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From Editor's Desk

It has been my privilege and honor to be the Editor-in-Chief of this prestigious Journal of the Association of Anatomists, Tamil Nadu which has a long and unforgettable heritage. Along with the advent of the Association of Anatomists, Tamil Nadu, it was decided to commence a scientific journal to foster the two primary objectives of the association viz promotion of science and encouraging younger generation to participate in scientific endeavors. I am happy to state that our association and the journal, which have been steadily marching past silver jubilee, have ignited scientific aspirations in several young minds through various activities like annual conferences, publication of papers and conducting dissertation competitions.

Time has come to take our journal to newer heights and I have great pleasure in announcing that we have taken the following steps in bringing our journal to international standards.

- First, renaming our journal as International Journal of Anatomical Sciences (abbreviated as IJAS)
- Second, the journal shall be made online with a dedicated online portal for manuscript management and publication.
- Third, converting our journal into an open access type to improve international readership and thereby ensuring wider reach.
- Finally, to implement stringent quality control through anonymous review mechanism.

I am happy to state that all the above tasks have been accomplished and that the current issue is the first issue of the International Journal of Anatomical Sciences. The editorial team will very much appreciate receiving comments and suggestions for the improvement of the journal and also request the co-operation of all the members of our association.

May god bless the Association and the IJAS

A. Krishnamurti
Editor-in-Chief

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Research Paper

Correlation of Anthropometric and Upper Femoral, Morphometrics with Osteoporotic Related Hip Fracture Risk

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Key Words: hip fracture, bone mineral density, femoral morphometry

Abstract: Hip fractures have high morbidity and mortality among people and are generally seen in elderly population. In this study our focus was to know the relation of anthropometric factors and proximal femoral morphometry with fracture risk. Total of 107 women were recruited in this study. Determination of Bone mineral density by DXA scan is gold standard in prediction of osteoporotic related hip fracture. Based on scores of BMD we divide the Participants into two groups. 1. Fracture risk group and 2. Non fracture risk group. Age, BMI, hip axis length (HAL), neck shaft angle (NSA), and neck width (NW), were recorded and measured from the dual x-ray absorptiometry (DXA) print out. Age had negative relation with BMD and BMI had positive relation with BMD. HAL and NSA were more in fracture risk group. So our study suggests that, one should strive to use both geometry and BMD to predict the susceptibility to fracture in patients.

The number of hip fractures has been estimated to rise from 1.7 million in 1990 to 6.26 million by the year 2050, worldwide and this is mostly due to the increasing life expectancy and increasing size of the population in nearly all countries (Cooper *et al*., 1993). It increases the morbidity and mortality in elderly men and women (Baudoin *et al*., 1996).

Many risk factors are there to define the etiology of hip fracture. Age, diseases and trauma are the three main causes that play an important role in the etiopathology of hip fractures. (Alffran *et al*., 1964). It is also an outcome of age related osteoporosis. Alffran *et al*., (1964) emphasize the importance of osteoporosis as a predisposing factor in hip fractures. Together with age and gender, bone mineral density measurement is one of the reliable methods to evaluate the risk of osteoporotic –related hip fractures

The other potential risk factors for hip fracture are lower body weight, cigarette smoking, caffeine intake, use of long acting sedatives and inactivity. Other risk factors such as density also relate to the strength of the bone (Cheng *et al*., 1997).The reduced bone mass during aging alone does not explain this phenomenon (Ramalho *et al*., 2001), and other factors such as decreased muscle mass (Dargent–Molina *et al*., 1996), postural instability, bone quality (Cumming *et al*., 1995; Dargent–Molina *et al.,* 1996), genetic factors like polymorphism in the type 2 collagen synthesizing gene that would alter the bone structure (Quershi *et al*., 2000) and also the geometry of the proximal femur (Gnudi *et al*., 2002) are also

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suggested to cause fracture. So Many studies have been carried out to prevent fractures, as most hip fractures follow a fall.

Recently authors tried to estimate the risk of fracture through measurement of hip geometry like hip axis length, neck shaft angle, neck width with DXA scan. (Pande *et al*., 2000; Gnudi *et al*., 2002; Alonso *et al*., 2000).

As the great majority have used the densitometry scan image to measure the geometric values mentioned above, we also used DXA scan to measure femoral geometry. To determine whether the geometric measurement of morphological features of the proximal femur are independent predictors of hip fracture and whether they improve the discriminate ability of the femoral bone mineral density (BMD), we measured and compared the hip axis length, the femoral neck width, neck shaft angle and the femoral BMD of randomly selected individuals with and without hip fracture risk by taking a hip scan using dual x- ray absorptiometry (DXA)). The recent interim report from the world health organization (WHO) task force for osteoporosis, recommends using only bone mineral density (BMD) for determining the fracture risk.

Earlier studies carried out in different ethnic groups have found that the incidence of hip fractures differ from country to country. This evidence suggests that like others factors, proximal femoral morphometry, may equally be important in determining hip fracture risk.

Materials and Methods

This study was conducted on 107 post menopausal women in the age group 50 - 60 years, who visited bone clinic for screening of osteoporosis. The experimental procedure was approved by the local ethics committee. We divided the participants into two groups based on the following criteria.

Control group (n= 57) Women who had normal BMD as per WHO criteria (T >-1 SD) were included in this group.

Fracture risk group (n= 50). Women who had osteopenia (T <-1SD TO >-2.5) or osteoporosis (T<-2.5 SD) were included in this group.

For both the groups age , BMI, HAL,NSA, NW, and BMD were recorded and measured from their DXA scan print out. All values were statistically correlated using SPSS statistical package.

Exclusion criteria for the study were hip fracture, any metabolic bone disease, or treatment with sex hormones like calcitonin. The information consent was obtained from the subjects to take secondary data from the DXA print out.

The following parameters were considered and measured for this study:

- BMD values of the proximal femur at neutral position, calculated by DXA scan (Lunar DPX).
- Age, recorded from patient's history.
- Body height and weight were measured with an anthropometer and beam-balance scale.
- Body mass index was calculated from height and weight measurements, using the formula Weight / Height in meter^2

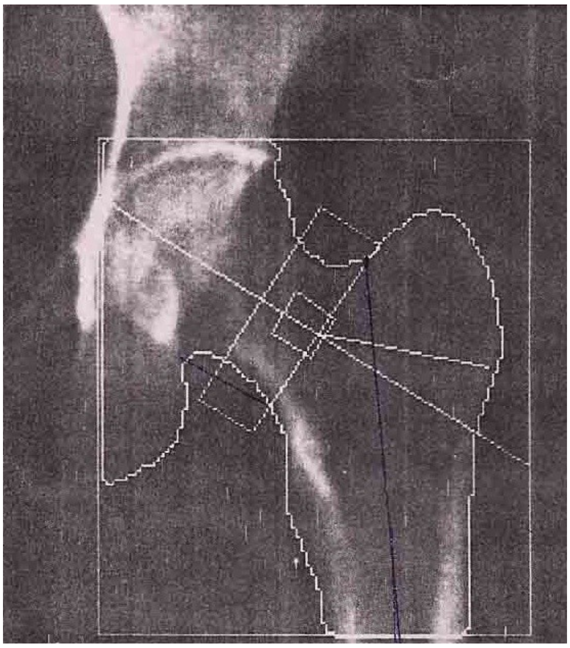
Following morphometrics were measured (refer Fig. 1).

Hip axial length (HAL) was measured as the linear distance from the base of greater trochanter to the apex of the acetabular rim by aligning the ruler manually during the analysis procedure with the software provided with the device.

Femoral neck width (NW) was measured as the shortest distance within the femoral neck perpendicular to the femoral neck axis.

The angle between the hip axial length and shaft axis gives neck shaft angle (NSA).

Fig. 1 DXA print out



Observations

The mean values of the anthropometric parameters like age , BMI, and upper femoral morphometric parameters like HAL, NSA, NW of 57 non fracture risk Chennai control group were found to be 50.44 kg, 26.87kg/m2, 5.55 cm, 127.8^{o}, and 1.74 cm (Table 1 and 2).

The mean values of the anthropometric parameters like age, BMI, and upper femoral morphometric parameters of 50 fracture risk group were found to be 53.6 kg, 26.87 kg/m2, 5.64, 128.78^{o}, and 1.76 cm (Table 3).

In this study the Pearson' correlation coefficients between anthropo-metric, upper femoral morphometric and BMD were calculated to evaluate the relationship between the above factors.

Age had positive correlations with HAL (r = 0.303; p = 0.002). BMI had positive correlation with BMD (r = 0.339 BMD, p = 0.000). HAL had positive correlation with age(r=0.303; p = 0.002), and NW (r=0.342; p = 0.000). NSA had negative correlation with BMD (r = -0.239; p = 0.013). NSA had negative relation with age (r =-.282 p= .003). BMD had negative correlation with age, (r = - 0.267 p = 0.005), with HAL(r = - 0.389; p = 0.000).

Table 1 The mean and standard deviation of the Physical characteristics namely age, BMI, HAL, NW, NSA and BMD of the participants

	Mean	Std. Deviation	N
AGE	51.93	12.177	107
BMI	26.8741	4.39041	107
HAL(cm)	5.6514	0.31244	107
NW	1.7645	0.17170	107
NSA (degree)	128.29	7.464	107
Area	29.2547	3.42380	107
BMC	24.8940	6.09370	107
BMD	0.85468	0.177891	107

Table 2 Averages and standard deviations of anthropometrics and femoral morphometrics of non fracture risk group in women

	Mean	Std. Deviation	N
AGE	50.44	12.177	57
BMI	26.8741	4.39041	57
HAL (cm)	5.55	.31244	57
NW	1.74	.17170	57
N S A (degree)	127.8	7.464	57
B M D	0.8679	.177891	57

Table 3 Averages and standard deviations of anthropometrics and femoral morphometrics of fracture risk group in women

	Mean	Std. Deviation	N
AGE	53.60	12.517	50
BMI	26.8741	4.3224	50
HAL (cm)	5.6400	.31321	50
NW	1.7800	.17170	50
N S A (degree)	128.78	7.265	50
B M D	0.6370	.15789	50

Table 4 Correlation between femoral morphometrics, anthropometrics and BMD of both fracture and non fracture groups in women.

		AGE	BMI	HAL (cm)	NW	NSA (degree)	AREA	BMC	QMD
AGE	Person Correlation	1	0.109	0.303**	-0.18	-0.282**	0.375**	-0.066	-0.267**
	Sig.(2-tailed)	107	0.264	0.002	0.851	.003	0.000	0.501	0.005
	N		107	107	107	107	107	107	107
BMI	Person Correlation	0.109	1	-0.182	0.106	0.072	0.154	0.380**	0.339**
	Sig. (2-tailed)	0.264		0.061	0.276	0.464.	0.113	0.000	0.000
	N	107	107	107	107	107	107	107	107
HAL(cm)	Person Correlation	0-303**	-0.182	1	0.342**	-0.004	0.342**	-0.199*	-0.389**
	Sig.(2-tailed)	0.002	0.061		0.000	0.964	0.000	0.040	0.000
	N	107	107	107	107	107	107	107	107
NW(cm)	Person Correlation	-0.018	0.106	0.342**	1	-0.102	0.515**	0.220*	-0.025
	Sig.(2-tailed)	0.851	0.276	0.000		0.298	0.000	0.023	0.801
	N	107	107	107	107	107	107	107	107
NSA(degree)	Person Correlation	-0.282**	0.072	-0.004	-0.102	1	-0.099	0.136	-0.239*
	Sig.(2-tailed)	0.003	0.464	0.964	0.298		0.311	0.163	0.013
	N	107	107	107	107	107	107	107	107
AREA	Person Correlation	0.375**	0.154	0.342**	0.515**	-0.099	1	0.512**	0.036
	Sig.(2-tailed)	0.000	0.113	0.000	0.000	0.311		0.000	0.716
	N	107	107	107	107	107	107	107	107
BMC	Person Correlation	-0.066	0.380**	-0.199*	0.220	0.136	0.512**	1	0.862**
	Sig.(2-tailed)	0.501	0.000	0.040	0.023	0.163	0.000		0.000
	N	107	107	107	107	107	107	107	107
BMD	Person Correlation	-0267**	0.339**	-0.389**	-0.025	-0.239*	0.036	0.862**	1
	Sig.(2-tailed)	0.005	0.000	0.000	0.801	0.013	0.716	0.000	
	N	107	107	107	107	107	107	107	107

** Correlation Is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Discussion

India is a large country with a wide variety of environmental conditions. It shows ethnic multiplicity and is characterized by an interracial mixing rarely seen in other countries. Taking into account of these factors the data base obtained in our study may not be representative of the entire Indian population and therefore our normative data should be used only for a population sharing the same genetic potential and living under similar environmental conditions. One limitation of our study was the recruitment of volunteers. The study sample was not population based but recruited from the subjects who visited bone clinic. It is possible that this may introduce a selection bias focusing on the wealthier and better educated part of the population or alternatively on those who through life style or living conditions are prone to osteoporosis. To our knowledge, this is the first study of BMD in a large south Indian population using DXA measurements. In the present study we cannot exclude cohort effects such as socio economic status, life time exercise patterns or nutritional habitat. A survival bias may also have occurred since we made bone measurements only in the individuals able to come to the outpatient clinic.

The hip axis length has been found to be correlated with the risk of fracture (Nakamura *et al*., 1994). Our result also shows higher value of HAL in fracture risk group ref table 3.The precise physical mechanism of this is unknown. However Faulkner is of the opinion that a longer hip axis length leads to a higher probability of impacting the great trochanter and to lower impact absorption after a fall. (Faulkner, 1995; Schwartz *et al*., 1999).

In our study the neck shaft angle also discriminated healthy from osteoporotic subjects. Neck –shaft angle varies among the published studies on fracture risk. In every comparison study except those of Cody and Nahigian in 1993 (a CT study) and Ferris *et al.*, in 1989, (where hips were held in maximum internal rotation), the NSA is larger in the fracture –prone group. Our method of femoral NSA measurement proved both reliable and precise. Furthermore the mean values and ranges are similar to those reported in other studies (Alonso *et al*., 2000; Gnudi *et al*., 2002; Faulkner *et al*., 1993; Quershii *et al*., 2001). Our study also anticipates that larger NSA to be associated to an increased hip fracture risk in later life. But our data regarding NSA was in contrast to those of Faulkner *et al*., (1993) who report no association between neck shaft angle and hip fracture risk.

Ex vivo biomechanical tests also shows that neck shaft angle does not correlate with femoral neck strength (Cheng *et al*., 1997; Schwartz *et al*., 1999). So it correlation to fracture risk may involve other mechanism. It may be hypothesized that neck shaft angle or the ante version angles interact with the direction of the fall, thus affecting the femoral neck loading angle. This angle, according to Pinilla *et al*., (1996) is inversely related to fracture load and its variation may therefore be associated with different fracture risk.

These discrepancies may be due to racial differences in the neck shaft angle Nakamura *et al*., (1994) or to different compensations of the anteversion angle during positioning of patients on the scan bed producing different effects on this measurement. The occurrence of hip fracture may also be influenced by anthropoimetric factors (Farmer *et al*., 1989). Aging is one of the important reasons for hip fracture. It increases exponentially with age (Cumming *et al*., 1989). Many studies show that short individuals have a lower risk of hip fracture compared to tall individuals (Hemenway *et al*., 1995).

