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Original Research Article

Comparative Study of Epiphyseal Fusion Around the Elbow Joint in Sports Persons and General Population of Age Group Between 12 to 18 Years in Mumbai Region

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Key words
Epiphyseal growth,
Elbow joint,
Sports person.

Abstract

Background: Developmental maturation of different tissues and bones occurs at different biological ages and is influenced by the physical activity, especially during adolescence. Exercise is positively associated with Epiphyseal growth plates, increased bone mineral content and mass compared with normative data. **Aim:** The aim of this paper was to compare study of epiphyseal fusion around the elbow joint in Sports persons and general population of age group between 12 to 18 years. **Material and methods:** Study was conducted in 50 equal number of cases enrolled in two groups i.e. sports person and general population. Radiological assessment for fusion or no fusion of ossification centre of Elbow joint was done. **Results:** It was observed that Fusion at elbow joint occurs 1 to 2 years earlier in sports person than in general population. **Conclusion:** The purpose of this study is to present an overview of the effects of physical activity on the function of the epiphyseal growth plate.

1. Introduction

Over the past decade, there has been a surge in the number of sports opportunities available to young athletes.[1] The effects of exercise on the molecular nature of secreted human growth hormone (GH) or its biological activity are not well understood.[2] Yet it is known that children have more elastic soft tissue and more potential for remodeling than adults.[3] Epiphyseal growth plates are often less resistant to deforming forces than ligaments or joint structures. A child's skeletal system shows pronounced adaptive changes to intensive sports training.[4,5] The growing skeleton is said to be more responsive than the mature skeleton to the osteotrophic effect of exercise.[6] Most long bones end near the joint in a separate epiphysis which at first consists of cartilage and is later ossified. This epiphysis becomes fused with the shaft of the bone and in most cases only at the

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end of puberty.[7] Thus the stage of growth and development of the child is suggestive of the amount and intensity of exercise that can be performed and tolerated.

In order to estimate age with more precision and accuracy, dental status and physical examination including secondary sexual characters should be taken into consideration along with ossification test. It is not possible to enunciate in a hard and fast rule for age determination from this union for the whole India because India is composed of areas which differ in climatic, dietetic and disease factors which affect skeletal growth. This study aimed to formulate references in future to compare the epiphyseal fusion in sport persons and general population category.

Aims and objectives

The objectives were:

1. To compare the appearance & fusion of ossification centers around the Elbow joint in sports persons and general population.
2. To know variation if any and exception of skeletal maturity affecting appearance and / or fusion of centers of ossification around the elbow joint.

2. Material and methods

This is a comparative study involving age estimation of cases in the age group 12 to 18 years referred by Sports authority of India in last one year and forthcoming 6 months' duration. X-rays of elbow joint were taken routinely as per Sports authority of India form. Study was conducted in 50 equal number of cases enrolled in two groups (sports person and general population). These subjects are Sports individual coming for medical age estimation sent by various State Association approved by sports authority of India in State of Maharashtra, belonging to schools, Colleges of different cities, predominantly of western Maharashtra and Medico legal cases (General Population) came for age estimation. The cases selected after ruling out the nutritional, developmental, and endocrinal abnormality which affects the skeletal growth. Authorization of institutional ethical committee was obtained by submitting the study project. Informed consent of subject obtained prior to examination. Chronological age was affirmed after evaluating proof of date of birth. General and physical examination (Secondary sexual characters, height and weight) was done in Department of Forensic Medicine and Toxicology, of this institute.

X-ray of elbow joint was taken at department of radiology. Radiological assessment for fusion or no fusion of ossification centre of Elbow joint was done. After taking radiographs, these radiographs were examined at the Department of Forensic Medicine &Toxicology.

The epiphysis of elbow joint were observed for appearance (A) and not appeared (NA) and different phases of fusion were graded according to Dr. William Sangma et al and Mckern and Stewart 5 stages[8] as follows:

Stage 1 (F1): Non-union – when the epiphysial cartilage did not begin to decrease in thickness.

Stage 2 (F2): Commence of union – when the thickness of epiphysial cartilage was found to be reduced appreciably (1/4thunited).

Stage 3 (F3): Incomplete union – when the epiphysis have begun to fuse with shaft and complete union was well underway (1/2 united).

Stage 4 (F4): Complete union – when the epiphysial cartilage was bony in Architecture and its density indistinguishable from the epiphysis and diaphysis in its neighborhood but an epiphyseal line called epiphysial scar could still be distinguished. (3/4 united)

Stage 5 (F5): Complete union – with absence of epiphysial scar.

