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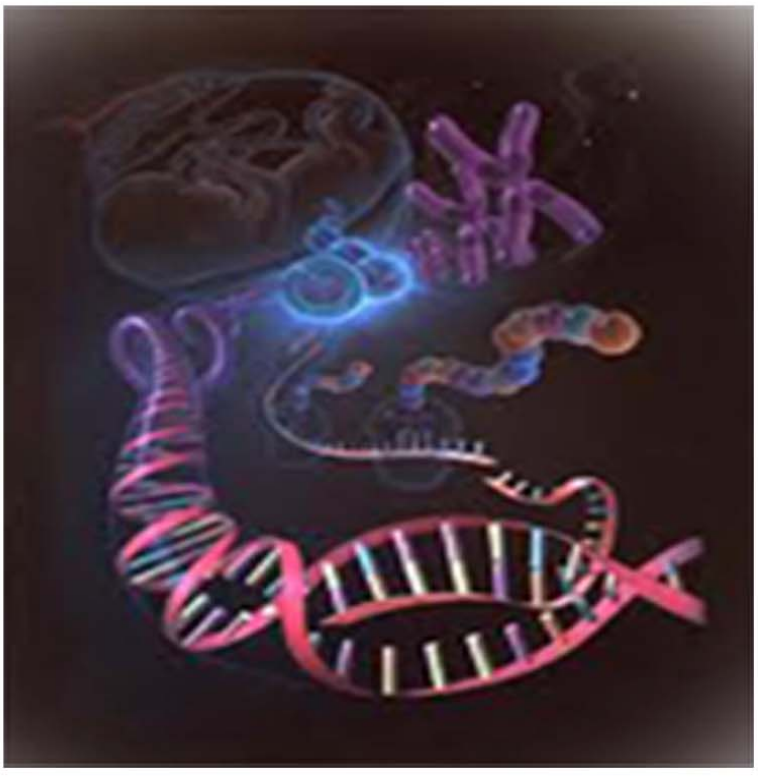

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Research Paper

MORPHOLOGY OF KNEE JOINT OF TETRAPOD-CLASS-REPTILIA-GENUS-CALOTES-SPECIES-VERSICOLOR (GARDEN LIZARD) TO MAMMALS

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Advancement in knowledge of the comparative Anatomy of joints has generally lagged behind than that of other structural systems. The knee joint has been chosen for special study as representing the largest and functionally important articular unit, provided with an extensive synovial cavity and a variety of both intra and extra articular structure. Haines (1942). The garden lizard is only mammals which does not possess of popliteus muscle. The femoro fibular and femoro tibial articulation has both internal and external ligamentus connection and menisci. There is a femoro- fibular disc, a fibro cartilaginous pad occupying the anterior part of the femoro-fibular joint. Lateral condyle of femur possess a concave facet for articulation with fibula, the fibula is separated by a shallow gap from the tibia but bears a facet for articulation with the femur. The knee joint is of peculiar interest as manifesting a change of mechanism of locomotion in passing from tetrapod (Garden Lizard) to mammals and affording a means of studying, the corresponding modifications of anatomical structures. 10 Garden lizards (versicolor) were selected and 10 human knee joint were selected from the dissection hall in Anatomy department of Hi- Tech Medical College, Rourkela, Orissa, India.

Keywords: Bony articular part, Intracapsular structure , Extracapsular structure and muscular changes, Locomotory effect

INTRODUCTION

Haines (1942) observed that the femur of garden lizard has two condyles, lateral and medial. The lateral is larger than medial, the lateral condyle possess a concave facet for articulation with fibula. Bernett (1954) stated that the fibula commonly articulates with the femur via cartilaginous disc which is apparently an extension of the lateral meniscus.

Kaplan (1958) noted that the extensor digitorum longus originated from the lateral condyles of femur just anterior to the lateral (fibular) collateral ligament. The tendon of the extensor is intra articular. The extensor digitorum

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longus crosses the lateral meniscus and run over the lateral side of leg. The extensor muscle does not run to the phalanges of the toes. It stops short of the toes and apparently acts mostly on the tarsus as an extensor of the foot.

Romer (1962) stated that the muscles of the hip and thigh region adduct the femur and flex the knee joint, in locomotion, that is they raise the body off the ground and push it forward. The flexor tibialis externus and flexor tibialis internus in reptiles appear to be homologues in mammals with the semimembranosus and semitendinosus. This long, large muscle covers the under surface of the thigh and flex the tibia at the knee joint. He also described that quadriceps femoris muscle has two part- one part consists three vasti fused together and the second part the rectus femoris.