Conclusion

Non invasive imaging techniques can provide measures of geometry and a correlate to macroscopic material properties (BMD). Until we have effective methods for measuring micro architecture and genetic or other biomarkers for individual response dynamics, we should strive to use both geometry and BMD to predict the susceptibility to type of fracture in patients

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Research Paper

Diffuse Idiopathic Skeletal Hyperostosis

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Key Words: thoracic vertebrae, anterior longitudinal ligament, supra-spinous ligament

Abstract: A dry bone specimen comprising six thoracic vertebrae held together by ossified anterior longitudinal and supra-spinous ligaments is reported. The specimen was subjected to plain radiography. The antero-posterior and lateral views confirmed the ossification of the above ligaments. Moreover, the ossified anterior ligament was found to be separated from the body of the vertebrae by a space and a radio-dense line paralleling the longitudinal axis of the vertebrae. The inter-vertebral disc space and the zygoapophyseal joint space were free. A piece of the ossified mass, subjected to histo-pathological examination also confirmed the ossified ligaments. Review of literature suggests that this is a case of diffuse idiopathic skeletal hyperostosis (DISH).

The anterior longitudinal ligament is extending from atlas to sacrum is a flat strong band found along the anterior surfaces of the vertebral bodies which becomes broader when traced caudally. It is thicker and narrower in the thoracic region than in the cervical and lumbar regions. The posterior longitudinal ligament on the posterior surfaces of the vertebral bodies inside the vertebral canal gradually narrows when traced downwards. These ligaments are adherent to the inter-vertebral discs, hyaline cartilage lining the articular surfaces, margins of adjacent vertebral bodies and the laminae. At various levels, ligamentous fibres blend with the subjacent periosteum, perichondrium and periphery of the annulus fibrosus (Williams *et al.*, 1995).

Supraspinous ligament is a strong fibrous band connecting the tips of spinous process from C7 to the sacrum. Its most superficial fibers span over three or four spines, the deeper fibers bridge over two or three spines, while the deepest connect adjacent spines becoming continuous with interspinous ligaments (Williams *et al.*, 1995). Heylings (1978) considers supra-spinous ligament to cease at the fifth lumbar spine.

The anterior longitudinal, posterior longitudinal and supraspinous ligaments (para-spinal ligaments) undergo degeneration secondary to attrition, and they often ossify. This condition is broadly termed as spinal enthesopathy. Ossification involving the anterior longitudinal ligament is referred to as Forestier's disease. Further, a diffuse variant exhibiting additional extra-axial features is termed as diffuse idiopathic skeletal hyperostosis (DISH)

Material and Methods

Morphological examination was undertaken on a dry bone specimen comprising six thoracic vertebrae held

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together by ossified anterior longitudinal and supraspinous ligaments, identified in the bone bank of the Dept. of Anatomy, VMKV Medical College, Salem. The specimen was subjected to plain radiographic study. Histo-pathological examination also was carried out on a piece of the ossified tissue.

Observations

Gross examination revealed a tortuous mass anteriorly along the sides (prominent on the right side) of the vertebral bodies holding them together. A clear space was noted between the mass and the vertebral bodies. The spinous processes were also found to be held together by a similar tortuous mass (Fig. 1). The gross appearance of the mass was like that of candle wax dripping down the spines. The intervertebral disc space was found to be maintained and the zygoapophyseal joints were found to be free (Fig. 2). The intervertebral foraminae and vertebral canal appeared normal. Other parts of the vertebrae including the pedicles, laminae, transverse processes and the costal facets also appeared normal. The anteroposterior and lateral views of radiographs showed the mass to be of bony nature. It was found to be separated from the body of the vertebrae indicated by a space and radiodense line paralleling the longitudinal axis of the vertebrae (Fig. 3). The inter-vertebral disc space and zygapophyseal joint space were free. Histo-pathological examination confirmed the tissue as ossified (Fig. 4).

Fig.1 Shows six thoracic vertebrae held together by ossified anterior longitudinal ligament and supraspinous ligament

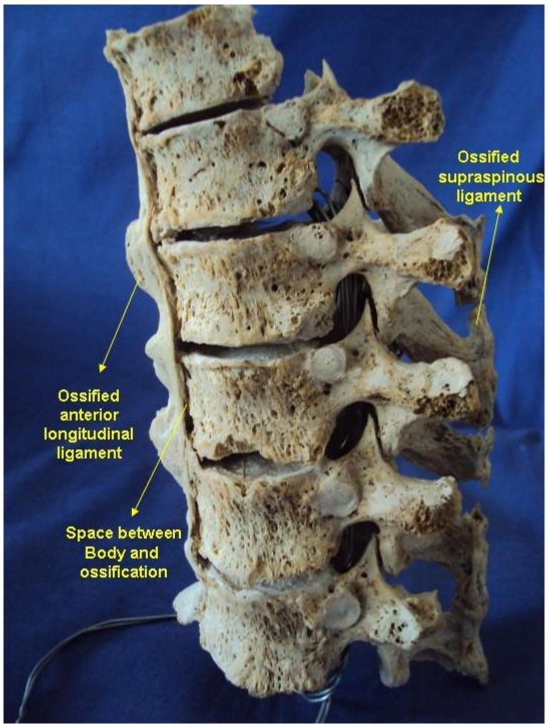


Fig. 2 Intervertebral disc space and zygoapophyseal joint space are maintained.

Discussion

The differential diagnosis of paraspinal ligament ossification includes Forestier's disease, Ankylosing spondylitis and Rheumatoid spondylitis (Khozaim Nakhoda and Grays, 2009). Other associated problems like fluorosis, ossified posterior longitudinal ligament (OPLL), hypophosphatemia and hypoparathyroidism need to be considered. The present observation of ossification along the anterolateral aspect of the vertebral body involving more than four thoracic vertebrae,

Fig. 3 Anteroposterior and lateral views showing ossified ligaments and radiodense line

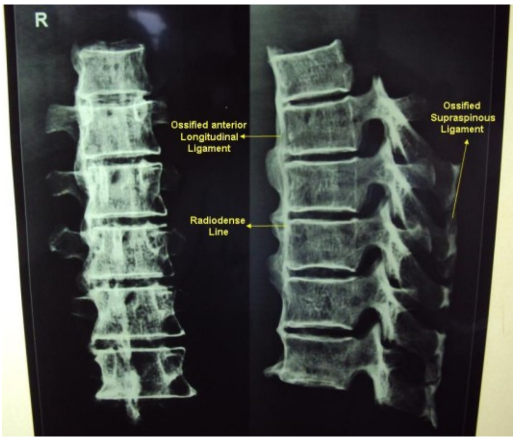
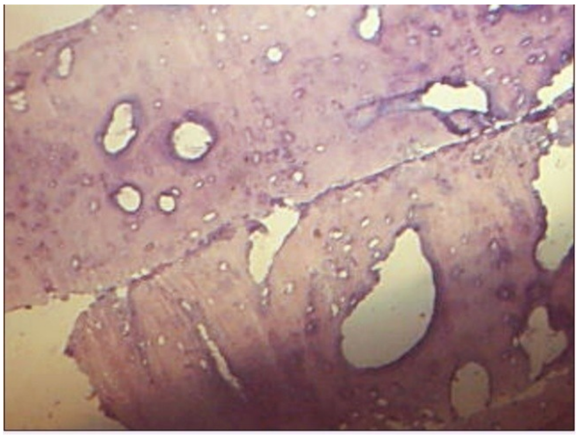


Fig. 4. Histology of mass showing lamellar bone pattern (H&E, 10X)



supraspinous ligament ossification, maintained disc space, free facetal joints, separation of the ossified mass from the body and candle wax dripping appearance favour the diagnosis of Forestier's disease otherwise known diffuse idiopathic skeletal hyperostosis (DISH).

DISH is an idiopathic rheumatological abnormality in which exuberant ossification occurs along the ligaments (McCafferty *et al.*, 1996). The incidence of this disease is about 6 – 12 % (Khozaim Nakhoda and Grays, 2009) and shows a male predominance (Westerveld *et al.*, 2008). It is noted predominantly in elderly individuals usually after 50 years. But some had observed paediatric cases with ossification of anterior longitudinal ligament of cervical spine (Coakley *et al.*, 1995). Although DISH commonly affects the anterior longitudinal ligament, ossification of posterior longitudinal ligament of the cervical spine is also noted in 2% of Japanese and 0.16% of Whites by Ono *et al.*, (1982). However the pathophysiology of this phenomenon remains unknown.

DISH is found in 1-3 % of baboons, monkeys, gorillas, bears, camels, horses (Bjorkergren *et al.*, 1985; Ferigolo, 1988; Rothschild and Woods, 1988). It is interesting to note that paleontologic records showed DISH in dinosaurs and early mammals (Rothschild, 1987; Rothschild and Berman, 1991). DISH is usually asymptomatic. Reduction in range of spinal movement may occur if vertebral fusion is extensive (Olivieri *et al.*, 2007).

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International Journal of Anatomical Sciences 2010, 1:11-13

Research Paper

A Study of Microstructure of the Annular Ligament

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Key Words: annular ligament, cartilage, collagen fibers, cadaveric study

Abstract: In the elderly pain around the lateral side of the elbow is often diagnosed as lateral epicondylitis and the wear and tear of the common extensor origin is often implicated. However surgical ablation of the common extensor origin, physiotherapy and repeated intra articular injection have failed to alleviate the misery. Of late erosion of the inner surface annular ligament is considered to be a significant cause. Haematoxylin and eosin stained sections of the cadaveric annular ligament were studied to investigate the nature of the inner surface of the annular ligament. The inner surface of the annular ligament is lined by white fibrocartilage. The nature of the cartilage does not seem to be mentioned in standard references. The findings are discussed in detail.

The Annular ligament of the superior radio ulnar joint also known as the orbicular ligament in clinical practice is a very unique structure which forms four fifths of the articulating surface for the head of the radius. It plays a significant role in the stability of the superior radio ulnar joint (Tubbs *et al.*, 2006). It is a resilient and a funnel shaped structure which has an outer and inner surface (Kanagasuntheram *et al.*, 1996). The functional importance of annular ligament has not been comprehensively defined in orthopaedic literature (Bozkurt *et al.*, 2005). The outer surface blends with the radial collateral ligament of the elbow and provides origin to the supinator muscle. The inner surface is lined by a thin coating of cartilage (Williams *et al.*, 1986) and towards the lower aspect it is lined by synovial membrane. No other ligament has this uniqueness which truly makes it a pliable articulating surface. Standard textbooks of Anatomy do not mention the nature of this cartilage which lines this inner surface. The aim of the study was to ascertain the nature of the cartilage microscopically as well as look for any variations and macroscopic changes which could provide a clue for indeterminate causes for pain around the elbow for an orthopaedician (Faro and Wolf, 2007).

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Materials and Methods

This study was carried out in 72 upper extremities belonging to both sexes after completion of dissection by the undergraduate students. Macroscopic dissections were performed on the specimens. The annular ligament was detached at both upper and lower ends from its osseous attachments. The inner surface of the annular ligament was examined for pitting, erosions and degeneration similar to bony changes. Tissue samples for microscopic studies were obtained with a predilection towards the upper part of the annular ligament. Tissues obtained were processed and paraffin blocks were prepared. Sections were taken from the aforesaid blocks and stained with haematoxylin and eosin stains. Slides were examined microscopically and lysed samples were excluded from the purpose of study.

Observations

The study showed that all the ligaments examined were thick with a mean of 1.5 mm. The internal surface of the ligaments exhibited erosive changes indicative of wear and tear. In 32 specimens there was pitting similar to that of in bony articulating surfaces (Fig. 1). There was no evidence of degeneration. Histological examination of stained tissues exhibited features of dense fibrous tissue arranged in bundles with fibroblasts interspersed and small chondrocytes arranged in groups (Fig.2) amongst the bundles suggestive of white fibrocartilage. A total number of 54 stained tissues were examined microscopically and all showed evidence of white fibrocartilage (Fig. 2).

Fig. 1 Shows pitting on the inner surface of Annular ligament.

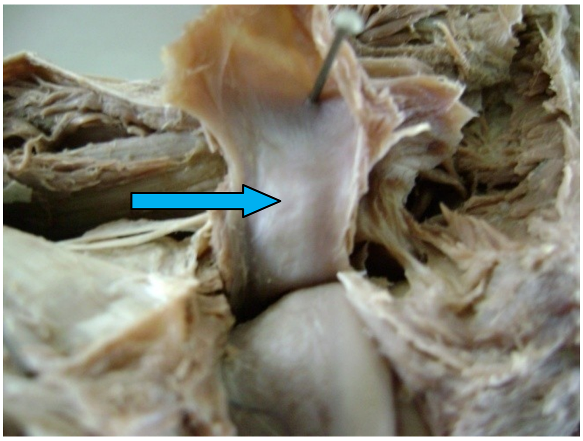
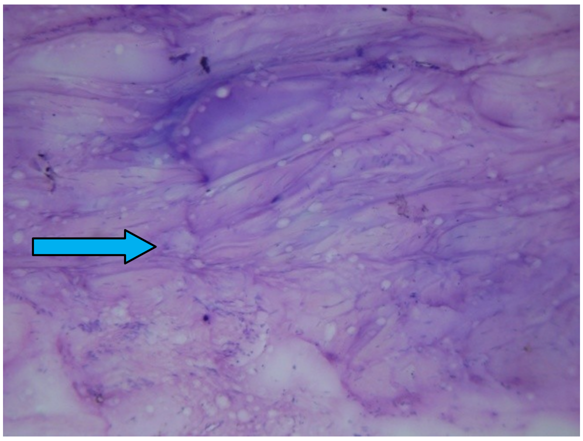


Fig. 2 Shows bundles of collagen fibers and fibroblasts.



Discussion

The superior radio ulnar joint has the same fundamental structure as other synovial joints as it has a capsule, which is lined by synovial membrane and reinforced externally by accessory ligaments. The capsule of the elbow joint is in continuation with the capsule of the superior radio ulnar joint and the synovial membrane also being a continuity. The articular cartilages of synovial joints are formed of a special variety of hyaline cartilage which reflects their preformation as cartilaginous models in embryonic life (Barnett *et al.*, 1961). The articular surfaces of bones which ossify in mesenchyme are covered with white fibrocartilage (Williams *et al.*, 1986). In a synovial articulation the opposing articulating surfaces are usually hyaline cartilage in nature. When the opposing articulating surfaces possess different cartilaginous surfaces it tends to ossify as age advances. The sacro iliac joint was said to have such opposing articulating surfaces but it now conclusively proven that both auricular surfaces of the sacrum and the innominate bone are made up of hyaline cartilage (Standring and Mahadevan, 2008). Standard textbooks mention the articulating surface of the superior radio ulnar joint as osseo ligamentous ring but in view of evidence of white fibrocartilage it is safe to conclude and name it as a osseo cartilaginous ring of the superior radio ulnar joint.