- Skeletal maturity was evaluated radiologically studying the various centers of ossification and the results were compared with the previous known standard studies.
- Master chart was prepared and tabulated. It was classified, analyzed and compared. Data analysis was done in computer using SPSS software. At the conclusion, conclusions were drawn which were compared with accessible results of various past studies.

3. Results

In this study, age estimation of total 100 cases i.e. 50 equal number of cases enrolled in two groups (sports person and non-representative sample of general population) was carried out in which 20 cases were males and 30 cases were females in each category. In sports person and general population category, maximum number of cases belonged to 12-14 years of age group. Out of total sport persons examined in this study, 38.0% were handball players followed by 24.0% swimmers

and 16.0% were Judo players. There was only one cricketer examined.

Table No. 1: Trochlea in General and Sports Persons Cases: In general population cases beginning of fusion (F2 Stage) was noted in 1 case whereas near fusion (F4 Stage) was seen in 2 cases in 12 years age group. sports persons in the age category of 12 years, 27.27 % cases each were in F4 Stage and F5 Stage of Fusion. In the age group of 13years, 50.0% cases showed complete fusion in general cases whereas 70.0% cases showed complete fusion in sports cases. In the age group of 14 years, 42.8% of cases were in F4 stage and 28.6% in f5 stage in general cases, all cases of sports persons showed complete fusion. In general population, age category of 15 years, 37.5% and 62.5% cases were in F4 Stage and F5 Stage respectively whereas sports persons showed complete fusion. Hence, it can be interpreted that the fusion of trochlea occurred between 13 to 16 years in general population whereas 12 to 14 years in sports persons.

Table No. 2: Lateral Epicondyle in General and Sports Persons Cases: In general population cases, the centre of ossification for lateral epicondyle did not appear in 1 case in both 12 years and 13 years' age group whereas in all other 48 cases it appeared. Similarly, in sports persons it did not appear in only one case in 12 years' age group whereas in all other 49 cases it appeared. beginning of fusion (F2 and F4 stage) was noted in 1 case each in 12-year group in general cases whereas in sports persons 40.0% cases showed fusion in F4 and F5 Stage Each. In the age group of 13 years of general population, 28.57% cases showed complete fusion whereas in the age group of 14 years, 42.85% of cases were in F4 stage and 28.57% in F5 Stage. while in sports persons, 80.0% cases in the age group 13 years, complete fusion was noted. in the age category of 14 years, almost all cases showed complete fusion. similarly, in the age category of 15 years, 25.0% and 75.0% cases were in F4 Stage and F5 Stage respectively in general cases whereas in sports cases of age 15 years and onwards showed complete fusion. Hence, it can be interpreted that the fusion of lateral epicondyle occurred between 13 to16 years in general population whereas 12 to14 years in sports persons.

Table No. 3: Medial Epicondyle in General and Sports Persons Cases: Beginning of fusion (F2 Stage) was noted in 1 case in 12 years' age group in general population cases while 18.18% cases showed complete fusion in sports persons. In the age group of 13 years, 25.0% cases showed complete fusion, whereas, 71.42% and 62.5% cases showed complete fusion in the age group of 14 years and 15 years respectively. In general cases while in the sports persons age group of 13 years and 14 years, complete fusion was observed in 50.0% and 72.72% cases respectively. Almost all cases of general population in the age group of 16 years onwards showed complete fusion. in sports persons, age group of 15 years and onwards showed complete fusion. Hence, it can be interpreted that the fusion of medial epicondyle in non representative sample of general population occurred between 13 to 16 years whereas 12 to 15 years in sports persons.

Table No. 4: Head of Radius in General and Sports Persons Cases: Beginning of fusion (F2 Stage) was noted in 1 case in 13 years' age group whereas 2 cases showed near fusion in general population and in sports persons in the age group of 12 years, beginning of fusion was observed in 1 case whereas near fusion was observed in 4 cases. In the age group of 13 years, 40.0% cases showed near fusion (F4 Stage) and 30.0% cases showed complete fusion (F5 Stage). Similarly, 1 general case also showed near fusion in age group of 14 years whereas in sports persons near fusion and complete fusion was observed in 72.73% cases and 18.18% cases respectively. In the age group of 15 years' general population cases, 37.5% cases each shared near fusion (f4 stage) and complete fusion (f5 stage) while complete fusion was observed in 71.43% cases in sports cases. Similarly, in the age group 16 years, near fusion (F4 stage) and complete fusion (F5 Stage) were observed in general cases and in sports showed complete fusion above 16 years onwards. Complete fusion was observed in all general cases after the age of 17years. Hence, it can be interpreted that the fusion of head of radius in general population occurred between 15 to17 years whereas 13 to 16 years in sports persons.

