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RESEARCH ARTICLE
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AGE ESTIMATION FROM EPIPHYSEAL UNION OF MEDIAL END OF CLAVICLE IN PUKHTOONS

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ABSTRACT

Introduction: Forensic age estimation is a current and an important area of research for forensic scientists. Forensic expert has to execute an important medicolegal obligation of assessing the age in civil and criminal situations and his opinion plays an important role in the execution of justice, He has to review the available literature for the assessment of age in various populations.
Research has been carried out in various regions on mixed population and no study is available on our racial population.
Objective: Objective of this study is to determine the mean age of epiphyseal union of medial end clavicle in Pathans of Khyber Pakhtunkhwa by Radiological examination.
Study Design and Setting: Cross sectional study.
Subjects: 334 living subjects including male and female gender.
Methods: The subjects visiting the x-ray department for minor ailments and for other clinical conditions would be exposed for x-ray chest, postero-anterior view uses standard technique. An informed consent would also be taken.
The principles of radiation exposure would be determined by the department of radiology before x-rays were taken. These subjects would not be exposed to X-rays specifically for epiphyseal union analysis. Subjects from 18 years to 30 years of age were selected for study.
Results: The mean age of fusion of epiphysis of medial end clavicle was found to be 24 ± 3.76 years, no significant difference was observed for early fusion in female to male ratio. Statistically significant difference was observed for time of complete fusion on age basis in both the genders.
Conclusions: (1) It is concluded on the basis of result of this study that mean age of epiphyseal union of medial end clavicle is 24 ± 3.76 in Pathans of KPK. (2) There is no difference in time of epiphyseal union of clavicle gender wise.

Key words: Age assessment, medial clavicular epiphysis, x-rays, Khyber Pakhtunkhwa, Pathans.

INTRODUCTION

Age is an important component and ingredient of a person's identity. Aging is a biological and organic process taking place in living organisms and showing the effects of increasing age. Age is an important parameter of personal identity which can be assessed by various means for different purposes including criminal responsibility and in such cases only scientific methods have to be adopted for correct age estimation. The identity of individual can be established by agencies like Panchayat to Police. Aging in humans is multi-dimensional process of physical, psychocological and social change. This is an accumulation of changes in an organism and object over time (1). But when all such agencies failed then the medical jurist is consulted. By the virtue of his knowledge and experience he is able to do the job

Parameters like 3rd molar tooth eruption the range being too long i-e 18-25 years age, is not very helpful(2). Similarly the long bones of limbs have a varying range of epiphyseal union (16-19 years)(3). Fusion of sternum is completed at age of 40 years. The epiphyseal union at the medial end of clavicle gives a range of 20 to 25 years (28 -31 years)(4) this age is critically important in certain situations, civil as well as criminal.

In Pakistan 21 years of age assures some rights to an individual and represents a fully mature person as he enjoys the right to get independence in managing his/ her property, sell his property and if he is under courts of wards, after attaining 21 years he becomes independent. He can get a driving license for a heavy vehicle which confirms an indicator of his sense of responsibility (5). Age determination of 21 years of age helps in estimation of the age of an offender at the time of committing crime . For the government service age of an individual must be between 18-25 years and for Pakistan Health Services and Engineering Services is upto 35 years. A candidate in election for National or Provincial Assembly should be 25 years of age and for senate election age should be 30 years. For presidential election age should not be less then 45 years(6). Wrong assessment of bone age may arguably lead to a sentence inappropriate for age and may result in miscarriage of justice.

In Pakistan medicolegal cases are also reported at basic health unit level, where facilities like Ultrasonography, CT, and MRI are not available and interpretation of the findings is the field of an expert.

The choice of method in our study to establish a standard that can be evenly utilized through out country is chest x-ray, as it is simple and easy to interpret.

Different studies on clavicular end union have been carried out internationally and locally on mixed population with various results. This study is conducted on Pakhtuns of Khyber Pakhtunkhwa (KPK) specifically, so that a standard can be formulated for this race and for this purpose the medial end of clavicle has been selected.

TECHNIQUES AND METHODS

The application of radiology in forensic sciences was introduced in 1876, just 1 year after the discovery of the x-ray by Roentgen, to demonstrate the presence of lead bullets inside the head of a victim(7). Radiology plays an important role in human age determination. Radiographic method is simple, quick, economical and non-mutilating for age identification(8). Radiological images are utilized in the process of age estimation, which is one of the essential tools in identification of living as well as dead.

Radiology is the branch of medical science dealing with medical imaging. It may use x-rays or other such radiation devices. It also includes techniques that do not involve radiation, such as MRI (Magnetic Resonant Imaging) and ultrasonography(9). Conventional radiography is the most basic & economical method in assessing age from medial end of clavicle. Chest X-ray P-A view is normally taken to asses age from medial end of clavicle in living individual. This method at times becomes less important due to overlapping of ribs, vertebrae & mediastinal shadow(10). Sometimes these structures prevented the exact estimation of medial epiphyseal stage development. Notches which are taken as partial union on naked eye may be visible as complete fusion on radiography. Till date no comparative

study exists between different methodologies used & their outcome discrepancies. The problem related with conventional radiography & tomography is eliminated by computed tomography.
Exposure to radiation is lower than in tomography & provides better anatomic picture & visualization of soft tissue structures(11). Spiral C.T also is used to estimate the ossification of medical clavicular end. It is most likely accepted by the patients because reduce respiratory movement artifacts & short examination time. Ultrasonography & magnetic resonance imaging are other techniques which are free from hazards of radiation(12). In Legal and ethical aspects, the use of radiation exposure free imaging technique has great advantage.