MATERIALS AND METHODS

Ten Garden lizards collected from the central animal house and Ten knee joints of human being from dissection hall Department of Anatomy , Hi-Tech Medical College, Rourkela, Orissa, India. All the animals were sacrificed, with prior clearance from ethical committee, Hi-Tech Medical College after giving Euthanasia dose of phenobarbitone and preserved in 10% buffer formalin.

The morphological study of knee joint of garden lizard was carried out under the following headings.

1. Articular surface
2. Muscles
3. Ligaments

OBSERVATION

Articular Surfaces

Distal end of Femur in garden lizard is expanded and pulley shaped. It consists of two condyles, the lateral and medial condyle which articulates with tibia and fibula. The two condyle of the femur are separated by an intercondyler groove. The medial condyle is more prominent and lateral condyle of femur is rounded and less prominent. Immediately above the lateral condyle, the facet for articulation with the head of fibula is present. The distal end of the femur on its anterior aspect possesses small grooves which accommodate the patellar sesamoid bone (patella or knee cap) Figure 1A and 1B.

Upper End of Tibia: The tibia is the largest bone of the leg, upper end of tibia is broader transversely than anteroposteriorly and consists of lateral and medial condyles. The medial condyle is prominent than the lateral condyle, the articular surface of the medial condyle of the tibia is oval in outline. Lateral condyle of the tibia presents a small articular surface which is flattened in general outline and is slightly concave.

Upper End of Fibula: Is enhanced, broader transversely and lateral part is slightly raised above the surface, it articulates with narrow groove on lateral femoral condyle.

Patella: Is flattened from before backward and is roughly triangular in shape. It consists of a broad base and a pointed apex.

MUSCLES

Quadriceps Femoris muscle is the main extensor muscle of the knee joint. The origins of muscle seem to vary from one species to another. Romer (1963) stated that garden lizard has only 2-head, one part composed of fused, vastus lateralis, vastus intermedius, vastusmedialls known as femorotibialis and the second part known as iliotibialis (Figure 2 and Table 1).

Figure 1 A : Photograph of Bony Characteristics of Distal end Femur, Upper end of Tibia (Garden Lizard)

Figure 1B : Photograph of Bony Characteristics of Distal end Femur, Upper end of Tibia (human)

Figure 2: Showing The Muscles Acting on Knee Joint of Garden Lizard-quadriceps Femoris, Sartorius, Semimembranosus, Semitendinosus, Biceps Femoris, Gastrocnemius (Anterior and Posterior View of Knee)

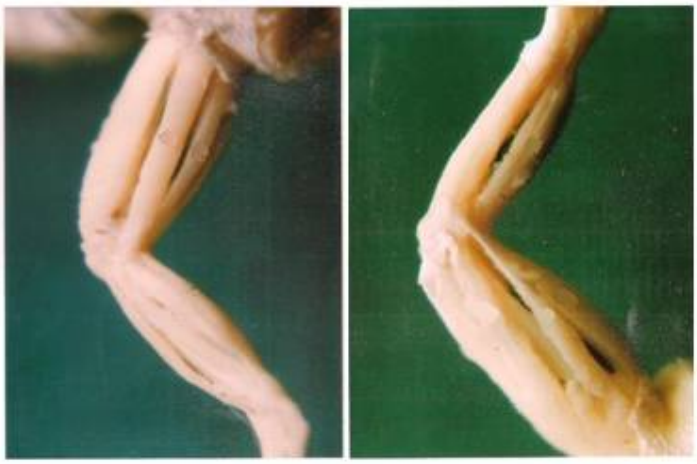

Table 1: Showing Origin and Insertion of Various Muscles Acting on Knee Joint of Species Garden Lizard to Human Being

