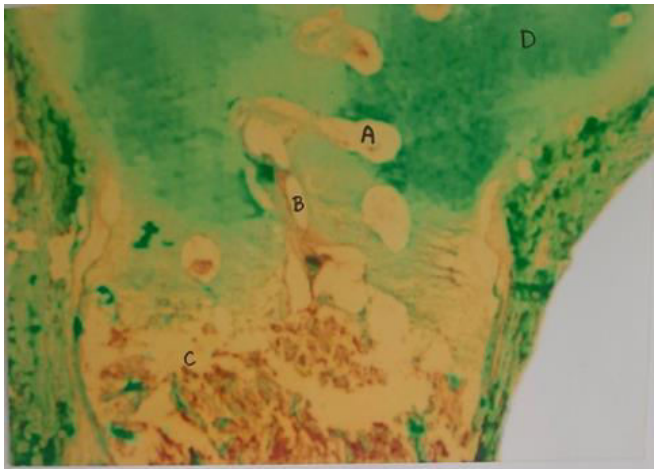

Fig 6: A) Epiphyseal cartilage canal B) Diaphyseal vessel C) Shaft of humerus D) Head of humerus in foetus of 17 weeks in Masson's trichrome

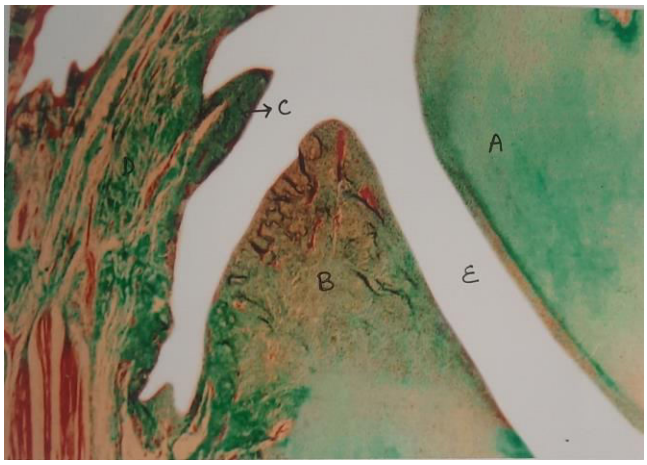

Fig 7: A) Head of humerus B) Glenoid labrum C) Synovial villi D)Capsular ligament E)Joint cavity in foetus of 18 weeks in Masson's trichrome

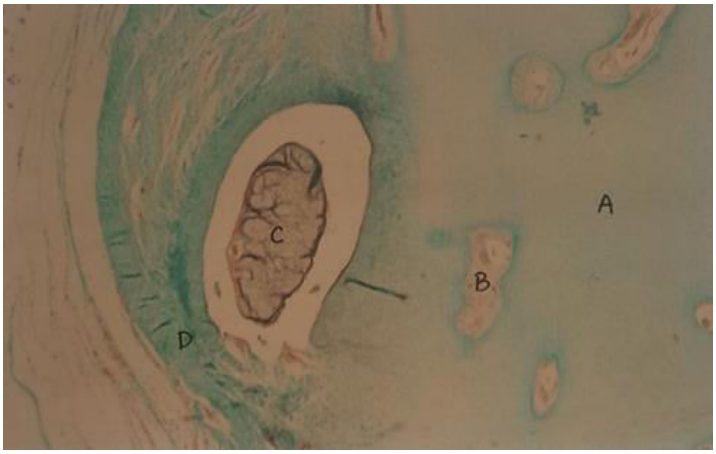

Fig 8: A) Head of humerus B)Cartilage canals C)Tendon of biceps D)Transverse humeral ligament in foetus of 19 weeks in Masson's trichrome

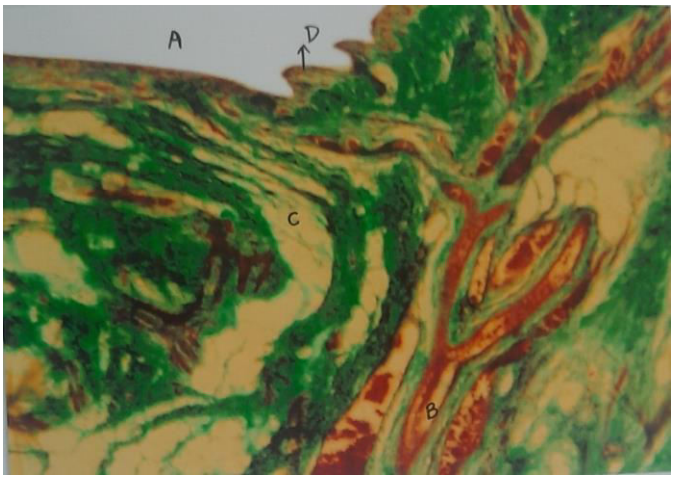

Fig 9: A) Joint cavity B) Blood vessels C) Synovial tissue D)Synovial villi in foetus of 22 weeks in Masson's trichrome