INTERPRATATION OF OSSIFICATION CENTERS BY X-RAYS

Radiographs are images created with X-rays, and used for the evaluation of many bony and soft tissue structures(13). Secondary centers of the bone are called epiphyseal centers of ossification. The age at which they first become appear on X-rays is known as appearance of epiphysis. The bone looks like as an irregular nodule on X-rays in the initial stages of epiphyseal ossification. Epiphyseal ossification spreads and replaces the cartilaginous epiphysis gradually(14). The cartilage between the epiphysis and diaphysis is called epiphyseal disc. It appears as a narrow translucent band in X-rays. The cartilaginous disc grows & replaced by bone progressively. At the growing end of diaphysis, a white line is seen in ski gram: radio graphically it is an epiphyseal disc. Epiphyseal ossification is enclosed in a thin layer of cortical bone.
Bone length arrests when cartilage cells stop to multiply. Bone from the metaphysis then extends across the diaphyseal disc. Bone continuity thus established between diaphyseal and epiphyseal ossification, called epiphyseal union(15).
Medical imaging is the technique and process used to create images of the human body (or parts and function thereof) for clinical purposes (medical procedures seeking to reveal, diagnose, or examine disease) or medical science (including the study of normal anatomy and physiology).
X-rays have very short wavelength i.e. 1/10,000 of the visible light: it is due to this property which allows X-rays to penetrate materials(16). X-rays are observed by the substances according to their atomic weight & density; the more the atomic weight or density of a substance, the higher will be the absorption. Bone has high percentage of calcium which absorbs x-rays more than skin & muscles. The lower the atomic weight, the more transparent it will be. The radiograph is based on the differential absorption of X-rays. Substances penetrated readily are radiolucent. The structures penetrated with difficulty are called radio-opaque(17). Photographic film is placed behind an object & an exposure done.
The translucent parts allow the X-rays to pass through while those parts which do not allow penetration appear radiopaque. X-rays are either partially or completely absorbed in dense parts. In the corresponding part of the film, black & white picture is seen. The bones of the individual are clearly defined in X-rays because of their high calcium content.
In short, denser objects have got more absorption and less penetration of x-rays while less dense objects have got less absorption and more penetration of x-rays. Thus dense objects looking white and less dense or translucent objects looking black on x-ray films.
For age estimation from epiphyseal union of medial end of clavicle, P.A (postero-anterior) chest view is used in normal routiene work. The film used with blue tinged single emulsion film is utilized. In pediatrics X-rays strength is 50-55 KV. In adults this strength is 100 KV [56]. The scientific unit for radiation dose in milisievert (mSv) rad, ram, Roentgen, sievert, are other units. In chest X-Ray P.A view film is obtained with face of patient towards cassette & X-Ray is six feet away. X-Rays is always taken when subject is in inspiration and he is told to hold his breath in inspiration [57]. Safety and ethical aspect are important in case of radiation. There are three factors that control the amount, or dose, of radiation received from a source. Radiation exposure can be managed by a combination of these factors:
1. Time: Reducing the time of an exposure reduces the effective dose proportionally. An example of reducing radiation doses by reducing the time of exposures can be achieved by improving operator training to reduce the time they take to handle a source [58].

2. Distance: Increasing distance reduces dose due to the inverse square law. Distance can be as simple as handling a source with forceps rather than fingers [58].
3. Shielding: The term 'biological shield' refers to a mass of absorbing material placed around, radioactive source, to reduce the radiation to a level safe for humans, walls surrounding the room with the x-ray generator may contain lead sheets and shielding the parts of body which are not X-rayed. Lead is the most common shield against X-rays because of its high density (11340 kg/m^3), doubling the thickness of shielding will square the shielding effect.(18)

X-rays generated by peak voltages below	**Minimum thickness of lead**
75 kV	1.0 mm
100 kV	1.5 mm
125 kV	2.0 mm
150 kV	2.5 mm
175 kV	3.0 mm
200 kV	4.0 mm
225 kV	5.0 mm
300 kV	9.0 mm
400 kV	15.0 mm
500 kV	22.0 mm
600 kV	34.0 mm
900 kV	51.0 mm

Effective radiation dose and background radiation exposure for different radiological procedures

Procedure:	**Approximate dose for effective radiation**	**Natural background radiation**	**Life time risk of fatal cancer from examination:**
Chest			
Radiography-Chest	0.1 mSv	10 days	Minimal 1 in 1,000,000 to 1 in 100,000
Computed Tomography (CT)- Chest low dose	1.5 mSv	06 months	Very Low 1 in 100,000 to 1 in 10,000
Computed Tomography (CT)-Chest	7 mSv	02 years	Low 1 in 10,000 to 1 in 1000
Women's Imaging:			
Mammography	0.4 mSv	07 weeks	Very low 1 in 100,000 to 1 in 10,000
Bone Densitometry (DEXA)	0.001 mSv	03 hours	Negligible Less then 1 in 1,000,000
MENS IMAGING:			

Bone Densitometry (DEXA)	0.001 mSv	03 hours	Negligible Less then 1 in 1,000,000

Note: In the above-mentioned risk levels there are 1 in 5 chances to die from Cancer.

AIM AND OBJECTIVE

- To determine the mean age at which the complete epiphyseal union of medial end of clavicle occurs in the Pathans of Khyber Pakhtunkhwa by plain radiograph.

OPERATIONAL DEFINITION

Non union

In radiological terms Non –union is defined as a radio lucent line as a gap at both the ends of the long bone in connection with head/ lower end and in clavicle the medial end and lateral end of clavicle(19).

Union

In radiological terms Union is defined as a radio-opaque line throughout the dimensions of epiphysis, still separately discernable from metaphysis by virtue of lesser density than adjacent area.

MATERIAL AND METHODS

Study Design: Cross sectional study.

Setting:

- Radiology Department Jinnah Teaching Hospital Peshawar.
- Department of Forensic Medicine Jinnah Medical College.

Duration of Study: Six months (5th March 2024 till 5th September 2024)

Sample Size: 334 living subjects including male and female

Sampling Technique: Convenient sampling.

Sample Selection: From the patients with known age and sex who visit the X- ray department of Kuwait teaching hospital, Lady Reading hospital Peshawar and Rehman Medical Institute for their own concerned minor clinical problems or routine preoperative investigations.

Inclusion Criteria:

- Both male and female will be included.
- Both father and mother being Pakhtuns.
- Apparently healthy.
- 18 – 30 years of age.
- CNIC will be used as confirmatory document for age and race.

Exclusion Criteria:

- Patients without CNIC.
- Non Pakistanis.
- Non Pakhtuns.
- Pregnant ladies.
- Any history of major systemic disease, e.g. chronic renal disease, tuberculosis.
- Bone disease, e.g. chronic osteomyelitis, osteoporosis, bone cancer.