	Quadriceps femoris		Sartorius		Semitendinosus		Semimembranosus	
ANIMAL	Origin	insertion	Origin	insertion	Origin	Insertion	Origin	insertion
Garden lizard	2 Head - vm+vi+vl from femur, R.f.- Ilium	Patella	Ant. Superior iliac spine	Post medial surface of tibia	Ischial tuberosity	Post, medial surface of tibia	Ischial tuberosity	Back of medial condyle of tibia
Human	4 head, 3 vasti- femur, R. femoris –ilium	Patella	Ant. Superior iliac spinc	Medial surface of tibial	Ischial tuberosity	Post, medial surface of tibia	Ischial tuberosity	Medial condyle of tibia
	Biceps femoris		Popliteus		Gastrocnemius		Ext. digi. longus	
ANIMAL	Origin	insertion	Origin	insertion	Origin	insertion	Origin	Insertion
Garden lizard	Post. Aspect of iliac crest	Posterior aspect of posterior end of shaft of fibula	Absent	Absent	2 heads back of medial and lateral femoral condyle	Plantar aponeurosis of foot	Ant. Surfaces of lateral femoral condyle	Dorsal aspects of bases of distal phalanges of digits 2-5metatarsus
Human	1.ischial tuberosity and sacro tuberous ligament 2.upper part of lat. Supra condylar line and lateral inter muscular septum.	Upper and lateral part of head of fibula.	Lat. Aspect of lat. Femoral condyle	Back of tibia above the soleal line.	2 heads medial andlateral femoral condyle.	Calcaneal tuberosity.	Med. Surface of fibula.	Dorsal aspects of prox. mid and distal phalanges of 2-5 digits.

Sartorius in the present study in garden lizard and human being observed in the superficial muscle situated in front of thigh similar finding were observed by HOLMES S.J. (1934).

The Semimembranosus, Samitendinosus and Biceps Femoris: These muscle are the members of the hamstring group, they are the muscles of the flexor compartment of the thigh. In the present study in garden lizard. The semitendinosus muscle arises from the lower medial part of ischial tuberosity. The tendon of the muscle is cord like and lies on the Semimembranosus and get inserted into upper part of the medial surface of the tibia.

The Semimembranosus muscle arises from the upper and lateral part of ischial tuberosity and gets inserted into back of the medial condyle of tibia. The muscles are flexors and medial rotator of leg and extensor of hip joint.

The Biceps Femoris in human being the muscle has two heads of origin while in garden lizard, originates by a single head from the post acetabular iliaccrest and get, inserted into the posterior aspect of proximal end of the shaft of the fibula. The muscle extends the hip, flex the knee, similar finding was observed by Romer (1963) in garden lizard.

Popliteus: In the present study, the popliteus muscle is not seen in garden lizard, similar finding were observed by dye scoti (1987).

Gastrocnemius: It has two heads of origin, the medial head arise from the posteromedial surface of femur, while the lateral head arise from posterolateral aspect of the lateral condyle of femur. The two head run towards each other and join together the tendocalcaneus wind around the ankle joint and is inserted in the plantar apenurosis, which in turn makes connection with the plantar aspects of toes. Similar findings were observed by Romer (1963) in garden lizards.

Extensor Digitorum Longus: In the present study the muscle takes origin from the small fossa on the lateral femoral condyle. The muscle runs downward on the lateral side of leg. It does not run to the phalanges of the toes, but stops short of the toes and acts mostly on the tarsus as an extensor of the foot similar finding were observed by Kaplan (1958).

LIGAMENTS

The menisci: In human being it is semilunar in shape, Intracapsular and made up of fibro-cartilage. They serve to widen, protect and deepen the tibial articular surfaces that receive the femoral condyles. Their peripheral attached borders are thick and convex and their free, inner borders thin and concave. The proximal surfaces are smooth and concave and in contact with the articular cartilage on the femoral condyles. The distal surfaces are smooth and flat, resting on the tibial articular cartilage (Figure 3).

The structural arrangement suggests specific biomechanical functions for the two regions: the inner thin portion of the meniscus is suited to resist compressive forces while the thick periphery is capable of resisting tensional forces.

Outward displacement of the menisci from the femoral condyle is resisted by firm anchorage of the peripheral circumferential fibers to the intercondylar bone at the meniscal horns. Menisci spread load by increasing the congruity of the articulation and give stability by their physical presence and also provides the proprioceptive feedback, probably assist lubrication and may

Figure 3: Medial And Lateral Meniscus (A) And Anterior and Posterior Cruciate Ligament(B) Of Human

cushion the underlying bone from the considerable forces generated during extremes of flexion and extension.

The knee joint of garden lizard is compared with man; there is a femoro fibular articulation. The femoro fibula disc is the lateral expansion of the lateral meniscus. This is interposed between the lateral condyle of femur and the fibula with which it articulates. The femoro fibular disc is narrow triangular wedge of tissue attached by its base to the lateral meniscus and by its apex to the fibular collateral ligament.