Olecranon in General and Sports Persons Cases: Incomplete fusion (F3 Stage) was observed in 1 case in the general cases of age group of 13 years, whereas near fusion (F4 Stage) was observed in 2 cases and 1 case in the age group of 13 years and 14 years respectively. While in the sports cases age group of 12 years, near fusion (F4 Stage) and complete fusion (F5 stage) was noted in 30.0% and 10.0% cases respectively. Similarly, 44.45% cases and 33.33% cases in the age group of 13 years showed near and complete fusion respectively. in the general cases age group of 15 years, near fusion

Table No. 1: **Trochlea in general and sports persons**

Trochlea									
Age	**Category**	**Appearance**		**Fusion**					
		Not appeared	**Appeared**	**F1**	**F2**	**F3**	**F4**	**F5**	**Total**
12	General	0	8	5 (62.5%)	1 (12.5%)	0 (0%)	2 (25.0%)	0 (0%)	**8 (16.0%)**
	Sports	0	11	2 (18.19%)	0 (0%)	3 (27.27%)	3 (27.27%)	3 (27.27%)	**11 (22.0%)**
13	General	0	8	3 (37.5%)	0 (0%)	1 (12.5%)	0 (0%)	4 (50.0%)	**8 (16.0%)**
	Sports	0	10	0 (0%)	0 (0%)	2 (20.0%)	1 (10.0%)	7 (70.0%)	**10 (20.0%)**
14	General	0	7	0 (0%)	0 (0%)	2 (28.6%)	3 (42.8%)	2 (28.6%)	**7 (14.0%)**
	Sports	0	11	0 (0%)	0 (0%)	0 (0%)	1 (9.09%)	10 (90.91%)	**11 (22.0%)**
15	General	0	8	0 (0%)	0 (0%)	0 (0%)	3 (37.5%)	5 (62.5%)	**8 (16.0%)**
	Sports	0	7	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7 (100%)	**7 (14.0%)**
16	General	0	10	0 (0%)	0 (0%)	0 (0%)	1 (10.0%)	9 (90.0%)	**10 (20.0%)**
	Sports	0	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)	**6 (12.0%)**
17	General	0	5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	**5 (10.0%)**
	Sports	0	5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	**5 (10.0%)**
18	General	0	4	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (100%)	**4 (8.0%)**
	Sports	0	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	**0 (0%)**
Total									**50 (100%)**

Table No. 2: Lateral epicondyle in general and sports persons

Lateral epicondyle									
Age	**Category**	**Appearance**		**Fusion**					
		Not appeared	**Appeared**	**F1**	**F2**	**F3**	**F4**	**F5**	**Total**
12	General	1	7	5 (71.42 %)	1 (14.29 %)	0 (0%)	1 (14.29%)	0 (0%)	**7 (14.0%)**
	Sports	1	10	0 (0%)	0 (0%)	2 (20.0%)	4 (40.0%)	4 (40.0%)	**10 (20.0%)**
13	General	1	7	4 (57.14 %)	0 (0%)	1 (14.29 %)	0 (0%)	2 (28.57%)	**7 (14.0%)**
	Sports	0	10	0 (0%)	0 (0%)	1 (10.0%)	1 (10.0%)	8 (80.0%)	**10 (20.0%)**
14	General	0	7	1 (14.29 %)	0 (0%)	1 (14.29 %)	3 (42.85%)	2 (28.57%)	**7 (14.0%)**
	Sports	0	11	0 (0%)	0 (0%)	0 (0%)	1 (9.01%)	10 (90.91%)	**11 (22.0%)**
15	General	0	8	0 (0%)	0 (0%)	0 (0%)	2 (25.0%)	6 (75.0%)	**8 (16.0%)**
	Sports	0	8	0 (0%)	0 (0%)	0 (0%)	0 (0%)	8 (100%)	**8 (16.0%)**

16	General	0	11	0 (0%)	0 (0%)	0 (0%)	0 (0%)	11 (100%)	**11 (22.0%)**
	Sports	0	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)	**6 (12.0%)**
17	General	0	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)	**6 (12.0%)**
	Sports	0	5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	**5 (10.0%)**
18	General	0	4	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (100%)	**4 (8.0%)**
	Sports	0	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	**0 (0%)**
Total									**50 (100%)**