Conclusion

White fibrocartilage is resistant to degeneration but is subject to vagrancy of time where it could undergo wear and tear but as age advances it tends to show a fibrous union restricting mobility which could contribute as a cause for chronic pain around the lateral side of the elbow. Hence practicing physicians have to bear in mind the cartilaginous nature of the annular ligament as a contributory factor for unresolved pain on the lateral side of the elbow.

Acknowledgements

I wish to express my sincere thanks and gratitude to my teacher and guide Prof. Melani Rajendran, HOD of department of Anatomy, SRMC & RI for permitting me to utilize the resources for dissections and Prof. Deepti Shastri, HOD of department of Anatomy, VMKVMC for permitting me to utilize the resources for dissections, histological studies and for constant guidance and encouragement.

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International Journal of Anatomical Sciences 2010, 1: 14-16

Research Paper

A Study on the incidence of Retromolar Foramen and Canal in Indian Dried Human Mandibles and its Clinical Significance

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Key Words: mandible, third molar, retromolar canal & retromolar foramen

Abstract: The retromolar foramen (RMF) is one of the nonmetrical variants of the mandible (Ossenberg, 1987). The dental practitioners should be aware of this variant and the possible complications which may occur during anesthetic, surgical, and implantation procedures of the mandible .Indian adult dried human mandibles (150) were observed for the presence of retromolar foramen (RMF) or retromolar canal. Their gross morphological features were studied. These canals showed variations in location, length and diameter in relation to third molar.

Many people require removal of their third molar also known as wisdom teeth. As with any surgical procedure, there are some possible risks and complications (Anderson, 1998). The lower third molar region includes the area in which this tooth, its supporting elements and the adjacent soft parts, the lingual nerve and the elements of the paralingual space. Posterior to lower third molar there is a cribose triangular surface, the retromolar triangle and the retromolar fossa laterally (Suazo *et al.*, 2007). The cribose area of the retromolar triangle communicates with the mandibular canal, describing it via an anesthetic technique for the inferior alveolar nerve block (Suazo *et al.*, 2008, Sandoval *et al.*, 2008). Clinically, this region is covered by an elevation of mucosa of variable size.

Retromolar fossa is a depression where the buccinator muscle is attached above the inferior alveolar canal. From a clinical point of view this area forms, a open corridor for the passage of infections arising in connection with the third molar, this is the so-called Chompret-L' Hirondel abscess (abcès migrateur de Chompret-L'Hirondel) used it path (Libersa *et al.*, 1982; Peron, 2004). On the surface of the retromolar fossa found the retromolar foramen (RMF), which creates a canal of variable depth, regarded as an anatomical variation. Since most of the anatomical books do not mention about this foramen or canal this study was undertaken to analyze the incidence in Indian adult dried mandibles.

Materials and Methods

A total of 150 Indian adult dried human mandibles were observed for the presence of retromolar foramen (RMF) or retromolar canal in Department of Anatomy, Sri Ramachandra Medical College and Research Institute. Their locations in relation to third molar were taken into account for observation. The diameter and

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the depth were measured by using Mitutoyo's Dial Caliper.

Observations

The retromolar foramen and canal Fig. 1 was found in 26 of 150 mandibles (17.3%) of which 8 on the right side (5.3%), 6 on the left side (4%) and 12 bilaterally (8%) (Table I). The depth of the retromolar foramen and canal was found to be an average of 12mm Fig.2a and 2b. The diameter of the retromolar foramen and canal was found to be an average of 1.3 mm. The distance between posterior third molar to retromolar foramen and canal was found to be an average of 4.5 mm on the right side and 4mm on the left side Fig.3. The distance between anterior border of ramus to retromolar foramen was found to be an average of 8.4 mm on the right side and 8.3mm on the left side. The distance between lingula to retromolar foramen was found to be an average of 14.1mm on the right side and 12.6mm on the left side.

Table 1 Distribution of Retro Molar Foramen

Sex	Right side	Left side	Bi-lateral	Total	%
Male	3	2	5	10	6.6
Female	5	4	7	16	10.6

From the above observations the occurrence of RMF was more in females compared to males. The diameter of RMF was found to be larger in the right side. The distance of RMF from third molar, anterior border of ramus and lingula are also found to be higher on the right side. The bilateral occurrence of RMF was found to be higher in females.

Fig. 1 Photograph showing retromolar foramen on both sides.

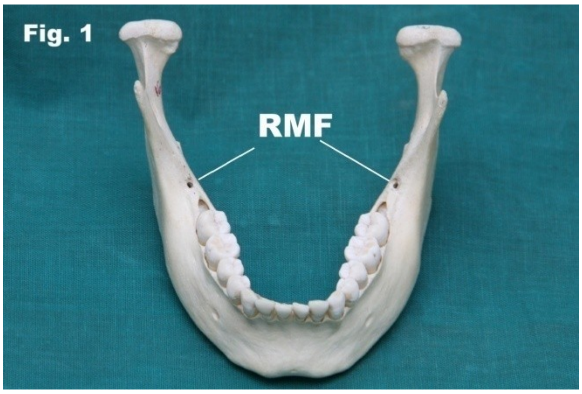

Fig. 2a Photograph showing the depth of retromolar foramen on the right side.

Fig. 2b Photograph showing the measurement of the depth of retromolar canal.

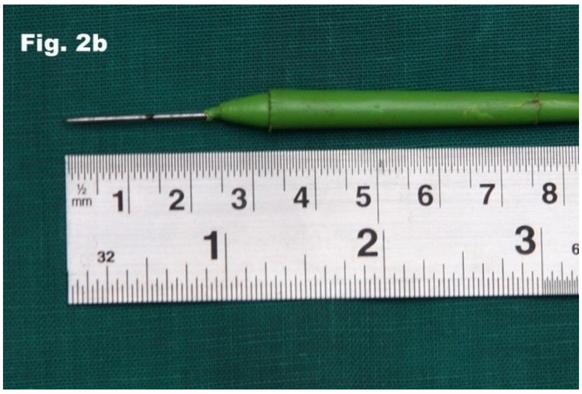

Fig. 3 Photograph showing retromolar foramen on the left side.

Discussion

The incidence of RMF located in the retromolar fossa, in our study was 17.3%. It is higher than what reported earlier by Suazo, *et al.*, (2008) 12.9% in Brazilians, but lower than what reported by Kodera & Hashimoto, (1995) 19.5% in Japanese population and Narayana *et al.*, (2002) 21.9% in the South Indian population.

Kodera and Hashimoto (1995) performed the dissection of retromolar canal in Japenese cadavers and found within the retromolar canal, the artery running was a branch from the inferior alveolar artery, it ran through the canal forwards and joined with the branches of the buccal artery and the facial artery. The nerve in the retromolar canal was a branch from the trunk of inferior alveolar nerve and branched off to the following areas: the third mandibular molar, the mucosa of retromolar triangle, the buccal mucosa, and the buccal gingiva of the mandibular premolar and molar region. These elements may be injured in the dieresis procedures, flap lifting, bone tissue for autologous bonegrafts, osteotomy for the surgical extraction of lower third molars, placement of osseointegrated implants for orthodontic or during the division of the mandibular ramus in the sagittal split osteotomy surgery (Reyneke *et al.*, 2002 , Boronat Lopez and Peñarrocha Diago, 2006).

This study clearly establishes the incidence of the retromolar foramen and its clinical significance. The retromolar foramen is highly variable in their morphology and morphometry. The cortical plate over the retromolar triangle is not heavy as the bone surrounding it and it is more cancellous (Ash *et al.*, 2003). During routine anesthetic, surgical and implantation procedures of the mandible, care should be taken not to damage the neurovascular bundle passing through the retromolar foramen.

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International Journal of Anatomical Sciences 2010, 1: 17-20

Research Paper

Greater Splanchnic Nerve

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Key Words: greater splanchnic nerve, sympathectomy.

Abstract: Sympathectomy is done for relief of pain concerned with abdominal organs such as pancreatic pain. According to Naidoo (2001) establishing a predictable pattern of splanchnic neural anatomy may be of surgical relevance. Therefore an attempt has been made to study the level of origin as well as the pattern of formation of the greater splanchnic nerve in 25 adult cadavers with a view to obtain more information about them to help overcome the failure rate in sympathectomy procedures. The highest level of origin was seen from T4 and the lowest ganglia contributing to the formation of the greater splanchnic nerve was T11.

Sympathetic preganglionic efferent fibres emerge through the thoracic and upper lumbar spinal nerves as white rami communicans and reach the sympathetic chain. These fibres emerge from the medial side of lower thoracic sympathetic chain to form the splanchnic nerves. The greater splanchnic nerve usually is formed by the myelinated preganglionic efferents emerging via 5 to 9 or 10th thoracic ganglia. They end in the coeliac ganglia.

Sympathectomy is done for relief of pain concerned with abdominal organs such as pancreatic pain. Srickland (1995) tried performance of local anesthetic and placebo splanchnic nerve blocks via indwelling catheter to predict benefit from thoracic splanchnectomy in a patient with intractable pancreatic pain. According to Naidoo (2001) establishing a predictable pattern of splanchnic neural anatomy may be of surgical relevance. Therefore an attempt has been made to study the level of origin as well as the pattern of formation of the greater splancnic nerve in 25 adult cadavers with a view to obtain more information about them to help overcome the failure rate in sympathectomy procedures.

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Material & Methods

During dissection of thorax after the removal of the lungs the sympathetic chain was cleaned and the ganglia were defined. The origin of the greater splanchnic nerve from different ganglia and its formation were noted.

Observation

The number of ganglia from which the greater splanchnic nerve was arising varied from 2 ganglia to 6 ganglia and in one the greater splanchnic nerve was absent. (Table 1).

Table 1

No. of specimens	Total no. of ganglia involved in formation
1 specimen	6 ganglia
7 specimens	5 ganglia
17 specimens	4 ganglia
22 specimens	3 ganglia
2 specimens	2 ganglia
1 specimen	Absent

The level of origin of the greater splanchnic nerve varied from the T4 – T11 ganglia. The highest level of origin was from T4 ganglion (Fig. 1). The lowest level of origin was fromT11 (Fig. 2).

Fig. 1 Highest level of origin of greater splanchnic nerve from T4 thoracic ganglion (GSN – Greater splanchnic nerve)

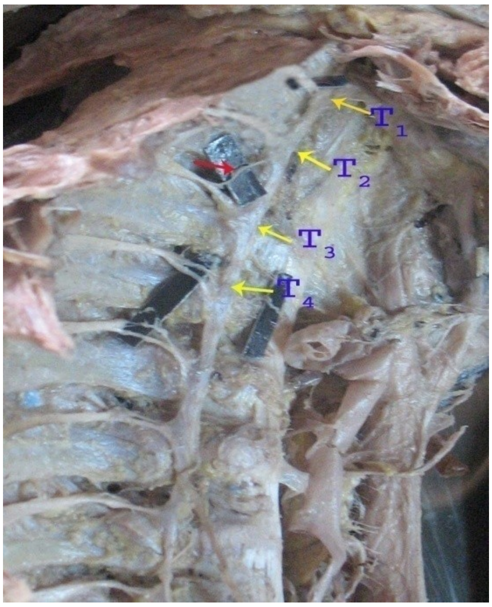
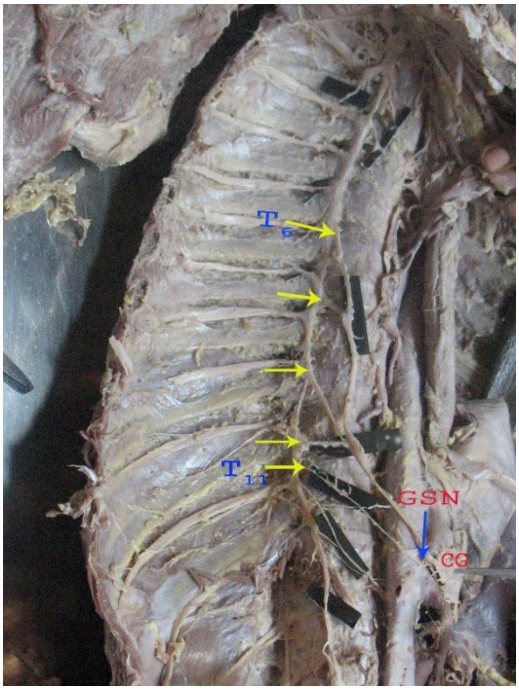
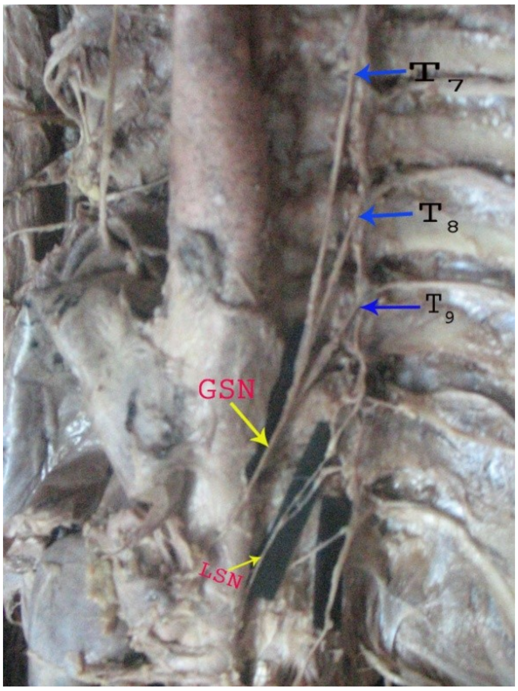


Fig. 2 Lowest level of origin of greater splanchnic nerve from T11 sympathetic ganglion. (GSN – Greater splanchnic nerve)



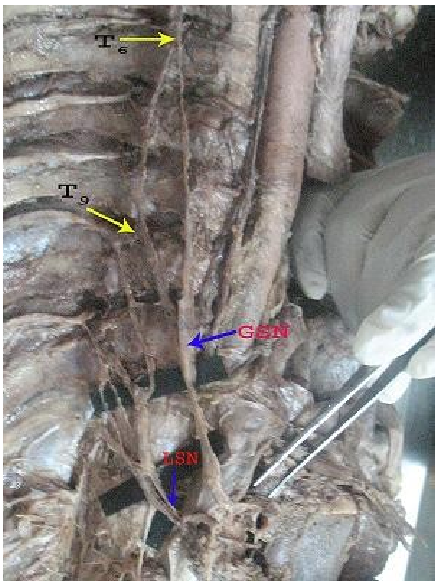
The most common origin was from three ganglia (Fig. 3) as seen in 22 specimens (Table 1).

Fig. 3 Pattern of origin of greater splanchnic nerve from 3 ganglia (T7,8,9). (GSN – Greater splanchnic nerve; LSN – Lesser splanchnic nerve)



Maximum number of a specific pattern was observed in the case of 4 ganglia (Fig. 4) where the origin was from 6,7,8,9 thoracic ganglia.

Fig. 4 Pattern of origin of greater splanchnic nerve from 4 thoracic ganglia (T6, 7, 8, & 9) (GSN – Greater splanchnic nerve; LSN – Lesser splanchnic nerve)



This was present in 10 specimens (Table 5). The pattern of origin within the specified number of ganglia also varied. (Table 2).