METHODOLOGY

Only those subjects would be included in the study that would fulfill the inclusion and exclusion criteria. The subjects visiting the x-ray department for minor ailments and for other clinical conditions

would be exposed for x-ray chest, postero-anterior view uses standard technique. An informed consent would also be taken. The fundamental principle of radiation protection would be kept in view i-e

- Justification of exposure
- Optimization of protection
- Application of Dose Limits

The principles of radiation exposure would be determined by the consultant / department of radiology before x-rays were taken. These subjects would not be exposed to X-rays specifically for epiphyseal union analysis. Subjects from 18 years to 30 years of age were selected for study.

Financial Support.
The project is financed by me. There is no conflict of interest.

Statistical Analysis

Data entered and analyzed in SPSS 25

Data Analisis

Statistical Package for Social Sciences "SPSS version-25" was used for data analysis. Variables like gender, race, radiological findings, frequencies and percentages were computed. **Mean** (24 years) **and Standard Deviation** (SD) (±3.76) were calculated for age. **Chi-square test** was used for determination of association of different categorical factors like age and gender associated with epiphyseal union of medial end of clavicle.

Student T.Test was not significant. **P-value** <0.05 was considered significant for epiphyseal union for age. But it is not significant among gender basis.

RESULTS

Total numbers of individuals in this study were 334. Male subjects were 217 and females were 117 in number. The mean age of epiphyseal union of medial end clavicle is 24±3.76 for both males and females. No difference of early fusion is noted in female gender. Association of variable like gender and age with epiphyseal union of medial end clavicle is determined by Chi-square test. P-value for the mean age of fusion of clavicle is significant (P-value<0.05). Student T.Test was insignificant. The probability of clavicle epiphyseal union is more for age 24-27 years. The chance of epiphyseal union of medial and clavicle is higher as age advances. Male gender was dominated in the both categories. No volunteers were included in the study.

FREQUENCY OF GENDER, RACE AND RADIOLOGICAL FINDINGS.

Variables	Frequency (n)	Percentage
Gender		
Male	217	65%
Female	117	35%
RACE		
Pathan	334	100%
Radiological Findings		
Not seen	115	34.4%
Not fused	63	18.9%
Fused	156	46.7%

Statistics

		AGE
N	Valid	334
Mean		23.9940
Std. Deviation		3.76645
Minimum		18.00
Maximum		30.00

Age of Fusion of Clavicle

Years	Frequency	Not Seen	Not fused	Fuse
18	25	23 (92%)	02 (8%)	
19	28	19 (67.9%)	09 (32.1%)	
20	27	18 (66.7%)	09 (33.3%)	
21	24	17 (70.9%)	07 (29.1%)	
22	23	21(91.3%)	02((8.7%)	
23	28	17(60.7%)	11(39.3%)	
24	25		14(56%)	11(44%)
25	26		05(19.2%)	21(80.8%)
26	24		02(8.3%)	22(91.7%)
27	26		02(7.7%)	24(92.3%)
28	25			25(100%)
29	28			28(100%)
30	**25**			**25(100%)**
Total	**334**	**115**	**63**	**156**

Age of Epiphyseal Union of Clavicle among Female Gender

Years	Frequency	Not Seen	Not Fused	Fused
18	08	07(87.5%)	01(12.5%)	
19	13	10(76.92%)	03(23.08%)	
20	14	11(78.58%)	03(21.42%)	
21	05	03(60%)	02(40%)	
22	09	08(88.89%)	01(11.11%)	
23	11	07(63.63%)	04(36.37%)	
24	13		07(53.84%)	06(46.16%)
25	07		02(28.58%)	05(71.42%)
26	02		0(0%)	02(100%)
27	12		01(8.33%)	11(91.67%)
28	07			07(100%)
29	05			05(100%)
30	11			11(100%)
Total	**117**	**46**	**24**	**47**

Age of Epiphyseal Union of Clavicle among Male Gender

Years	Frequency	Not Seen	Not Fused	Fused
18	17	16(94.11%)	01(5.89%)	
19	15	09(60%)	06(40%)	
20	13	07(53.84%)	06(46.16%)	

21	19	14(73.68%)	05(26.32%)	
22	14	13(92.86%)	01(7.14%)	
23	17	10(58.83%)	07(41.17%)	
24	12		07(58.34%)	05(41.66%)
25	19		03(15.79%)	16(84.21%)
26	22		02(9.1%)	20(90.90%)
27	14		01(7.14%)	13(92.86%)
28	18			18(100%)
29	23			23(100%)
30	14			141(100%)
Total	**217**	**69**	**39**	**109**

Radiological Findings for Age (in years)

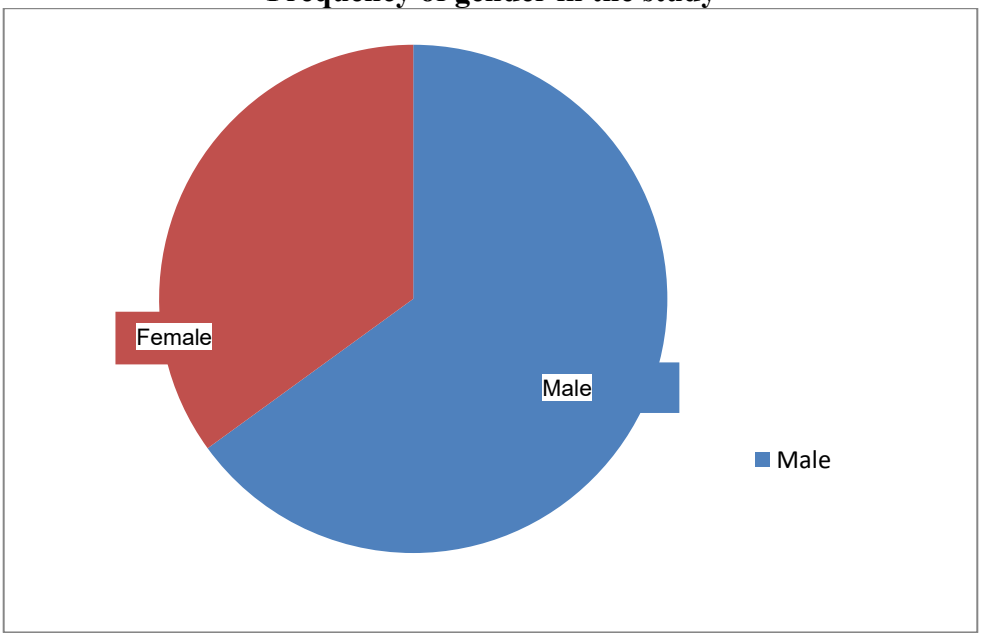
	AGE(in years)			
18-20 yrs	Count % within AGE (in years)	**60** **75.0%**	**20** **25.0 %**	**0** **0%**
20.01 - 23.0	Count % within AGE (in years)	**55** **73.3%**	**20** **26.7 %**	**0** **0%**
23.01 – 26.00	Count % within AGE (in years)	**0*** **0%**	**21** **28.0 %**	**54** **72.0 %**
26.01+	Count % within AGE (in years)	**0*** **0%**	**02** **01.9 %**	**102** **98.1 %**
Total	Count % within AGE (in years)	**115** **34.4%**	**63** **18.9 %**	**156** **46.7 %**
P- value		**<0.05**		