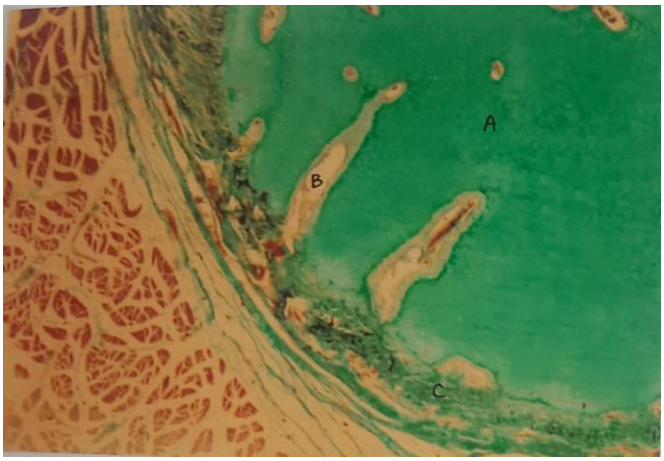

Fig 10: A) Head of humerus B) Cartilage canals C) Perichondrium in foetus of 22 weeks in Masson's trichrome

IV. DISCUSSION

Cartilage canals are present in head of humerus at 10 weeks. By 12 weeks, cartilage canals are seen in both humerus and scapula. Branching of cartilage canals in head of humerus is seen at 14 weeks. Cartilage canals make their presence in greater tubercle at same time. In scapula, cartilage canals reach glenoid fossa by 14 weeks. Similar findings were noted by Gardner, E. and Gray, D.J.[3]But Anderson, H.[8] had noted presence of cartilage canals at earlier stage of 9 weeks. Cartilage canals contain small blood vessels which are seen to be arising from perichondrial vessels. Area surrounding vascular cartilage canals does not show basophilia in any of two skeletal elements. Our finding is in accordance with Anderson, H.[8]. but Gardner, E., and Gray, D.J.[3] noted basophilia around cartilage canals.

Vessels invade glenoid fossa of scapula through perichondrium in region of glenoid labrum at about 16 weeks. Existence of communication between epiphyseal and diaphyseal vessels has often been denied. Bertrand, P.[5] stated that vessels contained in cartilage canals of epiphysis are terminal. In our study communication between epiphyseal and diaphyseal vessels of humerus has been observed at 17 weeks. This finding is in accordance with Gardener, E., and Gray, D.J.[3]

Synovial tissue is more vascular near free margin of glenoid labrum and extends beyond glenoid lip to neck of scapula in upper part of joint. Synovial tissue is thicker, looser, and more vascular in regions which do not lie below tendons. Similar findings were put forth by Gardner, E. and Gray, D.J.[3] Synovial villi show vascularization by 16 weeks. Each villus has smooth surface layer which covers loose tissue containing many capillaries and fine collagen fibres. These findings are in accordance with Haines, R.W.[9] and Laila, M.[10]. Gardner, E. and Gray, D.J.[3] noted vascularization of villi at earlier age of 14 weeks.

Blood vessels enter joint near coracoids process. Vascularity of this area continues to increase with each stage of development. Blood vessels reach synovial tissue by penetrating capsule. Similar findings were noted by Gardner, E. And Gray, D.J.[3]By 12-1/2 weeks capillaries are seen in free

margin of glenoid labrum. This is in accordance with studies of Anderson, H.[8] Vascularity in glenoid labrum was noted by Gardener, E. and Gray, D.J.[3] at 10 weeks.

Blood vessels are noted in tendon of biceps brachii by 16 weeks whereas other tendons like those of supraspinatus and infraspinatus muscles show vascularization by 18 weeks. Blood vessels separate tendons into fascicles.

V. SUMMARY

Head of humerus is vascularised by cartilage canals by 10 weeks. They arise from perichondrial vessels. These begin to branch by 14 weeks. In scapula cartilage canals are seen by 12 weeks. Synovial villi appear by 14 weeks and are vascularised by 16 weeks. They develop collagenous cores and show branching. Blood vessels enter joint in subcoracoid region. This region has increased vascularity in all stages of development. The epiphyseal vessels are seen to communicate with diaphyseal vessels at 17 weeks. Hence a definite communication exists between two and cartilage canals of epiphysis are not terminal. Capillaries are seen in free margin of glenoid labrum by 12-1/2 weeks and blood vessels are seen to develop in tendon of various muscles around 16 to 18 weeks.

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