IJAS 2010, 1: 17-20

Table 2

Number of ganglia involved in the formations	02	03	04	05	06
Number of patterns observed	02	09	05	02	01

The details of the patterns are given in Table 3, 4, 5, 6 & 7. Two patterns were observed when the greater splanchnic nerve was arising from 2 ganglia (Table 3). Nine patterns were seen when it was arising from 3 ganglia (Table 4). Five patterns were seen when it was arising from 4 ganglia (Table 5) Two patterns were seen when it was arising from 5 ganglia (Table 6). Only one pattern was seen when it was arising from 6 ganglia (Table 7).

Table 3

Patterns	No. of specimens
7,8	01
8,11	01

Table 4

Patterns	No of specimens
5,6,7	01
5,7,9	01
6,7,8	03
6,7,9	03
6,8,9	04
6,8,10	03
7,8,9	05
7,9,10	01
8,9,10	01

Table 5

Patterns	No of specimens
4,6,7,8	01
5,6,7,8,	03
5,7,8,9	01
6,7,8,9	10
6,8,9,10	02

Table 6

Patterns	No of specimens
5,6,7,8,9	04
6,7,8,9,10	03

Table 7

Patterns	No of specimens
5,6,7,8,9,10	01

Discussion:

The greater splanchnic nerve showed great variability both in the level of its origin and in the pattern of its formation. Reed (1951) found 58 patterns of the origin of the greater splanchnic nerve among 100 cadavers. In the present study 19 patterns of origin were seen in 50 specimens. Edward and Baker (1940) found the greater splanchnic nerve arising from 3 ganglia in only 23% of the bodies as compared to the findings of the present study which shows 44% (22 specimens). Moreover, the splanchnic nerves were rarely bilaterally symmetrical according to him. In the present observation, it was bilaterally symmetrical in three cadavers.

The observation that the greater splanchnic nerve arising from T7,T8,T9 ganglia in 5 specimens is similar to the observations of Edward and Baker (1940) who have stated that the most frequent origin in their series was from the seventh, eighth, and ninth ganglia.

Reed (1951) in 100 bodies (both sides) found the highest contribution to the greater splanchnic nerve came from the fourth ganglia in 4 cases; from fifth ganglion in 64 cases; from the 6^{th} ganglion in 85 cases; from the seventh ganglion in 41 cases and from the eighth in 6 cases. In the present study the highest origin of the greater splanchnic nerve from the 4th ganglion was found in one specimen and the lowest from the 11^{th} ganglion in one specimen.

Among many patterns of arrangement which Reed (1951) observed, the most common pattern was seen in 13 specimens (6.5%) in which the greater splanchnic nerve was formed by the rami from the sixth, eighth, ninth thoracic sympathetic ganglia. In the present study, the large number of the greater splanchnic nerves with a common pattern was seen in 10 specimens (20%) and the rami were coming from 6^{th} 7^{th} 8^{th} and 9^{th} ganglia.

From these observations it is obvious that in thoracolumbar sympathectomy the sympathetic chain has to be removed upto the highest point of origin of greater splanchnic nerve to overcome failure rate in sympathectomy.

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International Journal of Anatomical Sciences 2010, 1: 21-25

Research Paper

A Study of the Anatomical Variations of the Circle of Willis Using Magnetic Resonance Imaging.

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Key Words: circle of Willis, magnetic resonance imaging angiography, anastomosis

Abstract: Variations in the circle of Willis was studied using Magnetic Resonance Imaging Angiography in fifty patients of South Indian population at random. Variations have been found in 16 cases. All arteries in the circle of Willis showed variations except the anterior communicating artery, 5 cases showed variations in the anterior cerebral artery, 6 cases in the internal carotid artery, 2 cases in the posterior cerebral artery, 1 case in the posterior communicating artery and 2 cases in the basilar artery. Magnetic Resonance Imaging is the best tool to show the collateral circulation and the anastomotic variants of the circle of Willis.

Circle of Willis is a large arterial ring which unites the internal carotid and vertebro-basilar systems. It is formed of an anastomosis between the internal carotid artery, anterior cerebral artery, anterior communicating artery, posterior communicating artery and posterior cerebral artery (Williams *et al.*, 1995). The anastomosis thus provided by this vascular ring is of great significance when one of the major arteries supplying the brain becomes occluded. The neurological deficit suffered as well as the ability of a patient to withstand occlusion of one or more of these major vessels depend on the presence of collateral circulation to the affected area. The haemodynamics of the circle is influenced by the variations in the caliber of communicating arteries and in the segments of the anterior and posterior cerebral arteries which lie between their origins and their junctions with the corresponding communicating arteries. A detailed knowledge of the normal anatomy of the circle of Willis, its anomalies, and the clinical significance of its variations is valuable to the clinicians and neuroradiologists. Therefore this study was carried out to find out the variations of the circle of Willis using Magnetic Resonance Imaging Angiography.

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Materials and Methods

Fifty patients at random from the Out Patient Department of Radiology and Imaging Sciences, Sri Ramachandra Medical College and Research Institute, Sri Ramachandra University for undergoing MRI were chosen for the study. The technique used was three Dimensional Time of Flight Magnetic Resonance Angiography (3D-TOF-MRA). Only the arteries forming the circle of Willis were studied. For the purpose of identification,the circle of Willis is divided into anterior and posterior configurations.The anterior configuration consisting of the anterior cerebral artery, anterior communicating artery and internal carotid artery. The posterior configuration consisting of posterior cerebral artery, posterior communicating artery and basilar artery. For the purpose of description,the segments of the anterior and posterior cerebral arteries are named as :

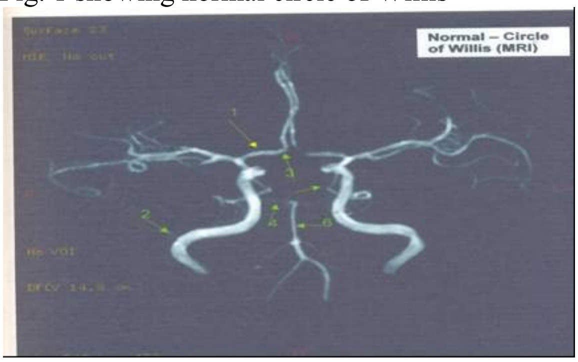
1. Anterior cerebral artery – horizontal (A1) segment that extends medially from its origin to its junction with the anterior communicating artery.

2. Posterior cerebral artery – Pre-communicating (P1) segment extends laterally from its origin at the basilar bifurcation to its junction with the posterior communicating artery.

Observations

Out of the fifty cases, only sixteen cases showed variations of the circle of Willis whereas others were found to be normal (Fig. 1).

Fig. 1 showing normal circle of Willis



1. anterior cerebral artery 2. internal carotid artery 3.anterior communicating artery 4.posterior cerebral artery 5.posterior communicating artery 6.basilar artery

The findings were:

1. Hypoplasia of the A1 segment of the right anterior cerebral artery in 5 cases (Fig. 2).

2. Hypoplasia of left internal carotid artery in one case (Fig. 3) and stenosis in 5 cases on the right or left sides (Fig 4).

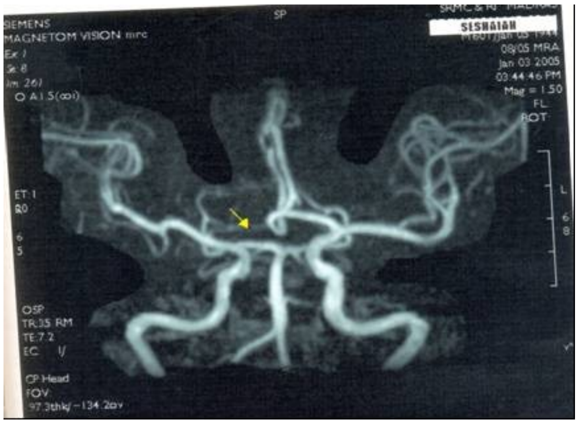
3. Hypoplasia of P1 segment of the right posterior cerebral artery in one case (Fig. 5) and diffused narrowing on the right side in another case (Fig. 6).

4. Absence of right posterior communicating artery and hypoplasia of left posterior communicating artery in the same case.(Fig. 7).

5. Stenosis of basilar artery in one case (Fig. 8) and ectactic changes in another case (Fig. 9).

6. No changes were observed in the anterior communicating artery.

Fig. 2 showing hypoplasia of the A1 segment of the right anterior cerebral artery.



Arrow indicates hypoplasia

Fig. 3 showing hypoplasia of left internal carotid artery

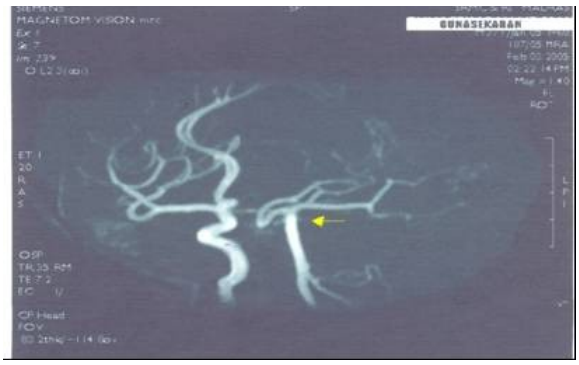


Fig. 4 showing tight stenosis of right internal carotid artery

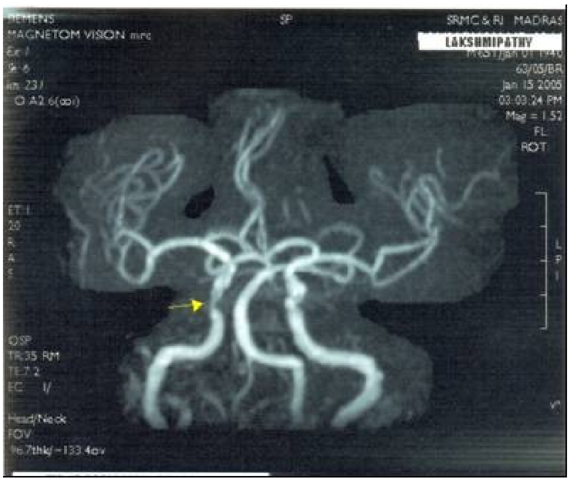


Fig. 5 showing hypoplasia of right posterior cerebral artery

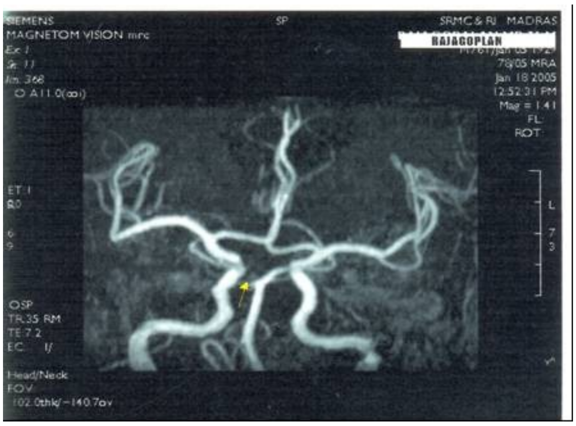


Fig. 6 showing diffuse narrowing of right posterior cerebral artery

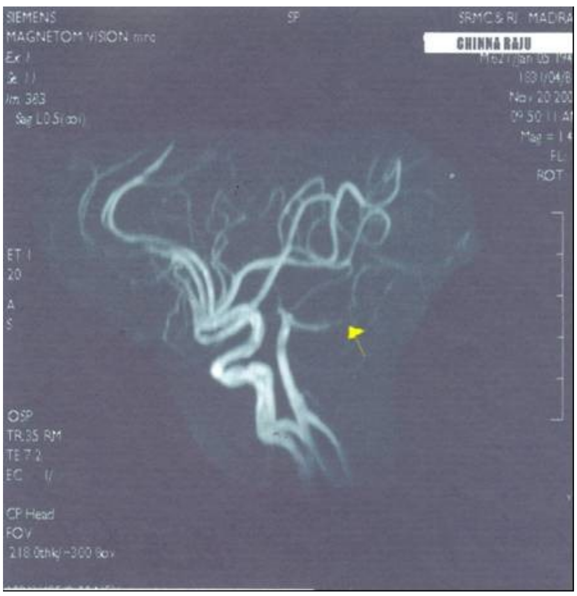


Fig. 7 showing absence of right posterior communicating artery and hypoplasia of right posterior communicating artery

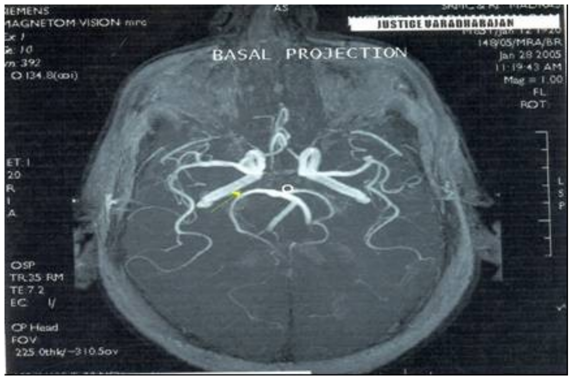
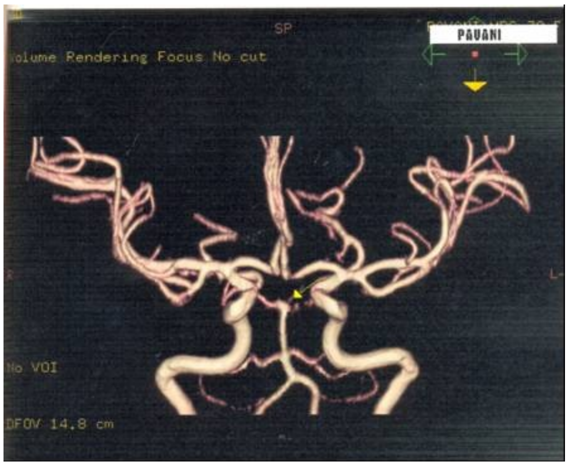


Fig.8 showing stenosis of basilar artery

Fig. 9 showing bulbosity of basilar artery



Discussion

Variations of the circle of Willis have been studied by many investigators. Al-Hussain et al (2001) carried out a study to describe the main variations of the circle of Willis to clarify the clinical importance of these variations. In his study, out of 50, only 14 polygonal types of circle of Willis were observed; whereas in the present study of 50 cases 16 cases showed variations in the circle of Willis.

In a study by Macchi et al (2002) by MRA, the variability of the circle of Willis in 118 persons showed normal circle of Willis in 47%, complete anterior configuration in 90% and complete posterior configuration in 48.5%. Voljevica et al., (2004) analyzed angiographies of 150 MRI patients, in which a complete anterior configuration of the circle of Willis was seen in 76% with hypoplasia of the anterior cerebral artery. But in the present study, normal circle of Willis was 46 % with hypoplasia of anterior cerebral artery, complete anterior configuration was 78% and complete posterior configuration was 90%. Circle of Willis is regarded as the major source of collateral flow in patients with severe carotid artery disease (Hendrikse *et at.*, 2001).When planning carotid surgery the configuration of the circle of Willis should also be taken into account. The cost of treatment of ischaemic stroke is increasing. Carotid bifurcation surgery can change the prognosis for symptomatic patients with over 70% of cartotid narrowing. Explanation of the carotid bifurcation is an important step in the diagnosis and must assess the degree of stenosis, the smoothness of the plaque and the collateral vessels (Rolland *et al.*, 1996).