* NOTE: Epiphyseal centers seen.

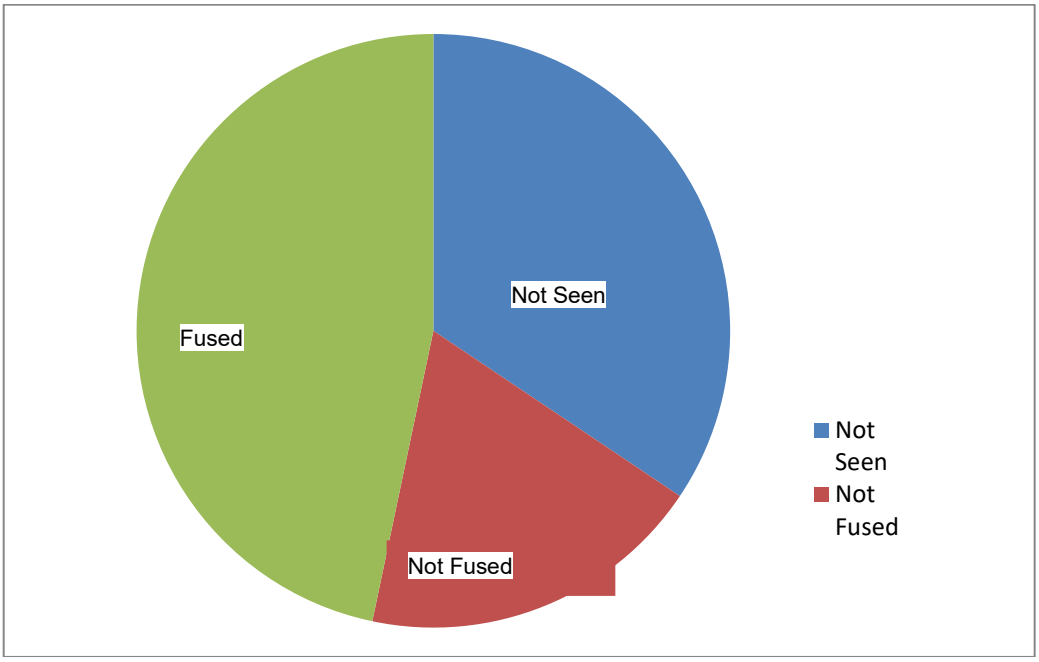
Radiological Findings for Gender

	GENDER	Not Seen	Not Fused	Fused
female	Count	**46**	**24**	**47**
	% within GENDER	**39.3%**	**20.5 %**	**40.2 %**
male	Count	**69**	**39**	**109**
	% within GENDER	**31.8%**	**18 %**	**50.2 %**
Total	Count	**115**	**63**	**156**
	% within GENDER	**34.4%**	**18.9 %**	**46.7 %**
P- value		**<.168**	**<.571**	**<.079**