Collateral Ligament: In garden lizard the proximal attachment of medial and lateral collateral ligament is to the medial and lateral condyles of femur while the distal attachment is to the medial and lateral aspect of proximal part of tibia respectively. In human being the two ligaments are superiorly attached to the medial and lateral epicondyles of femur and inferiorly the medial ligament is attached to the medial condyle of tibia, proximal part of medial surface and medial border of tibia. The distal attachment of lateral collateral ligament is to the styloid process and adjoining part of head of fibula (Table 2 and Figure 4A).

Cruciate Ligaments: They cross each other and are very strong Intracapsular structures. The point of crossing is located a little posterior to the a center of gravity. The anterior cruciate ligament is attached to the anterior intercondylar area of tibia, partly blending with the anterior horn of the lateral meniscus. The posterior cruciate ligament is thicker and stronger than the anterior cruciate ligament. It is attached to the lateral surface of the medial femoral condyle and extends up to the anterior part of the roof of the intercondylar notch, where its attachment is extensive in the anteroposterior direction. They pass distally and posteriorly to a fairly compact attachment posteriorly in the intercondylar region (Table 3 and Figure 4 B).

DISCUSSION

In the present study, comparison of the muscle acting on the knee joint of garden lizard with corresponding one in the lower limb of man. In

Table 2: Showing Attachments of Collateral Ligaments of Species (Garden Lizard) to Human Being

	Medial Collateral Ligament		Lateral Collateral Ligament	
Animal	Proximal Attachment	Distal Attachment	Proximal Attachment	Distal Attachment
Garden lizard	Medial condyle of femur	Medial aspect of proximal part of tibia	Lateral condyle of femur	Lateral aspect of proximal part of head of fibula
Human	Medial epicondyle of femur	Medial condyle Proximal part of medial surface and medial border of tibia	Lateral epicondyle of femur	Styloid process and adjoining part of head of fibula

Figure 4A: Showing the Collateral ligaments (a) of garden lizard

Table 3: Showing Attachments of Cruciate Ligaments of Species (Garden Lizard) to Human Being

	Medial Collateral Ligament		Lateral Collateral Ligament	
Animal	Distal Attachment	Proximal Attachment	Distal Attachment	Proximal Attachment
Garden lizard	Intermediate rough area on the proximal surface of tibia	Post. part of lateral wall of inter codylar fossa of femur	Post. Part of intercondylar area of the tibia	Ant. Part of med. wall of intercondylar fossa of femur.
Human	Intermediate rough area on the proximal surface of tibia	Post part of lateral wall of inter condylar fossa of femur	Post part of intercondylar area of the tibia	Anterior part of medial wall of intercondylar notch of femur

Figure 4B: Showing the Cruciate Ligaments and Menisci (B) Of Knee Joint Of Garden Lizard

reptiles such as lizards the tibia and fibula are not attached to each other by any strong interosseous membrane or ligaments apart from the superior tibia-fibular ligament already. At its lower end each bone is firmly attached to the tarsus by a hinge joint with rather limited movements, for the main mobility of the region is provided by the intertarsal joints.

The stability of the knee joint depends on the tone of the strong muscle acting on the joint and strength of the ligaments. In human knee, maintaining stability of patellofemoral joint and tibiofemoral joint, menisci, collateral ligament and cruciate ligament play major role.

Loading at the Knee During Walking: The force across the tibio femoral joint for most of the cycle in between two and four time's body weight. In contrast, the force across the patello femoral joint is no more than fifty percent of body weight. The force transmission across the joint increases sequentially as the movement increases. Walking up or down the stairs has little influence on tibiofemoral loading, but significantly increases patello femoral forces to two or three times of the body weight. In human knee- The popliteus is a flat muscle that forms the floor of the lower part of the popliteal fossa. It arises within the capsule of the knee joint by a strong tendon which is attached to a depression at the anterior end of the groove on the lateral aspect of the lateral condyle of femur. This ligament is a single most important stabilizer of the posterolateral region of the knee and resists external rotation of tibia on the femur during locking.

Fleshly fibers expand from the inferior limit of the tendon to form a triangular muscle that descends medially to be inserted in to the medial two thirds of the triangular area above the soleal line on the posterior surface of tibia and sends an expansion that covers its surface, popliteus rotates the tibia medially on the femur or when the tibia in fixed, rotates the femur, laterally on the tibia. It is usually regarded as the muscle that unlocks the joint at the beginning of flexion of the fully extended knee.