In the observations of Szabok *et al.* (2001), statistical analysis showed a significant relationship between the degree of stenosis and observed stroke pattern. In the present study of 50 patients, high grade internal carotid artery stenosis was seen in 10%. Although in the individual patient, any of the infarct patterns may occur, in statistical terms the incidence of a particular stroke pattern is clearly dependent on the degree of stenosis. Therefore territorial stroke can occur in internal carotid artery stenosis. The present study also showed absence of posterior communicating artery on the right side and hypoplastic posterior communicating artery on the left side and the internal carotid arteries on either side appeared normal in its course and caliber. But the patient had lacunes in both cerebral hemispheres. In a similar study by Schomer *et al.*, (1994), it was concluded that absent ipsilateral posterior communicating artery is a risk factor for ischaemic cerebral infarction in patients with internal carotid artery occlusion.

A small or absent ipsilateral posterior communicating artery is a risk factor for ischaemic cerebral infarction in patients with internal carotid artery occlusion. De Felice *et al.,* (2000) studied bilateral non functioning posterior communicating arteries of circle of Willis in idiopathic sudden hearing loss in some patients and suggested a strong association between a non-functioning posterior communicating artery of the circle of Willis in sudden hearing loss. After the occlusion of an internal carotid artery the principal source of collateral flow is through the arteries of the COW, but the size and patency of these arteries are quite variable. Study of the anatomy of the collateral pathways in patients with ICA occlusion with or without infarction in the watershed area of the deep white matter may identify patterns that afford protection from ischaemic infarction (Brunere *et al.*, 1995).

In the present study in one case, the basilar artery showed ectactic change at its bifurcation. The basilar artery aneurysm can cause stroke which may be due to thrombosis of the perforating arteries, arterio-arterial emboli or a compressive mechanism. Since sub arachnoid haemorrhage secondary to rupture of a dolichoectasia is exceptional, some authors support the use of permanent anti-coagulation rather than platelet antiaggregation in patients with ischaemia, where dilatations are limited to the basilar artery (Arenas *et al.,* 2001).

Conclusion

The signal intensity of blood flow within a vessel is dependent on the replenishment of fully magnetized spins at the entry of the imaging section. Accordingly, non-visualization of a vessel may be either due to the absence of the vessel or to a very slow or turbulent flow within the vessel itself. Completeness of the configuration of the circle of Willis evaluated by using 3D-TOF-MRA is thus expected to be under estimated, both in healthy subjects that may show a negligible flow across the communicating vessels due to the symmetrical blood supply to the circle of Willis and in patients with severe stenosis or occlusion of the internal carotid artery that may show turbulent flow in one or more segments of the circle of Willis due to the presence of collateral pathways

MRA for determining the degree of carotid stenosis prior to carotid endarterectomy is attractive because it does not have the high morbidity associated with conventional intra-arterial angiography. Both atherosclerotic and non-atherosclerotic carotid artery disease can be comprehensingly assessed with contrast enhanced Magnetic Resonance Angiography. Contemporary understanding of the collateral circulation may be greatly enhanced through further refinement of neuroimaging modalities that correlate angiographic findings with perfusion status, providing the basics for future therapeutic and prognostic applications.

Therefore it can be concluded that MRI is the most powerful non-invasive method to demonstrate collateral circulation via the basal communicating arteries and to identify haemodynamically relevant anatomic variants of the circle of Willis.

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Research Paper

Morphology of the Intercondylar Notch and its Clinical Significance

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Key Words: intercondylar notch, dimensions, anterior cruciate ligament

Abstract: The dimensions of the intercondylar notch of dry femora and in cadavers were measured and their clinical implications were assessed. The study was conducted in two groups, Group A (dry bones) and Group B (cadaveric knees). The dimensions including notch width, condylar width, notch depth, condylar depth and the shape of the notch were measured using standard guidelines in both groups. In group B, the status of the anterior cruciate ligament (ACL) was also noted and categorized. Using these datas, the notch width index (NWI) and notch depth index (NDI) were calculated. The results were analyzed statistically. The average notch width index was found to be 0.252 in dry bones and 0.230 in cadavers. The average notch depth index was found to be 0.467 in dry bones and 0.502 in cadavers. The shape of the notch (in both groups) in majority of the cases was "inverted U" and in few cases it was "triangular". Sixteen knees showed laxity of ACL with marginal reduction of both indices. The clinical implications are discussed.

The shape of the intercondylar notch plays an important role in knee injuries. Triangular shaped notches with straight edges cause damage to the ligaments. The shape of the intercondylar notches were observed by many investigators (Anderson *et al.*, 1987; Souryal and Freeman, 1993 and Shickendantz and Weiker 1993). The morphology of the intercondylar notch of the femur is related to the functioning of the cruciate ligaments. Abnormally narrow (stenotic) notches have been shown to increase the incidence of anterior cruciate ligament (ACL) injuries. The lower end of the femur presents two rounded and eccentrically curved condyles. The groove present anteriorly between them is called the patello-femoral groove. The notch separating them posteriorly is the intercondylar notch (Williams *et al.*, 1995).The cruciate ligaments have intimate embryological and functional relationship to the intercondylar notch (Robert Miller, 2008). The space available for the cruciate ligament is determined by the dimensions of the notch including the depth, width and shape.

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Narrowing of the intercondylar notch is termed as "intercondylar notch stenosis". Few authors have noted a strong association between stenotic intercondylar notches and anterior cruciate ligament injuries (Souryal and Freeman 1993). The intercondylar notch is found to be significantly smaller in knees with severe osteoarthritis due to osteophyte growth in the notch (Wada *et al.*, 1999), thus increasing the incidence of ACL ruptures in patients with degenerative arthritis (Heriberto Ojeda Leon *et al.*, 2005). Literature regarding the morphology of the intercondylar notch in Indian population is scarce. Therefore an attempt has been made to determine these dimensions and their clinical implications in Indian population.

Materials and Methods

The study was conducted in two groups (A & B). Group A comprised of dry bone samples (n= 200 femora) and group B, cadaveric knees (n=40). Dry bones and cadaveric knees from the Departments of Anatomy, Vinayaka Missions Kirupananda Variyar Medical College, Salem and Sri Ramachandra Medical College & Research Institute, Sri Ramachandra University, Chennai were utilized for this study.

i) The dimensions of the femoral condyles and intercondylar notches were measured using a vernier caliper. In group A, the measurements were taken directly from the bones and in group B, the measurements were taken in the cadavers at the anterior outlet of the knees with the knee in 90 degrees flexion (Fig.1).

The measurements of the parameters were taken according to the guidelines given by Anderson *et al.*, 1987; Herzog *et al.*, 1994 and Wada *et al.*, 1999. In both the groups, the notch width represented the width of the notch at two-thirds of the notch depth. The notch depth was identified as the maximum height of the intercondylar notch. The width of the femoral condyle between both epicondyles was measured as the condylar width and the maximum antero-posterior height of the lateral femoral condyle was measured (Wada *et al.*, 1992) as the condylar depth (Fig. 2). The notch width index (NWI) and notch depth index (NDI) were calculated with these data. The shape of the intercondylar notches and the status of the ACL were also studied. The results were tabulated and analyzed statistically. The data of this study was analyzed using SPSS 15.0.

Fig 1 Measurement of notch width in cadaver with knee in 90^{o} flexion

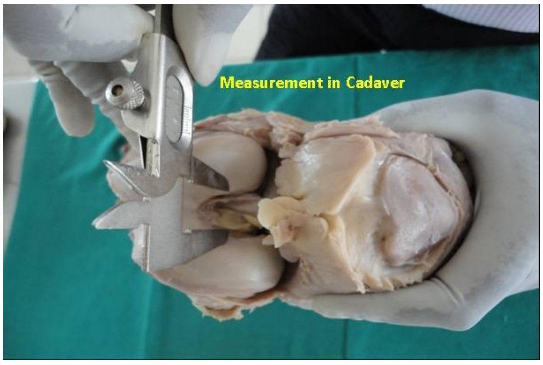
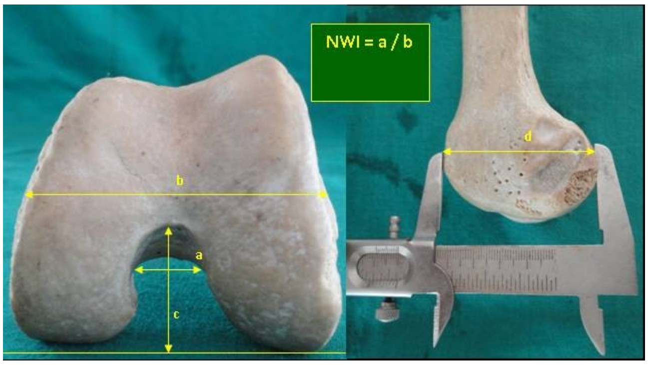


Fig 2 Measurement of different parameters



(a – notch width b – condylar width c – notch depth d – condylar depth)

Observations

The Descriptive Statistics like N, percentage, range, mean & standard error of mean including the Inferential statistics like student's t-test (Swan, 2005) with p – value of dry bone parameters and cadaver parameters are tabulated (Table 1). The mean $\pm$ SE of NWI and NDI in group A was found to be 0.252 $\pm$ 0.002 and 0.467 $\pm$ 0.003 respectively. The mean NWI and NDI in group B was 0.231 $\pm$ 0.003 and 0.503 $\pm$ 0.013 respectively.

The shape of the notch in 67% of group A and 80% of group B was found to be "inverted U" and 33% of group A and 20% of group B showed triangular shaped notches (Fig. 3). 16 knees in group B showed laxity of ACL and 24 knees had normal ACL. A comparison of NWI and NDI between the knees with normal ACL and lax ACL showed a marginal reduction of both the indices in the knees with laxity of ACL (0.227 and 0.514 respectively).

Table 1. Descriptive & inferential statistics

VARIABLE	N	SIDE	RANGE	MEAN	S E (MEAN)	95% CI	T - value	P - value
GROUP A								
Notch Width	200	Left (94) Right(106)	12 to 26 9 to 28	18.65 18.89	0.27 0.29	18.11 – 19.20 18.31 – 19.47	0.588	0.557
Condylar width	200	Left(94) Right (106)	61 to 87 57 to 89	73.97 74.58	0.61 0.57	72.70 – 75.19 73.45 – 75.71	0.724	0.470
Notch Depth	200	Left (94) Right(106)	19 to 33 20 to 34	27.27 27.20	0.29 0.27	26.68 – 27.86 26.67 – 27.74	0.172	0.864
Condylar depth	200	Left(94) Right (106)	43 to 69 35 to 72	58.38 58.71	0.51 0.52	57.36 – 59.39 57.67 – 59.76	0.453	0.651
GROUP B								
Notch Width	40	Left (21) Right (19)	14 to 23 15 to 22	18.14 19.05	0.50 0.50	17.08 - 19.20 17.98 - 20.12	1.260	0.215
Condylar Width	40	Left (21) Right (19)	65 to 88 66 to 94	79.19 81.94	1.28 1.61	76.51 - 81.87 78.54 - 85.34	1.347	0.186
Notch Depth	40	Left (21) Right (19)	21 to 37 24 to43	29.95 30.68	0.83 1.08	28.20 - 31.70 28.41 - 32.95	0.543	0.592
Condylar depth	40	Left (21) Right (19)	42 to 73 54 to 71	58.95 63.47	2.35 1.00	54.04 - 63.85 61.35 - 65.58	1.707	0.096

Fig. 3 Different shapes of the intercondylar notch noted in the present study

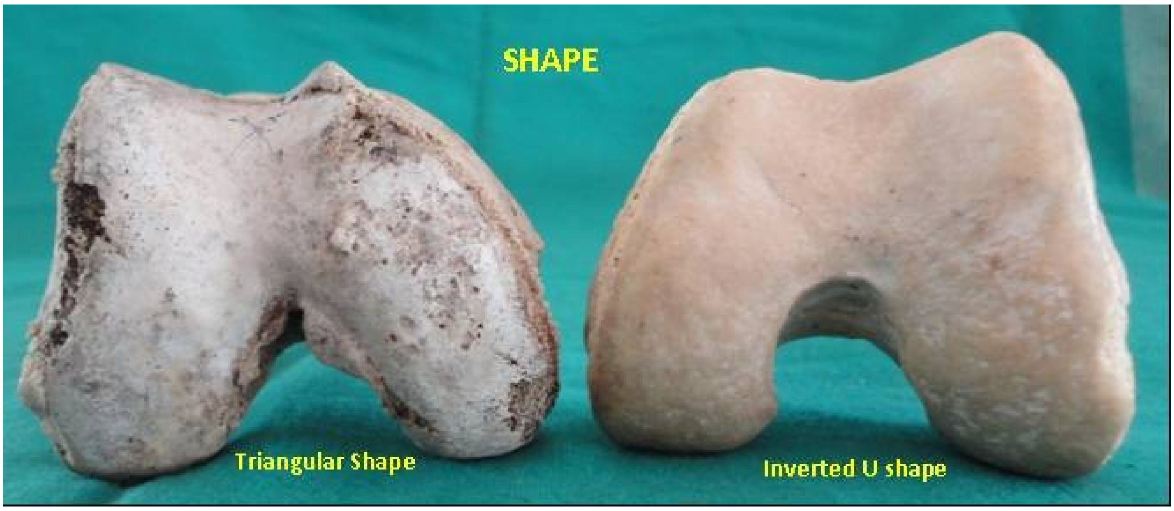
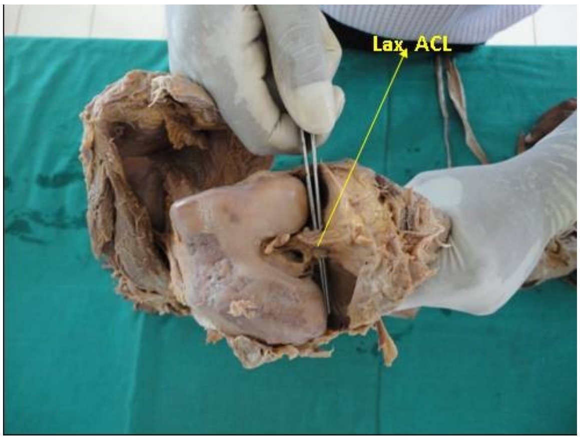


Fig.4 Shows lax ACL in one of the knees of Group B



Discussion

The ACL is one of the commonly injured ligaments in athletes and in patients with degenerative osteoarthritis. Orthopaedic surgeons describe the injuries of ACL as "the beginning of the end of the knee". The exact incidence remains unknown (Robert Miller, 2008). The ACL courses approximately at an angle of 40 degrees from its tibial attachment to the femoral attachment. The roof of the intercondylar notch is inclined 40 degrees to the longitudinal axis of the femur so that when the knee is in full extension, the roof is near the anterior surface of the anterior cruciate ligament (Robert Miller, 2008). The morphology of the notch therefore plays a very important role in the injuries of ACL.