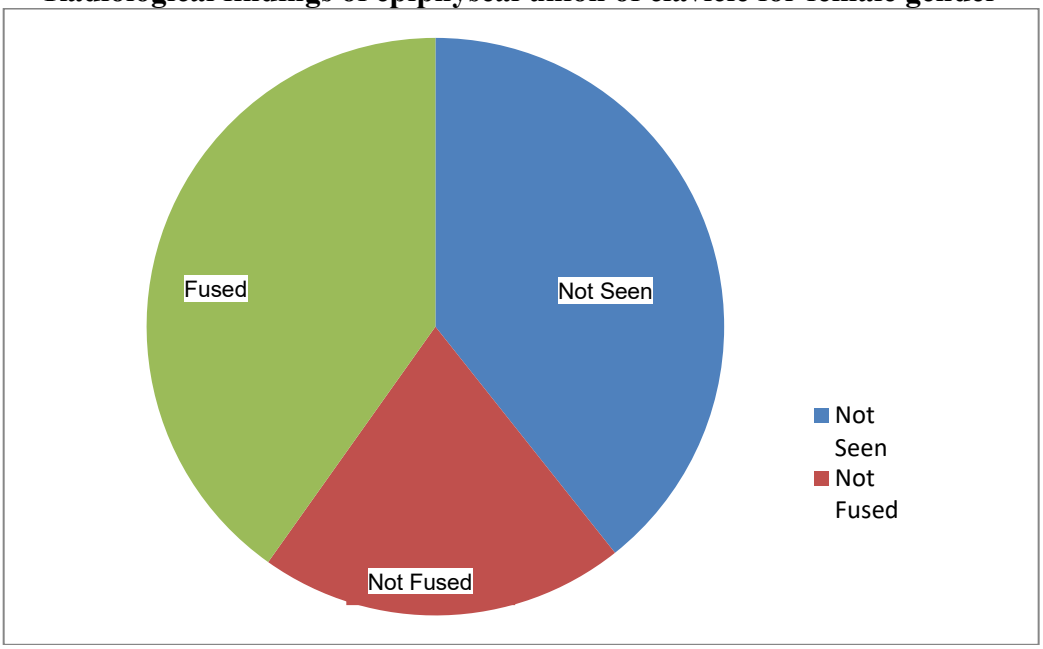
Frequency of gender in the study



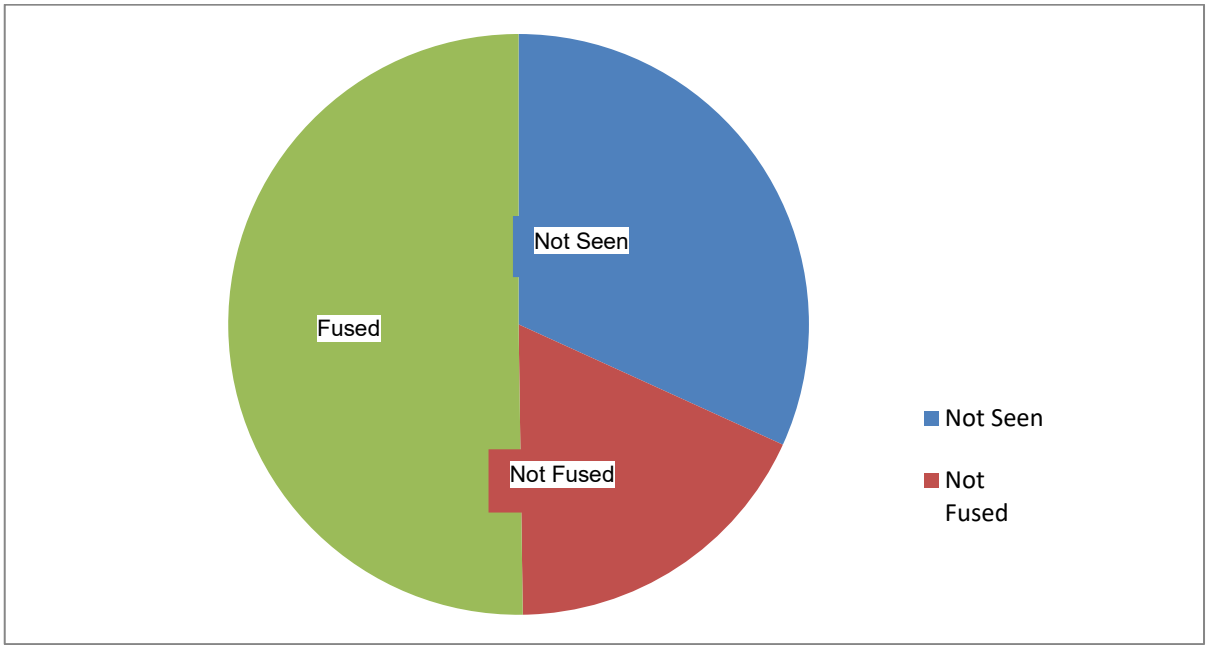
Frequency of Radiological findings for the study



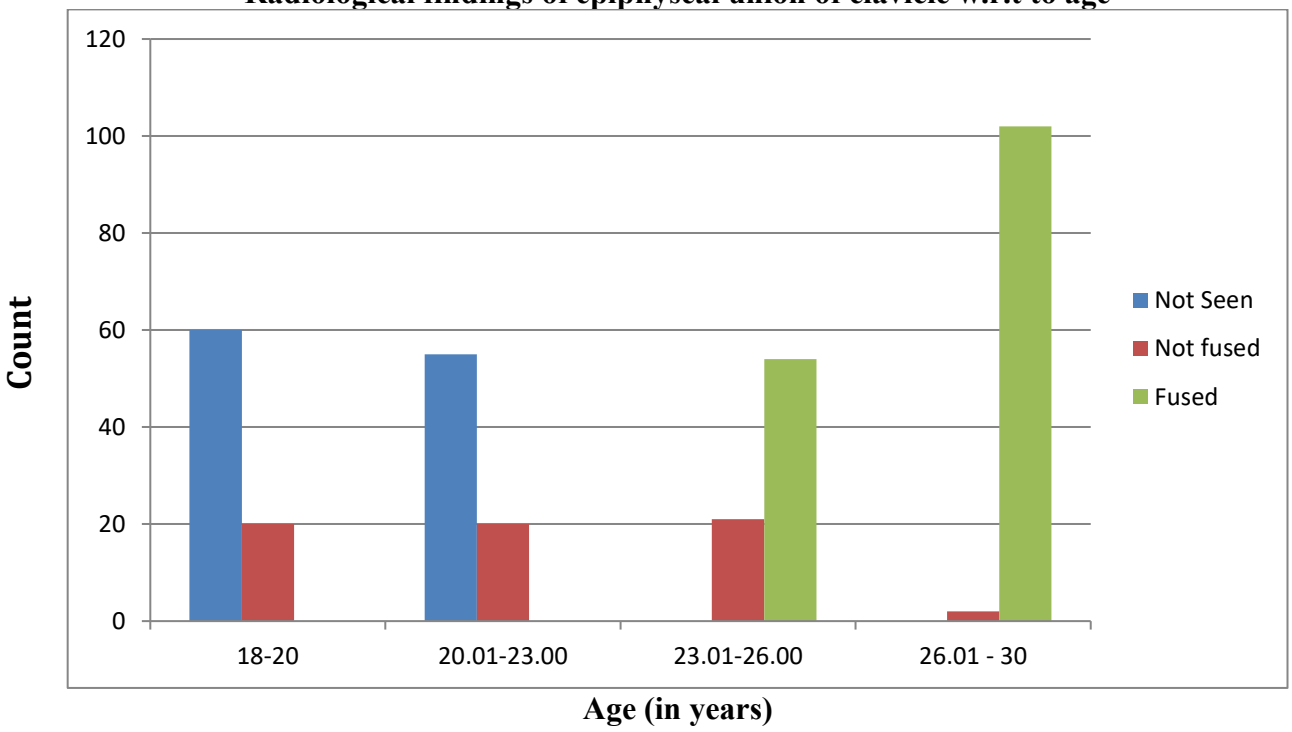
Radiological findings of epiphyseal union of clavicle for female gender



Radiological fidings of epiphyseal union of clavicle for male gender



Radiological findings of epiphyseal union of clavicle w.r.t to age



DISCUSSION

Numerous observations on the rate of Physical growth and development of children of different racial groups have been made in recent years, especially in connection with nutritional surreys conducted under the auspices of WHO & other international agencies in various parts of the world. There has been tendency to attribute the observed retardation, to the racial difference in the rate at which growth & development proceed. It is believed that the findings here reported briefly indicate the desirability of re-examing the assumption that such racial differences do in fact exists .