In the human knee, the flexion – extension occurs on the mobile transverse axis, which shifts forward during extension and backward during flexion. In this movement the femoral condyles move on the tibia and the menisci in the meniscofemoral compartment.

The rotation occurs around a vertical axis in the meniscotibial compartment. There are two types of rotation in the knee joint. The conjunct rotation is part of locking-unlocking mechanism. The adjunct rotation occurs in the semiflexed knee.

From a fully extended knee the flexion begins by unlocking movement, which consists of lateral rotation of femur or medial rotation of tibia. The rotation is integral at the beginning of flexion hence it is conjunct rotation due to contraction of popliteus muscle-key of knee joint.

The knee joint of garden lizard is compared with man; there is a femoro fibular articulation. The femoro fibula disc is the lateral expansion of the lateral meniscus. This is interposed between the lateral condyle of femur and the fibula with which it articulates. The femoro fibular disc is narrow triangular wedge of tissue attached by its base to the lateral meniscus and by its apex to the fibular collateral ligament. During evolution the patella makes its appearance for the first time in garden lizard as it was absent in frog. The upper end of tibia in garden lizard consists of lateral and medial condyles and intervening ill defined intercondylar eminences. There is an additional anterior tuberosity on the anterior part of upper end of tibia; the patellar ligament gets attached to this tuberosity. In the lizard, the fibula is a lateral bone of the leg, it is articulated to the tibia at its upper and lower end and free in the intervening area. The upper end of fibula in garden lizard, flat, expanded and triangular. The popliteus muscle is not seen. The gastrocnemius muscle passes beyond the posterior surface of calcaneus and gets inserted on the plantar aponeurosis. The muscle acts as flexors of knee, planter flexor of ankle, intertarsal joint. This probably helps in propelling movements which requires simultaneous flexion at the knee joint and plantar flexion at the ankle joint. In reptiles such as lizards the tibia and fibula are not attached to each other by any strong interosseous membrane or ligaments apart from the superior tibio-fibular ligament already. In the lizards the ankle joint there is no appreciable rotation, so that when the foot rotated relatively to the femur the tibia and fibula rotate with it, but at the same time they are free to move anteroposteriorly relatively to each other by flexion of the tibia on the tarsus with extension of the fibula.

The popliteus muscle is not seen. In garden lizard as this animal probably do not require medial rotation in their normal locomotion, this might be the reason for the absence of muscle. The gastrocnemius muscle passes beyond the posterior surface of calcaneus and gets inserted on the plantar aponeurosis. The muscle acts as flexors of knee, planter flexor of ankle, intertarsal joint. This probably helps in propelling movements which requires simultaneous flexion at the knee joint and plantar flexion at the ankle joint.

In garden lizard the origin of extensor digitorum longus is located on the lateral femotral condyle but in man it slips below the femur and takes origin from medial surface of fibula and get inserted on toes. In garden lizard the tendon stops short of the toes and is inserted into distal part of metatarsal bones. Does in reptiles, the protraction of hind foot in motion with

simulataneous extension of the knee and tarsus is apparently due to the contraction of the extensor digitorum longus muscle. This create advantage of distinct functional value.

CONCLUSION

The popliteus muscle is absent In Garden lizards. Biceps femoris has got sinle head of origin. The femoro fibula disc in garden lizard is the lateral expansion of the lateral meniscus The gastrocnemius muscle acts as flexors of knee, planter flexor of ankle, intertarsal joint. This probably helps in propelling movements which requires simultaneous flexion at the knee joint and plantar flexion at the ankle joint. In reptiles such as lizards the tibia and fibula are not attached to each other by any strong interosseous membrane. In the lizards the ankle joint there is no appreciable rotation, so that when the foot rotated relatively to the femur the tibia and fibula rotate with it, but at the same time they are free to move anteroposteriorly relatively to each other by flexion of the tibia on the tarsus with extension of the fibula.

In human being several factors, not found in other species, are added for stability and relative freedom of action of the knee joint and liberation of the toes for independent activity the toes are free to exert flexion and extension in stance and other activities independent of the knee joint.

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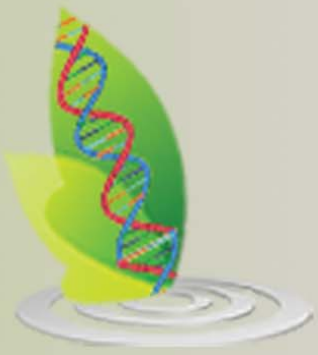

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