In this regard, notch width index (NWI) has frequently been used as an indicator of stenosis (NWI < 0.20) of the intercondylar notch (Anderson *et al.*, 1987; Souryal and Freeman 1993; Shickendantz and Weiker, 1993). The NWI represents the ratio of the notch width to the condylar width of the femur. In his study on 902 high school athletes using tunnel view radiographs of the knee joint, Souryal and Freeman (1993) found the normal notch width index to be 0.231 $\pm$ 0.044. In the present study a comparison of NWI and NDI between knees with normal ACL and lax ACL in group B, a marginal reduction of both the indices were noted in the knees with laxity of ACL. This difference was not found to be statistically significant (p= 0.605 and 0.804 respectively). Yet it indicates a mild degree stenosis and hence a dysfunctional (lax) ACL. Therefore this study is more in favour of the association between the notch stenosis and ACL damage and feel that critical stenotic notches (NWI<0.20) may predispose to ACL tears.

Souryal and Freeman (1993) also observed variations of the index between men and women. The index for males was found to be larger than women. Therefore the female population is at a higher risk for ACL injuries than men.

Notch depth index (NDI) has also been used by some authors to predict the stenosis of the intercondylar notch (Wada *et al.*, 1999), who had calculated the NDI as a ratio of the notch depth to condylar depth.

Anderson et al., 1987 observed variations in the shape of the intercondylar notch. According to him the shape may be "inverted U", triangular or wave shaped. A narrow, triangular notch with straight edges increases the incidence of ACL ruptures (Shepstone 2001). The results of the present study in terms of NWI and NDI vary marginally with the observations of other authors. The NWI in the present study in group A (0.252 $\pm$ 0.002) is observed to be slightly higher than the average value (0.231 $\pm$ 0.044) as observed by Souryal and Freeman, 1993. The NWI as observed in group B in the present study is same as that observed by Souryal and Freeman, 1993 (ie 0.231). The NDI in the present study in group A (0.467 $\pm$ 0.003) and in group B (0.503 $\pm$ 0.013) is almost similar to the observations of Wada et al.,(1999).

Controversy exists among different authors regarding the association between intercondylar notch stenosis and ACL injuries. Muneta *et al.*, (1997) and Teitz *et al.*, (1997) have proved that intercondyar notch stenosis is not a significant risk factor for ACL tears. However a strong association between the intercondylar notch stensois in degenerative arthritis of the knee and increased incidence of ACL damage has been confirmed by others (Wada *et al.*, 1999; Heriberto Ojeda Leon *et al.*, 2005).

Conclusion

This study throws light on the normal range of intercondylar notch width index and notch depth index in Indian population. The study also infers that stenotic notches may be a cause for dysfunctional ACL and in extreme cases may lead to tear of the same. Therefore this study would be of great help to Orthopaedic surgeons in predicting and preventing the ACL injuries in athletes and in patients with degenerative arthritis.

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Research Paper

Variations in the Origin of Left Hepatic Artery

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Key Words: left hepatic artery, left gastric artery, celiac trunk, common hepatic artery, liver surgery

Abstract: Hepatic artery is the gateway to successful hepatobiliary surgeries. Left hepatic artery usually arises from the common hepatic artery. Aberrant left hepatic artery may arise from the left gastric / gastro duodenal / right hepatic / celiac trunk / splenic or from superior mesenteric artery (Williams *et al.*, 1996). The origin of Left hepatic artery was studied in 50 cases by dissection method. After dissecting the branching pattern of common hepatic artery was noted and arteries were painted using red fevicryl paint and photograph was taken. Each photograph was given the specimen number. Left hepatic artery was seen arising from left gastric in 6 cases, from hepatic artery proper in 38 cases and from common hepatic in 6 cases. Left hepatic from left gastric lies in hepatogastric ligament and one must know this variation before dividing the ligament to reach the gastro esophageal junction.

Hepatic artery is the gateway to successful hepatobiliary surgery. Introduction of laparoscopic cholecystectomy has stimulated a renewed interest in the anatomy of the hepatic artery. Hepatic artery anatomy has been described adequately. Common hepatic artery arises from coeliac trunk and divides into gastro duodenal and hepatic artery proper. Hepatic artery proper divides into left and right hepatic artery (Williams *et al.*, 1996). Aberrant left hepatic artery may arise from the left gastric / coeliac trunk directly / right hepatic / splenic artery / superior mesenteric/ gastro duodenal or from aorta (Hollinshed and Rosse, 1985). A new emphasis is given to this by the introduction of liver transplantation hence the present study.

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Materials and Methods

50 specimens included embalmed 35 cadavers given for dissection to undergraduate students in department of Anatomy and 15 fresh specimens from postmortem bodies from department of forensic medicine, JSSMC, Mysore. Common Dissection method was used to study the specimens. After dissecting the branching pattern of Common hepatic artery was noted and arteries were painted using red fevicryl paint and photograph was taken. Each photograph was given the specimen number. Following statistical methods were employed in the present study

- Contingency Table analysis
- Chi-square test

Observations

Left hepatic artery arising from Hepatic artery proper was seen in 38 cases, from Left gastric in 6 cases and from Common hepatic in 6 cases (Table-1). The left hepatic arising from left gastric artery was found within the layers of hepatogastric ligament.

Chi-square value of 40.96 was found to be highly significant (P<. 000), indicating that maximum number of cases was observed in HP (76%), followed by LG (12%) and CH (12%). These figures are diagrammatically represented in Fig. 1.

Table 1 Frequency in variation of Left hepatic

		Frequency	Percent	Cumulative Percent
LH	HP	38	76.0	76.0
	LG	6	12.0	88.0
	CH	6	12.0	100.0
	Total	50	100.0	

LH-Left hepatic, CH-Common hepatic, HP-Hepatic proper, LG-Left gastric. Chi-square = 40.96; P< .000 (Highly significant)

Fig. 1 Bar diagram showing the frequency in variation of Left hepatic artery

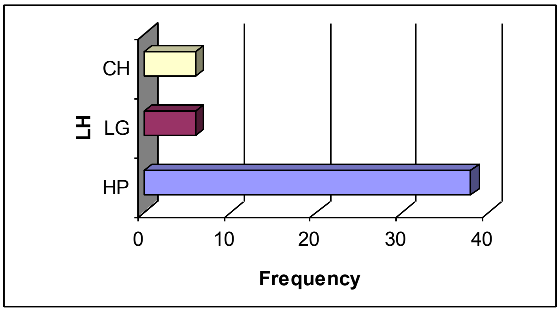
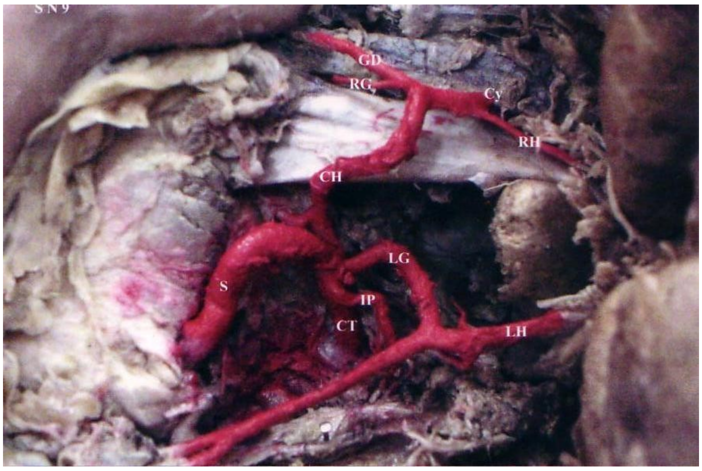


Fig. 2 Left hepatic artery arising from Left gastric artery



LH-Left hepatic, CH-Common hepatic, HP-Hepatic proper, LG-Left gastric, CT-Celiac trunk, GD-Gastro duodenal, IP-Inferior phrenic artery, Cy-Cystic artery, RG-Right gastric, S - Splenic artery, S.N 9-Specimen number 9.

Discussion

Left hepatic artery usually arises from the common hepatic artery. Aberrant left hepatic artery may arise from the left gastric, celiac trunk directly, right hepatic, splenic artery, superior mesenteric, sastro duodenal or from aorta.

Table 2 Origin of left hepatic compared with other study

Source	Michel	RM Jones & KJ Hardy	Present study
CH	85%	81%	12%
HP	-	-	76%
LG	11%	15%	12%
Others	4%	4%	0%

In the present study Left hepatic artery was seen arising from Hepatic artery proper in 76% of cases but Michels (1955) observed that in 85% of cases left hepatic was arising from Common hepatic and Jones and Hardy (2001) observed that in 81% of cases left hepatic was arising from Common hepatic. Present study value of left hepatic artery from left gastric artery was almost near to their study (Table 2). They have not mentioned about Left hepatic artery from hepatic artery proper. This difference may be because we have considered the hepatic artery into common hepatic and hepatic artery proper.

IJAS 2010, 1: 31-33.

Conclusion

Left hepatic arising from left gastric was observed in 12% of cases. This branch lies in the hepato gastric ligament and one must consider the possibility of such an artery before dividing the ligament to reach the gastro esophageal junction (Jones, 2001). Surgeons should be aware of this during ligating left gastric artery because sometimes it forms the sole blood supply to the left lobe of liver.

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Case Report

Spondylitis Ossificans Ligamentosa of Lumbar Vertebrae

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Key Words: anterior longitudinal ligament, ossification, lumbar vertebrae.

Abstract: During the routine examination of dry and processed bones, it was observed that the bodies of second, third and fourth lumbar vertebrae were fused due to the ossification of anterior longitudinal ligament. The posterior longitudinal ligament, ligamentum flavum and intervertebral discs were spared from ossification in the same specimen. The ossification of anterior longitudinal ligament in lumbar region is not commonly seen as in cervical and thoracic regions. The ossification of anterior longitudinal ligament in the lumbar vertebrae has been considered a part of Diffuse Idiopathic Skeletal Hyperostosis - DISH (Forestier's disease) Forestier's disease most commonly affects obese men who are more than 40 years old and more so in North Americans. The prevalence of the disease has been estimated to range between 12 and 22% in men and 12 and 13% in women. Most patients have mild to moderate restriction of spine movements, low back pain and stiffness in the lumbosacral region (Burkus, 1999). By radiological studies three types of ossification of anterior longitudinal ligament have been described segmental, continuous and mixed types (Mizuno, 2005). The present study makes an attempt to establish the relation between the various types of ossification of anterior longitudinal ligaments in different regions of vertebral column and Forestier's disease.

The axial skeleton of human vertebral column consists of 33 vertebrae. The vertebrae are held together by muscles and strong ligaments like anterior and posterior longitudinal ligaments. The anterior longitudinal ligament extends from the base of the skull to the sacral vertebrae (Chummy Sinnatamby, 1999). Its ossification is commonly seen in the cervical and thoracic regions, a condition rarely symptomatic and hence has not been widely described (Mizuno *et al.*, 2005). In the present study the bodies of second, third and fourth lumbar vertebrae were fused due to ossification of anterior longitudinal ligament and hence the report.

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Case Report

Data from routine examination of dry and processed bones in the department of Anatomy, JSS Medical College, Mysore was the basis for the present study. It was observed that the bodies of second, third and fourth lumbar vertebrae were fused due to ossification of the right anterolateral aspect of the anterior longitudinal ligament of lumbar vertebrae. It was noted that the height of the intervertebral disc spaces were preserved in the same specimen. The vertebrae of other regions were normal.

Fig. 1 Showing ossification of right anterolateral aspect of anterior longitudinal ligament of second, third and fourth lumbar vertebrae

Discussion

The ossification of anterior longitudinal ligament is considered as a part of diffuse idiopathic skeletal hyperostosis. Multisegmental ankylosis of vertebrae due to diffuse idiopathic skeletal hyperostosis – DISH (Forestier's disease) commonly involves the thoracic and lumbar vertebrae. Forestier's disease most commonly affects obese men who are more than 40 years old and more so in North Americans. The prevalence of the disease has been estimated to range between 12 and 22% in men and 12 and 13% in women. Most patients have mild to moderate restriction of spine movements, low back pain and stiffness in the lumbosacral region (Burkus and Denis, 1994). By radiological studies three types of ossification of anterior longitudinal ligament have been described (Mizuno *et al.*, 2005):

a. Segmental type: Partial or total ossification over a vertebral body without involving the disc space.
b. Continuous type: Ossification over many disc spaces as well as the vertebral bodies.
c. Mixed type: There's a combination of the segmental and continuous types.

The present observation appears as continuous type. Diffuse idiopathic skeletal hyperostosis has been defined as ossification along the anterior to anterolateral aspect of vertebral bodies with the preservation of the height of the intervertebral disc spaces distinguishing it from the degenerative discogenic diseases (Mizuno *et al.*, 2005). The Forestier's disease is diagnosed and distinguished from ankylosing spondylitis, on the basis of several radiographic criteria: calcification and ossification along the anterolateral borders of vertebral bodies and preservation of the integrity of the intervertebral disc without diminution of disc space height (Burkus and Denis, 1994). The ossification pattern of diffuse idiopathic skeletal hyperostosis involves the anterior longitudinal ligament, the lateral portion of the annulus fibrosis, and the adjacent vertebral bodies. The involvement of sacroiliac joint is more common in ankylosing spodylitis with the ossification of anterior longitudinal ligament and decrease in the disc space height (Maheshwari, 2005). The ossification of anterior longitudinal ligament is surgically treated by using an operating microscopic for the resection of the anterior longitudinal ligament (Mizuno *et al.*, 2005)

Conclusion

In the present study it was observed that there was fusion of the right anterolateral aspect of the bodies of second, third and fourth lumbar vertebrae due to ossification of anterior longitudinal ligament and is a part of diffuse idiopathic skeletal hyperostosis which is a rare entity and hence this report.

Acknowledgement

The authors are grateful to the Professor and Head of the department Dr.N.M.Shama Sundar, JSS Medical College, Mysore, for his support and encouragement during the work. We are grateful to the JSS Medical College and JSS University for allowing us to publish our work.

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Case Report

Double Dorsalis Pedis Artery – A Rare Case Report

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Key Words: dorsalis pedis artery, anomalous, musculocutaneous flap, peripheral pulse

Abstract: Dorsalis pedis artery running on the dorsum of the foot is one of the arteries, where peripheral arterial pulsation is felt. Also the musculo-cutaneous flaps based on dorsalis pedis artery are commonly used for reconstructive surgeries. Hence the knowledge of any variation in the course and distribution of dorsalis pedis artery is clinically important. Here a rare case of anomalous dorsalis pedis artery is presented.

The change in lifestyle in this 21^{st} century has increased the number of diabetic patients. It has become a challenge to the health care providers to deal with the complications due to diabetes. Long standing and neglected cases have been seen to end up with diabetic neuropathy and diabetic foot ulcers. These non healing ulcers are challenging problems, for surgeons, which are commonly dealt with by musculocutaneous flaps based on the branches of dorsalis pedis artery.

Dorsalis pedis artery of the dorsum of foot is the continuation of anterior tibial artery seen in 1^{st} intermetatarsal space, where it dips into the sole, between the heads of 1^{st} dorsal interosseous muscle to complete the plantar arch. In the foot it gives off medial and lateral tarsal arteries, arcuate artery and first dorsal metatarsal artery (William *et al.*, 1989).