Epiphyseal union of different long bones is mentioned in a table given.

Ossification centers & their Fusion.

Centers of bone	Fusion
Sternum	60-70 years

3rd and 4th segment	15 years
2nd and 3rd Segment	20 years
1st and 2nd Segment	25 years
Xiphisternal joint	40 years
Manubriosternum joint	60 to 70 years
UPPER LIMB	
Scapula	
Coracoid process	14 -15 years
Acromion process	17 -18 years
Humerus (upper end)	
Head	18 years
Greater tubercle	04 – 05 years with head
Lesser tubercle	05 – 07 years with greater tubercle
Humerus (lower end)	
Medial epicondyle	
Captitulum	Forms conjoint at tendon at 14 years
Trochlea	Unite with shaft at with 15 years
Lateral epicondyle	Medial condyle unite at 16 years
Radius	
Upper end	15 -16 years
Lower end	18 -19 years
Ulna	
Upper end	16 -17 years
Lower end	18 -19 years
LOWER LIMB	
Hip bone	
Triradiate cartilage	14 -15 years
Illiac crest	18 – 20 years
Ischial tuberosity	20 -22 years
Sacrum	25 years
Femur (upper end)	
Head	17 -18 years
Greater trochanter	17 years
Lesser trochanter	15 -17 years
Femur (lower end)	17 -18 years
Tibia	
Upper end	16 -17 years
Lower end	16 years

All epiphysis are of equal value in age estimation. The best among were the epiphysis of medial end clavicle, proximal humerus, distal radius, femoral head and illiac crest(20).

CLAVICLE: THE MEDIAL TWO-THIRD

Medial Two-thirds.—The medial two-thirds constitute the prismatic portion of the bone, which is curved so as to be convex in front, concave behind, and is marked by three borders, separating three surfaces.

Borders. The **anterior border** is continuous with the anterior margin of the flat portion. Its lateral part is smooth, and corresponds to the interval between the attachments of the Pectoralis major and

Deltoideus; its medial part forms the lower boundary of an elliptical surface for the attachment of the clavicular portion of the Pectoralis major, and approaches the posterior border of the bone. The **superior border** is continuous with the posterior margin of the flat portion, and separates the anterior from the posterior surface. Smooth and rounded laterally, it becomes rough toward the medial third for the attachment of the Sternocleidomastoideus, and ends at the upper angle of the sternal extremity. The **posterior** or **subclavian border** separates the posterior from the inferior surface, and extends from the coracoid tuberosity to the costal tuberosity; it forms the posterior boundary of the groove for the Subclavius, and gives attachment to a layer of cervical fascia which envelops the Omohyoid

Surfaces. The **anterior surface** is included between the superior and anterior borders. Its lateral part looks upward, and is continuous with the superior surface of the flattened portion; it is smooth, convex, and nearly subcutaneous, being covered only by the Platysma. Medially it is divided by a narrow subcutaneous area into two parts: a lower, elliptical in form, and directed forward, for the attachment of the Pectoralis major; and an upper for the attachment of the Sternocleidomastoideus. The **posterior** or **cervical surface** is smooth, and looks backward toward the root of the neck. It is limited, above, by the superior border; below, by the subclavian border; medially, by the margin of the sternal extremity; and laterally, by the coracoid tuberosity. It is concave medio-laterally, and is in relation, by its lower part, with the transverse scapular vessels. This surface, at the junction of the curves of the bone, is also in relation with the brachial plexus of nerves and the subclavian vessels. It gives attachment, near the sternal extremity, to part of the Sternohyoid; and presents, near the middle, an oblique foramen directed lateralward, which transmits the chief nutrient artery of the bone. Sometimes there are two foramina on the posterior surface, or one on the posterior and another on the inferior surface. The **inferior** or **subclavian surface** is bounded, in front, by the anterior border; behind, by the subclavian border. It is narrowed medially, but gradually increases in width laterally, and is continuous with the under surface of the flat portion.

On its medial part is a broad rough surface, the **costal tuberosity** (*rhomboid impression*), rather more than 2 cm. in length, for the attachment of the costoclavicular ligament. The rest of this surface is occupied by a groove, which gives attachment to the Subclavius; the coracoclavicular fascia, which splits to enclose the muscle, is attached to the margins of the groove. Not infrequently this groove is subdivided longitudinally by a line which gives attachment to the intermuscular septum of the Subclavius.[64]

The Sternal Extremity (*extremitas sternalis; internal extremity*).—The sternal extremity of the clavicle is triangular in form, directed medialward, and a little downward and forward; it presents an articular facet, concave from before backward, convex from above downward, which articulates with the manubrium sterni through the intervention of an articular disk. The lower part of the facet is continued on to the inferior surface of the bone as a small semi-oval area for articulation with the cartilage of the first rib. The circumference of the articular surface is rough, for the attachment of numerous ligaments; the upper angle gives attachment to the articular disk.

The age of a person can be established from the birth certificate the registration of which in our society especially in the rural population is very defective as most of the births take place in homes and these births are not reported. The parents often contact the local doctor for a certificate of birth for school admission and most often it is verified as such by the Municipal Corporation or local bodies. Thus it may not be a genuine certificate and may later be disputed.

Convention on Rights of Children (CRC) recommends that the child shall be registered immediately after birth and shall have the right from birth to a name, the right to acquire a nationality..." (CRC Article 7)(21). Birth registration opens the door to rights to children and adults which many other human beings take for granted: to prove their age; to prove their nationality; to receive healthcare; to go to school; to take exams; to be adopted; to protection from under-age military service or conscription; to marry; open a bank account; to hold a driving license; to obtain a passport; to inherit money or property; and to vote or stand for elected office "States Parties undertake to respect the right of the child to preserve his or her identity, including nationality, name and family relations..." (CRC Article 8)(21)

Despite 191 countries ratifying the Convention, the births of millions of children worldwide goes unregistered and Pakistan is no exception. It was estimated in 2008 that 51 million babies – more than two fifths of those born worldwide – were not registered at birth(22). This phenomenon disproportionately impacts indigenous populations and even in many developed countries, contributes to difficulties in fully accessing civic rights.

Tens of thousands more Pakistanis were displaced from their homes in 2010 as the military continued an assault against the Taliban (Reuters). About 2.3 million people, mainly in the northwest of the country, were displaced by fighting at the peak of the crisis, creating one of the largest internal displacements in recent times. Pakistan displacement is on rank 6th (23).In this situation of crisis in the country, the question of registration of births and deaths are out of question. Thus the new born individuals may be deprived of their rights in their own country.

Under juvenile act a person under 18 years of age is considered as an offender and barred from capital punishment, hard labour if found guilty of a henious crime is entitled for detention in juvenile or reformatory school.

Under the majority Act (Act IX of 1875), persons domiciled in Pakistan attain majority on completion of their eighteen years. A major can be issued a driving license, may cast vote and is issued National identity card.

The systems on which age estimations are made depend upon:

Length and Wight

Changes at Puberty and in old age.

Age estimation from teeth

Age estimation from ossification of Bones [6].

Changes at Puberty and in old age have corroborative value. This can't be utilized as standard parameter due to changes at different ages, hormonal release and senility. They show person to person variation.

There are variations in time of eruption of teeth upon dietetic, geographic, and other factors.3rd molar is most variable tooth in the dentition with respect to time of eruption, time of formation & size [71-72] and for this reason has been categorized as a non-ideal developmental marker [71-77]. The mineralization of third molar tooth is usually completed by 19 or 20 years. This feature cannot be used to ascertain whether a person has attained the forensically relevant 21 years age. An additional x-ray examination of the medial clavicular epiphyseal cartilage is, therefore, strongly recommended when assessing whether the person is over 21 years [78].

One of the most extensively studied bones is the clavicle which, of all long bones in the human skeleton, has the slowest and most prolonged development [11-12, 24, 28, 79-82]. From the embryological point of view, the clavicle consists of laminated bone [79]. The first mesenchymal differentiation center arises between the 7th and 12th weeks of embryogenesis, followed by lateral and medial bone apposition via chondral ossification. However, bony fusion only occurs during early adulthood [11, 80].

Several studies have been conducted on the time frame for ossification of the medial clavicular epiphyseal cartilage in the age group of concern for forensic age diagnostics. One group of studies adopted an anatomical perspective, assessing ossification my means of autopsy or direct skeletal inspection [12-13, 24, 28, 81-83] the other group took a radiological approach. Radiological methods allow the medial clavicular epiphysis in living individuals to be examined and consist of conventional radiography [14, 84-87] and computed tomography (CT) [16-17, 26, 29, 88] as well as new approaches with magnetic resonance (MR) imaging [18-19] and ultrasound [7, 20]. Several studies have confirmed the value of CT scan for the assessment of changes in the medial epiphysis of the clavicle in relation to the chronological age of the subjects examined [25]. The disadvantages of CT scans may be, in some cases, use of contrast dye injections, like low osmolar contrast material and a disproportionately higher radiation dose than other diagnostic X-rays methods [8, 27]. In addition, in CT examination of the medial clavicular epiphysis, it has been noted that, if slice thickness is increased above a certain maximum value, this might lead to errors

when assessing ossification status [31]. On the other hand, the MR examination can considerably decrease the radiation exposure using the necessary imaging procedures [46-47, 54]. However, MR scanning may be expensive and uses contrast materials, like gadolinium, and its closed in structure may create a claustrophobic sensation for some persons [8]. In addition, the real availability of such significant sample out of hospital environment is often probable.

Factors influencing the ossification and growth process of bones:

Race is an indication of heritage with which we are born regardless of location or learned behavior. Race cannot be changed**.** Ethnicity is about learned cultural behaviors celebrated through out regions around the world. It can be changed or altered or mimicked through choice and belief [80].

World population is divided into four major ethnic groups by Cavalli-Sforze, with more then 18, 00 native populations having 110 genetic markers. Caucasians, Australians, Mongolians, & Africans are major groups [81].

Chronic clinical conditions e.g. rheumatoid arthritis, sickle cell disease, osteomyelitis of bones, tubercular arthritis, tuberculosis may affect the process of epiphyseal union. Also chronic bone infections & trauma might be the major cause. Pathological conditions also results in delay of fusion of epiphyseal centers [86].

Certain hormones like growth hormones, thyroid hormones, sex hormones and adrenocortical hormones related to the proper bone growth and development [84].Hyperparathyroidism; it results in early epiphyseal union. Metabolic disorders; Osteomalacia and rickets: It delays epiphyseal union. Endocrine Disorders; Congenital hypothyroidism (cretinism): It also delays the epiphyseal union. Gigantism, it enhanced the epiphyseal union [85].Hypergonadism, pineloma causes the enhancement of epiphyseal fusion process while hypogonadism and Addison's disease results in delays it [29, 87].

In various studies the sample size, racial groups are not similar so their conclusion varied.

Our study conducted among residents of Pakhtuns of KPK mean age of epiphyseal union of medial end clavicle is 24 years

According to Basu, epiphyseal union had a climatic and racial variability [39].

Webb in 1981, conducted study on American involving multi racial population including male and female. It was observed that epiphyseal union of clavicle occured at 21 years [89].

Todd and Errico in 1928 carried out study on 166 subjects on Americans 130 were male and 36 were female. They were from white and black race. The samples were from cadavers. It was concluded that at 28 years age epiphyseal union of medial end clavicle occurred [7].

In 1957, Mckern/ and Stewart carried out study on medial end of clavicle on 374 cadavers who had died during Korean War. All the subjects were male and white in race and belonged to USA. Complete union was seen at 31 years of age [8].

It has been observed that in above mentioned studies, the epiphyseal union of medial end clavicle is different in different racial groups.

Modi stated for East India children that due to variations in climate, hereditary and diet and other various factors, it can not be expected to formulate a standard for age determination of epiphyseal union of medial end clavicle for whole of the India [40].

Present study is the FIRST one on national level to be carried specifically on racial basis, on local Pathans of KPK.

Comparison of time of epiphyseal union of medial end of clavicle in different races carried out by different researchers mentioned in a chart given.