Case Report

During routine dissection of the lower limb of a male cadaver, aged around 60 years, the anterior tibial artery (AT) on the right side divided into three branches midway between the two malleoli. Among the three branches, lateral tarsal (LT) artery was the lateral most, supplying tarsals. The two medial branches ran side by side together on the dorsum of the foot to reach the first inter-metatarsal space. The lateral one (D 2) of the two dipped in the proximal aspect of the space to join the plantar arch. The medial branch (D 1) continued as 1^{st} dorsal metatarsal artery. Both these arteries gave medial tarsal branches. Arcuate artery was absent in this case.

Discussion and conclusion

Since ages interesting anomalies of the dorsalis pedis artery have been noted by the anatomists and surgeons. According to Huber in his study in1941, the dorsalis pedis artery was found to arise from the perforating branch of peroneal artery and deviated either medially or laterally in 3% of the cases. In another study by Bailleul *et al.*, in1984 it was found that in 15 out of 67 specimens dorsalis pedis artery divided into two terminal branches 3cm distal to its origin. In this study the author also suggested arteriography to be taken prior to foot flap surgeries. In 1994, Maral *et al.*, studied the pattern of dorsalis pedis artery

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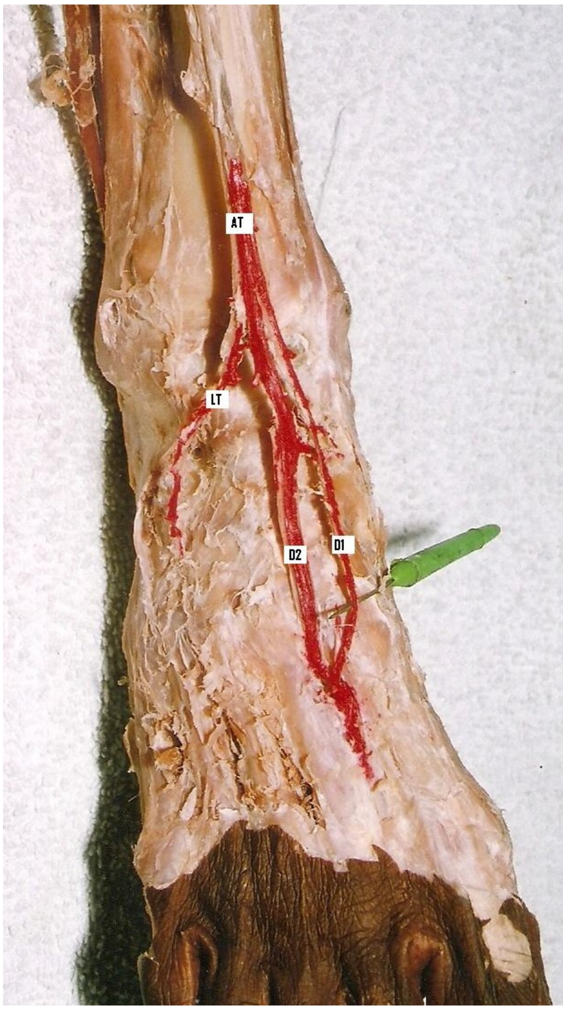
and found in around 8% of the cases the dorsalis pedis artery was the continuation of peroneal artery.

Fig. 1 Photograph of the dorsum of the right foot.



(AT- Anterior tibial artery; LT- Lateral tarsal artery ; D1 &D2 – Medial and lateral dorsalis pedis arteries)

In the present study two dorsalis pedis arteries were seen arising from the anterior tibial artery. Both the arteries ran side by side to reach first intermetatarsal space, one dipping in the proximal aspect of the space and the other continued as 1st dorsal metatarsal artery. The aberrant arteries or anomalous course of the arteries of the lower limb can be attributed to their development. The axis artery of the lower limb develops from the 5th lumbar intersegmental artery. The embryonic blood vessels acquire a plexiform appearance in the foot. The dorsalis pedis artery is a constant embryonic vessel that plays an important role in the normal arterial morphogenesis of the lower limb. The tiny blood vessels derived from the blood islands in the 3rd and 4th week of development merge with each other forming a continuous network of fine vessels. New vessels buds out from the walls grow out and get canalized to form newer vessels. These newer vessels of the neighbouring areas join to form a closed network. The adult arterial pattern of the lower limb develops from multiple and plexiform sources of vessels, and emergence of anastomoses between these vessels, which is followed by regression of some channels depending on the functional dominance. This explains why the anomalies of the blood vessels of the limbs not only present as divergence in the origin and course but also as supernumerary vessels in the region (Sadler, 1985) (Kesavi *et al.*, 2002).

Since the dorsalis pedis artery serves as an important pedicle for most of the reconstructive surgeries of the foot, the knowledge about the aberration of the usual anatomic pattern of origin, branching and anastomosing patterns of the artery are of prime importance to the general surgeons, orthopaedic surgeons, plastic and reconstructive surgeons who deal with this area.

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Case Report

Rare Origin of the Right Internal Thoracic Artery from Thyrocervical Trunk

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Key Words: internal thoracic artery, thyrocervical trunk

Abstract: Rare origin of the right internal thoracic artery from thyrocervical trunk was observed in one of the 100 cadavers in the Department of Anatomy, Kasturba Medical College, Manipal, Karnataka during the period 2001-2009. An attempt has been made to compare this finding with earlier reports and also to highlight the clinical significance of the variation.

An uncommon origin of the right internal thoracic artery (ITA) from the thyrocervical trunk was observed in dissection of the root of neck. The Internal thoracic artery normally arises as a branch from the inferior aspect of first part of the subclavian artery. It courses downwards in the ventral thoracic wall and divides into two terminal branches in the sixth intercostal space, the musculophrenic and superior epigastric arteries (Gabella, 1995). It also supplies sternum, ventral thoracic wall and diaphragm through sternal, anterior intercostals and two terminal branches. Daseler and Anson (1959), in describing its origin state that it arises ventrally from the first part of the subclavian artery, inferior to thyrocervical trunk, just medial to scalenus anterior muscle. In their study on 769 specimens they found the internal thoracic artery arising as a direct branch from the third part of the subclavian artery in six (0.78%) of the specimens investigated.

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Krechowiecki *et al.*, (1973), in a study of 100 cadavers (200 arteries) on the variations of the course of the internal thoracic artery, found the artery originating lateral to scalenus anterior muscle in one case (0.5%).

Nizanowski *et al.*, (1982), in their study on the ramifications of the subclavian artery, state that the vertebral and internal thoracic arteries showed the least deviation in their origin from the subclavian artery and abnormal or absent internal thoracic arteries in 11.4% of cases studied.

The Internal Thoracic Artery (ITA) has been widely used as a conduit in Coronary Artery Bypass Grafting (CABG) and revascularization of myocardium by surgical anastamosis of coronary artery and internal thoracic artery (Kuniyoshi *et al.*, 2002). The anatomy of internal thoracic artery facilitates its mobilization during surgery and its increasing use in coronary artery bypass grafting highlights the need to understand its variations. Internal thoracic artery arises from third part of subclavian artery in 0.83% of cases (Vorster *et al.*, 1998) or from the thyrocervical trunk in more than 10% of cases (Lischka *et al.*, 1982). In a rare case, as reported by Omar *et al.* (2000), ITA originated from third part of subclavian artery bilaterally, and yet in another case it gave origin to suprascapular artery (Yucel *et al.*, 1999).

Case Report

During routine dissection of head and neck in a male cadaver, the right ITA was found to arise from the thyrocervical trunk a branch from the first part of the subclavian artery (Fig. 1). The artery descended down and divided at the level of the right sixth costal cartilage into musculophrenic and superior epigastric arteries. The trunk of ITA provided the sternal branches, anterior intercostal arteries. No other abnormality could be detected.

Fig. 1 Photograph of the root of neck showing origin of right internal thoracic artery from Thyrocervical trunk.

(ITA-Internal thoracic artery; SC-Subclavian artery; TCT - Thyro-cervical trunk)

Discussion

The present case reports a rare origin of internal thoracic artery from the thyrocervical trunk on the right side in one of the 100 cadavers dissected (1%). Daseler and Anson (1959) found it in six (four Rt. & two Lt.) of 769 arteries (0.78%). Krenchowiecki *et al.*, (1973) found it in one of 200 arteries (0.5%).

The anomalies found in the branches of the subclavian artery could be explained by considering the embryologic development of this region. The two factors influencing the development of these branches are the ability of the blood to follow the longitudinal channels offering least resistance and the tension on the vessels resulting from the caudal shifting of the heart and aorta.

Congdon (1922), in describing the development of the subclavian arteries from the seventh paired dorsal segmented arteries, found that tension on the distal portion of the right aortic arch causes that portion of the aortic arch and the right fourth dorsal segmental artery to form the proximal part of the right subclavian artery. With failure of the part distal to the seventh dorsal segmental branch to obliterate, degeneration of the proximal part occurs, resulting in abnormal origins of the right subclavian artery from the aortic arch or descending aorta.

The vertical part of the internal thoracic artery develops from ventral anastomoses between ventral divisions of thoracic intersegmental arteries. Due to the caudal shifting of the aorta, the proximal parts of these segmental arteries are exposed to longitudinal tension and bending with a resulting retarded blood flow. This may result in abnormal connections between the longitudinal channels (vertebral and internal thoracic arteries) and subclavian artery or aortic arch.

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Conclusion

The internal thoracic artery is being used as alternative for revascularization of the myocardium in patients with coronary artery disease. Root of the neck is one of the sites commonly used in patients for percutaneous subclavian vein catheterization to determine central venous pressure (CVP) or to administer drugs and solutions in emergencies and for introducing a pacemaker.

It is therefore important to be aware of this rare variation in the origin and course of the internal thoracic artery.

Acknowledgments

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Case Report

An Unusual Flexor Digitorum Brevis Muscle and its Clinical Significance - A Case Report

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Key Words: flexor digitorum brevis, tendon

Abstract: An unusual flexor digitorun brevis muscle (FDB) was detected in the left foot of a 50 year old male cadaver. The muscle originated from the medial process of the calcanean tuberosity and was found to give off three tendons. The three tendons of FDB could be traced to second, third and fourth toes respectively. However, the tendon for the fifth toe was absent. Knowledge of such anatomical variants may be important clinically in view of reconstruction of heel pad by FDB musculocutanous flap transfer and interpretationof advanced diagnostic imaging modalities.

The flexor digitorum brevis (FDB) muscle is located between the abductor hallucis and the abductor digiti minimi and together they constitute the first layer of muscles on the sole. These muscles are closest to the skin of the sole superficially, surrounded by the planter aponeurosis and adjoined by the flexor digitorun longus (FDL) and the quadratus plantae. The muscle (FDB) takes origin from medial process of the calcaneus and plantar aponeurosis and inserted into the middle phalanges of second to fifth toes (Standring 2005).

The variations of the FDB were observed in 63% of cases, involving mostly the fifth toe and less fequently the fourth toe (Nathen and Gloobe 1973). Absence of fifth digit tendon was reported in 63.7% of cases (Chaney *et al.*, 1996). Nathan and Gloobe (1973) noticed the absence of the fourth or most lateral slip of the muscle to the fifth digit in 23% of cases and in some of these cases, the absent tendon was replaced by a tendinous slip either from the flexor digitorum accessorius muscle or from the flexor digitorum longus muscle. The present study reports a variation in the composition of tendons of FDB and attempts to discuss its clinical implications. Awareness of anatomical variants of FDB is clinically relevent for performing reconstruction of heel pad and while using advanced diagnostic imaging modalities such as computed topography and magnetic resonance imaging.

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Case Report

A variant of flexor digitorum brevis muscle was encountered in the left foot of a 50 year old male cadaver during the course of undergraduate medical training programme. The muscle originated from the medial process of the calcanean tuberosity, the central part of plantar aponeurosis and the intermuscular septa between it and adjacent muscles. It displayed a variation in the composition of its tendon. The muscle belly was found to give off three tendons near the mid segment of the foot. These three tendons were traceable to second, third and fourth toes respectively. However, the tendon for the fifth toe was absent (Fig. 1).

Fig. 1 Absence of flexor digitorum tendon for the fifth toe.

(FDB -Flexor Digitorum brevis muscle; FDL- Flexor Digitorum longus; A,B,C- tendon of flexor digitorum brevis muscle)

The muscle belly was 10.5 cm long and its maximum width was 2.5 cm. The tendons proceeding to second, third and fourth toes measured 9.4 cm, 6.8 cm and 5.8 cm respectively in length. The medial most tendon was relatively thin as compared to other two tendons. These tendons of FDB were found to be inserted as usual into the middle phalanx of the respective toes. The innervation of the muscle was derived from the medial planter nerve. There were no interconnecting bands between the individual tendons of FDB or with the tendon of flexor digitorum longus. No other morphological anomaly was noticed in the foot. Dissection of the right foot revealed normal anatomy of various soft tissue structures.

Discussion:

The knowledge of the normal and abnormal anatomy is essential in treating congenital abnormalities, traumatic and other pathological conditions of the foot and ankle (Chaney *et al.*, 1996). FDB is a highly specialized muscle which helps to control the changes in the posture of the foot (Grogono and Jowsey 1965). It carries out flexion of second to fifth toes, a function maintainted by the FDL when the former is expanded (Hartrampt *et al.*, 1980).

Standring (2005) reported the absence of fifth toe tendon, which may be replaced by small muscular slip from the long flexor tendon of from flexor accessorious. In the present case, absence of FDB tendon to little toe may possibly render tendon of FDL of that toe vulnerable to injury and displacement, since it is relatively unsupported. The neurovascular bundle along lateral side of the sole is liable to injury during surgical intervation in this region since it is deprived of the security provide by the fifth toe tendon FDB.

Three types of insertion of the FDB were recognized: absence of tendon, unsplit tendon, or tendon fused to the long flexor. The comparative assessment of size of the tendons of FDB revealed that the medial two tendons are usually larger than the lateral two (Sarrofian 1983). The present study revealed that the lengths of three tendons of FDB exhibited a decline from medial to lateral side and although the medial most tendon was the longest but it was found to be thinner than the remaining two tendons.

The toes are held extended at the metatarsophalangeal and distal inter-phalangeal joints and flexed at the proximal interphalangeal joints four toes. This probably results from the contraction of the terminal phalanges towards the sole and passively buckling the rest of the toes into the above position (Standring 2005). In the present case, presumably the flexion of little toe will be compromised because it will solely be carried out by FDL.

Reconstruction of plantar defects, especially the planter heel, presents a difficult problem as one of the main functions of this area is weight-bearing and reconstruction needs more anatomical consideration. The skin-grafted FDB flap provides an effective, feasible and reliable alternative reconstruction for extensive avulsed planter defects (Lin *et al.*, 1991).

An understanding and awareness of the possible and predictable anatomical variants can prevent confusion during surgery and diagnostic testing. Familiarity with these variants is essential to prevent errors in the interpretation of advanced imaging techniques.

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Case Report

Levator Glandulae Thyroideae with the absence of Pyramidal Lobe – A case report

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Key Words: levator glandulae thyroideae, pyramidal lobe, infrahyoid muscles, thyroglossal duct, ectopic thyroid

Abstract: Levator glandulae thyroideae is a fibromuscular band, if present is usually on the left side connecting the pyramidal lobe of thyroid gland and the hyoid bone. The presence of levator glandulae thyroideae and its anatomical variations gain importance, in the pathologies related to thyroid gland and their treatment modalities. Hence, this case has been presented here for such a clinical significance.