Author	Year	Race/Ethnic group	Gender		Method	Age of complete union	Age of complete union in 100% of the sample
			Male	Female			

Kreitner : et al.	1998	White, Europe	229	151	Thoracic CT	22 years	27 years
Inderbir	1993	Indian	---	---	---	25 years	---
Bass	1986	unknown	---	---	Osteological	23 years	--
Myers Suchey	1985	White, Black, Latin American, USA	605	254	Anatomical section	21 years	34 years
Jit, Kulkarni	1976	North Indian	391	193	Chest X-rays	22 years	25 years
Krogman	1962	USA	---	---		25-28 years	---
McKern, Stewart	1957	White, USA died in Korean War	374	---	Anatomical section	23 years	31 years
Galstaum	1937	Bengalis,	446	209	Chest X-rays	19 years	25 years
Flicker	1933	Australians	206	231	Chest X-rays	22 years	26 years
Todd, D Errico	1928	White, Black, USA	130	36	Anatomic preparation	22 years	28 years
In Pakistan studies conducted in this context are as follows:							
Alamgir A, Griffin S	1999	Residents of Abbottabad	102	---	Chest X-ray	25 years	----
Hassan Q	2011	Residents of Karachi	415	209	Chest X-ray	21 years	-----
Present Study	2013	Pathans, (KPK), Pak	217	117	Chest X-rays	24 years	28 years

Comparison with other studies

The maturation of clavicle in the postnatal period especially the epiphyseal union of medial end of clavicle has been under investigation for a long time [7-8, 21, 23, 90-91].

Different studies involving individuals of different races/ethnicity had been studied and the work published over the years in this era showed that the time span of epiphyseal union is closely related to one another. Study carried out by Owings Webb and Myers Suchey showed marked delay in the appearance of ossification centers [27]. It may be due to a methodological problem. It might be more difficult to detect the onset of calcification of medial end clavicle by anatomical section then by radiological methods (radiographs or computed tomography).

It is important to note that the studies conducted by Flicker (1933), Galstaum (1937), Jit-Kulkarni (1976) by x-ray chest on different racial / ethnic groups, the results varies from age 19-22 years. Also studies carried out in Pakistan in the year 1999 in Abbottabad and at Karachi in the year 2012 on different ethnic groups showed epiphyseal union of medial end clavicle at 25 years and 21 years.

Present study shows the results are close in range to the above mentioned research activities.

Kreitner Pointed out the problem with radiological method is superimposition of shadows of ribs, vertebra and mediastinal shadows [13, 26].

Researchers stress on radiation free imaging techniques in order to reduce exposure of radiation in age estimation.

Skeletal age is assessed by three methods [31].

1. The Atlas Method.

In this method Radiograph of hand is used to asses the age.

2 Bone by Bone Method. A Specific bone age is assigned to each bone and average age of bone to be examined is compared.

3 Ossification Tables.

This is applied when skeletal regions are to be investigated at one time and age estimated by means of ossification tables.

The epiphyseal union of medial end of clavicle was first classified in 4 stages by Kreitner et al, in 1997-98[31].

Stages were.

Stage 1: ossification center not yet ossified
Stage 2: ossification center has ossified, epiphyseal cartilage not ossified
Stage 3: epiphyseal cartilage partially ossified
Stage 4: epiphyseal cartilage fully ossified.

In 2004 Schmeling added 5th stage as

Stage 5: epiphyseal cartilage fused completely and epiphyseal scar is no longer visible [26].

We divided the stage of epiphyseal union into two stages for radiological assessment of fusion of medial end of clavicle. The same criteria have been adopted for the study conducted in Karachi - 2011[15, 31].

Stage 1: Non-Union
Stage 2: Union.

Non-ionizing technique, e.g., ultrasonic scanning used by some researchers. Schulz R et al, through ultrasound found union of medial end clavicle at 22.9 years in males and 22.5 years in female the age determined by this technique is consistent with age determined by x-ray and C.T scan [53]. Use of ultrasound is rapid, less time consuming and economical procedure. The drawback of this technique is that insufficient number of cases has been investigated so for.

MRI is another non-ionizing technique for assessment of epiphyseal union of medial end clavicle.

The studies done so far are almost in close confirmatory with results in x-ray and computed tomography. The new technique of MR scans is especially used for age assessment where ionizing radiation is prohibited, e g, in juvenile jails and asylums in some countries of the world [52].

The standard procedure recommended for assessment of age from epiphyseal union of medial end clavicle is computed tomography i-e. CT scans. Comparing the results of conventional radiography and CT scan it was reported only 2 out of 99 cases results were different: The significant aspect of CT methodology is to gain maximum accurate results by slice thickness, of not more than 1mm [12, 24, 31, 34, 92-93].Due to its higher spiral resolution, it is more superior technology. The superimposition of other skeletal structures is main disadvantage of CT [24].

The results in the present study showed that standards formulated for epiphyseal union of medial end clavicle by foreign researchers are applicable to our subjects also and applicable worldwide. The various factors for skeletal maturity and time frame of ossification of clavicle must be taken into consideration while assessing the age in medicolegal cases.

The recommended diagnostics for estimating forensic age estimation include physical examination, dental status, radiology of long bones and x-ray medial end of clavicle [26, 92].

Factors that should also be taken into consideration are: Subjects in warmer climates tend to have earlier fusion of the bones [24].People having any chronic clinical disease; poor socio-economic and nutritional status the fusion of epiphysis might be delayed.

In summary we can conclude that plain chest radiographs can essentially provide a basis for assessing clavicular ossification. If posterior anterior view impedes evaluation, a lateral view should also be considered to facilitate age estimation.

CONCLUSIONS.

1. It is concluded on the basis of result of this study that mean age of epiphyseal union of medial end clavicle is 24 ± 3.76 in Pakhtuns of KPK.

2. There is no difference in time of epiphyseal union of clavicle in both genders.

RECOMMENDATIONS.

1. Age estimation in personal identity as well as in criminal cases should be assessed by team of experts comprising of Forensic expert, radiologist, dentist and anthropologist.
2. More Research activities should be carried out using MRI and utrasonographic techniques, so as to assess a critical age in certain cases especially in criminal involvement.
3. In medicolegal practice for age assessment, CT scan should be considered as standard procedure.
4. Research studies should be conducted on racial basis in different parts of the country to evaluate the difference if any in time of epiphyseal union of medial end clavicle in different races.

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