Musculus levator glandulae thyroideae is a fibrous or fibromuscular band that stretches from the pyramidal lobe or upper border of isthmus of thyroid gland, usually on the left side, to the body of the hyoid bone above. (Standring, 2006). Mori (1964) classified levator glandulae thyroideae into five types; a) Hyopyramidalis, b) Thyreopyramidalis, c) Thyreoglandularis, d) Hyoglandularis, and e) Tracheoglandularis based on 210 levators, that he observed. Levator glandulae thyroideae observed in the present study fits into thyreoglandularis type (origin – thyroid cartilage, insertion – sheath of thyroid gland). This structure is said to represent the detached part of infrahyoid muscles and may be innervated by a twig from ansa cervicalis (Ranganathan, 2002)

Case Report

During routine dissection of neck, in a male cadaver aged about 60 years, the presence of levator glandulae thyroideae was observed on the right side. It was dissected with utmost care to look for its attachments above and below and for its innervation. A thin band of muscular like tissue stretched from the upper border of isthmus of thyroid gland, to the lower border of the lamina of thyroid cartilage, on the right side (Fig. 1). Hence, according to Mori's classification, the levator glandulae thyroideae in this case belongs to Thyreoglandularis type. It measured 1 cm in length and 0.6 cm in breadth. Careful dissection revealed that there was no pyramidal lobe and this band did not have innervation from any nerve and did not extend up to hyoid bone. The thyroid gland and other structures in the vicinity appeared normal

As this tissue appeared to be muscular, it was subjected to microscopic study. The tissue was dissected out from the cadaver and sectioned at four levels. The tissues were then processed, and stained by hematoxylin and eosin stain, as described by Culling (1974). The study revealed the presence of thyroid follicles lined by cuboidal epithelium, with moderate amount of colloid in their lumina and surrounding fibrous tissue, at the lower levels (Fig. 2) and only fibrous tissue in the section taken at the upper level (towards the thyroid cartilage).

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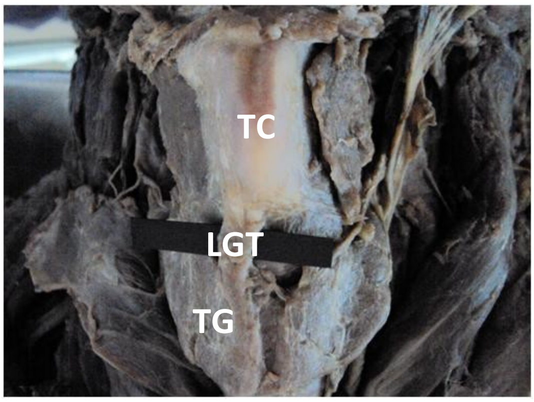
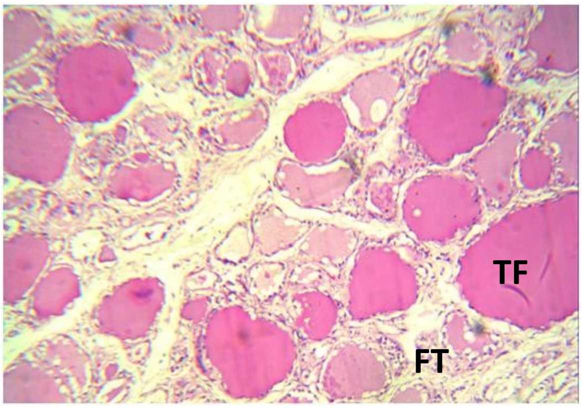
Fig. 1 Photograph of the thyroid gland with the levator glandulae thyroideae



(TC-Thyroid cartilage; LGT-Levator glandulae Thyroideae; TG- Thyroid gland)

Fig. 2 Photomicrograph of levator glandulae thyroideae showing thyroid follicles with colloid and fibrous tissue surrounding the follicles



(TF – Thyroid follicle with colloid; FT – Fibrous tissue)

Discussion

Musculus levator glandulae thyroideae stretches from the pyramidal lobe or upper border of isthmus of thyroid, usually on the left side, to the body of the hyoid bone above (Standring, 2006). It may receive its innervation from external laryngeal nerve (Sinnatamby, 2007). Moore and Persaud (1999) have stated that pyramidal lobe is seen in 50% of population and the muscular band may be made up of smooth muscle fibres and that the pyramidal lobe and the associated smooth muscle represent the persistent part of distal end of thyroglossal duct. Another study done in 90 male cadavers revealed that, pyramidal lobe was present in 37.77%, frequently arising from the left lobe, while the levator glandulae thyroideae was present in 30% instances, mostly attached above to body of hyoid bone (Joshi *et al.*, 2010).

The levator glandulae thyroideae observed in the present study is of thyreoglandularis type, which was found to be attached to thyroid cartilage on the right side, with no innervation from any nerve. The pyramidal lobe was also totally absent (Fig. 1). The microscopic study revealed that it was mainly made up of glandular tissue and partly by fibrous tissue towards the thyroid cartilage. Hence in this case, the levator glandulae thyroideae did not have innervation and it was made up of fibroglandular tissue (Fig. 2), which represents the persisting distal end of thyroglossal duct.

Accessory nodules / ectopic thyroid tissue of the thyroid are usually found at the embryonic origin of thyroid, at the foramen caecum and along the thyroglossal tract (Bergman *et al*., 2007; Ranade *et al.*, 2008). Therefore the anterior cervical region has to be investigated very carefully during surgery, in order not to leave behind any residual thyroid tissue, during total thyroidectomy (Braun *et al.*, 2007).

Conclusion

This study highlights the significance of thorough understanding of the thyroid anatomy and its associated anatomical variations, which thus form a cornerstone for safe and effective thyroid surgery.

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International Journal of Anatomical Sciences 2010, 1: 48-49.

A Tribute to the Guru
"The Diminutive Genius"

Ragunathar Kanagasuntheram
M.B.B.S (Cey); Ph.D (Cantab); D.Sc. (Jaffna); A.M (S'Pore); F.I.Biol. (Lond)
(1919 – 2010)

Ragunathar Kanagasuntheram, born on October 13, 1919 in Karainagar, a tiny village in Jaffna, Sri Lanka, had his early education at the primary vernacular school before joining the Karainagar Hindu College. Both at the school and the college he was always first in the class and won many prizes including the best all rounder prize. In the junior school certificate examination in 1936, he obtained a First Division pass, one among the three for the entire Sri Lanka. Later he moved to the Jaffna Hindu College and passed the London Matriculation examination in 1938 which enabled him to pursue his medical studies at the University College, Colombo.

His performance in the medical school was outstanding for he obtained First class in anatomy, physiology, pathology, Distinction in medicine, surgery and winning the Rockwood Gold medal in 1944. After completing the "House postings", he also passed the Primary FRCS examination in 1947. But destiny probably did not allow him to pursue further in that direction for he decided to teach anatomy to the students and joined as a Lecturer in anatomy in 1948. His thirst for knowledge made him move later to Cambridge to do PhD in anatomy under the guidance of Prof. H.A Harris and Prof J.D. Boyd at Fitzwilliam College. A scholarly thesis on the "Hand of gibbon" earned him not only the PhD in 1952 but also the prestigious post of Demonstrator in anatomy at Cambridge, a great honour. On his return to Colombo he was appointed as a Senior lecturer in the Department. Again in 1956 he visited Cambridge briefly to study Descriptive and Experimental Embryology under Professor Abercrombie FRS.

IJAS 2010, 1: 48-49.

The 1958 riots in Ceylon, forced Dr. Kanagasuntheram to leave his mother land and take up the post of a Senior lecturer at the University of Khartoum, Sudan. The shift to Khartoum enabled him to utilize the available facilities and finances to harness his research potential to a maximum. His work on primate anatomy brought him international recognition. He visited Cambridge every year and built up an everlasting relationship with Prof. Boyd. He also visited other research centers. Notable among them was his visit to the Laboratory of Neurophysiology at Wisconsin, USA, under Professor. C.N. Woolsey who taught him the neuro-physiological techniques for mapping the somatic sensory area of Galago, a rare species of lower primate found in Sudan.

It was in 1962 that Dr. Kanagasuntheram reached the topmost rung in the academic ladder, which he so carefully ascended, when he was appointed as the Professor of anatomy at the University of Singapore. Without resting on his laurels, he steamed ahead at the helm of affairs to build up the Department of Anatomy from scratch. On his initiative and perseverance, routine histology lab, animal house, micro-photographic unit, tissue culture lab, experimental embryology lab, surgical operation theatre, electron microscope lab, and electrophysiological lab, were all set up in stages, within a short span of 8 years. This enabled him to train seven PhD's in the department itself which included, I am proud to say, me and my late wife Dr. Leela Krishnamurti.

He has to his credit over 100 scientific publications in various International Journals of repute, some of which are widely quoted including Grey's Text book of Anatomy. Besides, he has also authored two books on anatomy. In recognition of his meritorious services, the University of Singapore conferred on him the title Emeritus Professor of Anatomy in 1980. The final accolade to his yeoman contribution to teaching and research was his election as a Fellow of Biological Sciences, London, supported by three FRS's. He was also the first Asian to be appointed as an examiner for Primary FRACS.

Professor Kanagasuntheram, affectionately referred to as "Kanaks" by pupils and colleagues scattered all over the world, was a simple, unassuming person ranked as one of the top academics from this part of the world. He was an active dedicated teacher of Comparative Anatomy & Embryology and a renowned researcher. Like all good teachers he was also a task master.

Strangely, destiny decried that Professor Kanagasuntheram should return to the land of his birth, Jaffna in 1981 to take up the post of Professor of Anatomy as well as the post of Dean Faculty of Medicine, of the newly established Jaffna Medical College which conferred on him the D.Sc. Once again, the 1983 unrest in Jaffna forced Professor Kanagasuntheram to go back to Singapore and later to South Australia where he spent his last days with his children and grandchildren and playing Tennis, which was his first love. The distinguished lamp that started in Karainagar went round the world illuminating till it finally got extinguished in South Australia on 19th July 2010.

Prof. A. Krishnamurti
Editor in Chief

International Journal of Anatomical Sciences 2010, 1: 50-51.

Tribute

Dr. C. Cecilia Isaac

(1927 – 2010)

"Full many a gem of the purest ray serene
Full many a flower is born to blush unseen"
- Elegy

Dr. C Cecilia Isaac, Professor of Anatomy, entered into eternity at the age of eighty three on 19-3-2010 after a brief illness. She had a fruitful life as a great teacher of Anatomy in various Government Medical Colleges of Tamil Nadu and after her superannuation in different private Medical Colleges in Chennai till her eighty first year of life.

Dr. Cecilia hailed from Rangoon, Burma, where her father was working in a Government Hospital. She literally walked into India close to Calcutta through the jungles of Burma along with her mother, four brothers and four sisters in the year 1942 during the World War II. The then Indian Government and its Congress leaders helped them to settle down at Madras.

After obtained the MBBS degree from the Stanley Medical College, Madras, Dr. Cecilia passed the M.S. Anatomy examination with a first class in 1965. She was wedded to her profession and her lifestyle was passion for teaching and compassion for the students. She had the distinction of three D's in her work – Discipline, Dedication and Determination to face challenges. The Anatomy museums of Madras, Thanjavur and Chengalpet Medical colleges vouchsafe for Cecilia's' handiwork.

IJAS 2010, 1, 50-51.

Even after retirement from the Tamil Nadu Government service, she continued to serve as a professor of Anatomy at Sri Ramachandra Medical College and later at the Meenakshi Dental College, at Chennai. In recognition of her contribution to the college and the students, the Vice Chancellor of Meenakshi University honoured her by naming the Anatomy Block at Meenakshi Dental College as Dr. Cecilia Isaac Bock

Her students, who are spread all over India and abroad, fondly remember their revered teacher Dr. C.I.

Dr. Saratha Kathiresan

International Journal of Anatomical Sciences 2010, 1: 52.

In Memoriam

Dr. S. Minakshisundaram, BSc, MBBS, MSc
(27-4-1927 – 12-6-2010)

Dr. S. Minakshisundaram was born on 27-4-1927 in a small town, Tindivanam in Tamil Nadu. After graduating from Annamalai University with a BSc degree in 1947, he joined Madras Medical College, Madras, and obtained the MBBS degree in 1955. He worked for a short period in the primary health center in Athur, Salem. His interest in teaching goaded him to join the department of Anatomy, Madras Medical College where he pursued his postgraduate studies and got the MSc Degree in Anatomy in 1954.

As a teacher, he was very effective and his lectures were well appreciated by his students. During his illustrious career as an anatomy teacher, Dr. S. Minakshisundaram has served as Professor of anatomy at Thanjavur Medical College, Madurai Medical College, Kilpauk Medical College, Stanley Medical College and Madras Medical College. Later he became the Assistant Director of Medical Education (ADME), Tamil Nadu Medical Service prior to his retirement in 1985. Even after retirement, he took up assignments as professor of Anatomy in PSG Institute of Medical Sciences, Coimbatore and Vinayaka Mission Medical College, Salem and as principal in Siddharth Medical College, Tumkur, Karnataka.

He has received the prestigious Dr. MM. Cooper Award in 2005 and Bharat Chikatsac Award in 2009. As a person, he was simple, sincere and quick witted with a high sense of humour.

Dr. S. Minakshisundaram died all of a sudden on 12th June, 2010 due to a massive heart attack. He is survived by his wife Dr. Premila, a microbiologist, daughter Dr. Padmaja, an ophthalmologist in USA, son-in-law and a granddaughter. Our Prayers to the Almighty to give enough strength and courage, to the bereaved members of his family, to bear this irreparable loss with fortitude

May his soul rest on peace

Dr. T.S.Ranganathan

International Journal of Anatomical Sciences 2010, 1: 53.

Tribute

Dr. S. Radha Ramanathan

MSc,PhD,FABMS,

Grand daughter of a great Tamil scholar “Karandhai Kaviarasu”, Dr. Radha Ramanathan, was the past president of the Association of Anatomist and the past Editor-in-Chief of the Journal Anatomical adjuncts. She started her academic pursuit at JIPMER, Pondicherry where she obtained the MSc and PhD degrees in anatomy from the University of Madras. Then, from very humble beginning as a Demonstrator in Anatomy at JIPMER and later as a Lecturer in Anatomy at the PGIBMS, Taramani, she continued her saga at RMMC, Annamalai University till she became the Professor of Anatomy.

Dr. Radha was an excellent and a popular teacher with both graduate and postgraduate students. She used to motivate all her students to undertake research projects and present their findings at the annual conference of our Association and has also successfully guided a PhD candidate in Anatomy. She has to her credit several scientific publications in National journals of repute and a Tamil version of a book on Nervous System entitled “நரம்பு மண்டலம் - ஓர் அறிவியல் பார்வை”. After a brief illness soon after her retirement in 2009, Dr.Radha Ramanathan’s successful academic career came to an end.

May her soul rest on peace.

Prof. A. Krishnamurti

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Contents