Table No. 3: Medial epicondyle in general and sports persons

Medial epicondyle									
Age	**Category**	**Appearance**		**Fusion**					
		Not appeared	**Appeared**	**F1**	**F2**	**F3**	**F4**	**F5**	**Total**
12	General	0	8	7 (87.5%)	1 (12.5%)	0 (0%)	0 (0%)	0 (0%)	**8 (16.0%)**
	Sports	0	11	7 (63.64%)	1 (9.09%)	0 (0%)	1 (9.09%)	2 (18.18%)	**11 (22.0%)**
13	General	0	8	6 (75.0%)	0 (0%)	0 (0%)	0 (0%)	2 (25.0%)	**8 (16.0%)**
	Sports	0	10	2 (20.0%)	1 (10.0%)	0 (0%)	2 (20.0%)	5 (50.0%)	**10 (20.0%)**
14	General	0	7	0 (0%)	1 (14.29 %)	0 (0%)	1 (14.29 %)	5 (71.42%)	**7 (14.0%)**
	Sports	0	11	0 (0%)	0 (0%)	0 (0%)	2 (18.18%)	8 (72.72%)	**11 (22.0%)**
15	General	0	8	0 (0%)	1 (12.5%)	1 (12.5%)	1 (12.5%)	5 (62.5%)	**8 (16.0%)**
	Sports	0	7	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7 (100%)	**7 (14.0%)**
16	General	0	10	0 (0%)	0 (0%)	0 (0%)	1 (10.0%)	9 (90.0%)	**10 (20.0%)**
	Sports	0	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)	**6 (12.0%)**
17	General	0	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)	**6 (12.0%)**
	Sports	0	5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	**5 (10.0%)**
18	General	0	3	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	**3 (6.0%)**
	Sports	0	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	**0 (0%)**
Total									**50(100%)**

Table No. 4:- Head of radius in general and sports persons

Head of radius									
Age	**Category**	**Appearance**		**Fusion**					
		Not appeared	**Appeared**	**F1**	**F2**	**F3**	**F4**	**F5**	**Total**
12	General	0	8	8 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	**8 (16.0%)**
	Sports	0	11	6 (54.55%)	1 (9.09%)	0 (0%)	4 (36.36%)	0 (0%)	**11 (22.0%)**

13	General	0	8	5 (62.5%)	1 (12.5%)	0 (0%)	2 (25.0%)	0 (0%)	**8 (16.0%)**
	Sports	0	10	2 (20.0%)	1 (10.0%)	0 (0%)	4 (40.0%)	3 (30.0%)	**10 (20.0%)**
14	General	0	7	6 (85.71%)	0 (0%)	0 (0%)	1 (14.29%)	0 (0%)	**7 (14.0%)**
	Sports	0	11	0 (0%)	0 (0%)	1 (9.09%)	8 (72.73%)	2 (18.18%)	**11 (22.0%)**
15	General	0	8	2 (25.0%)	0 (0%)	0 (0%)	3 (37.5%)	3 (37.5%)	**8 (16.0%)**
	Sports	0	7	0 (0%)	0 (0%)	0 (0%)	2 (28.57%)	5 (71.43%)	**7 (14.0%)**
16	General	0	10	0 (0%)	0 (0%)	0 (0%)	5 (50%)	5 (50%)	**10 (20.0%)**
	Sports	0	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)	**6 (12.0%)**
17	General	0	6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)	**6 (12.0%)**
	Sports	0	5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	**5 (10.0%)**
18	General	0	3	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (100%)	**3 (6.0%)**
	Sports	0	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	**0 (0%)**
Total									**50 (100%)**

was observed in 25.0% cases and complete fusion was observed in 62.5% cases. The sports cases in the age group of 14 years and 15 years showed near fusion in 70.0% cases and 62.5% cases and complete fusion in 30.0% and 37.5% cases respectively. Similarly, 30.0% and 70.0% general cases showed near fusion and complete fusion in the age group of 16 years respectively. While all the sports cases above 16 years and onwards showed complete fusion. all the general cases above 17 years and onwards showed complete fusion. Hence, it can be interpreted that the fusion of olecranon in general population occurred between15 to 17 years whereas 12 to 16 years in sports persons.

4. Discussion

Out of total sport persons examined in this study, 38.0% were handball players followed by 24.0% swimmers and 16.0% were Judo players. These sports are predominantly played in the urban region on competitive basis hence higher percentage of subjects in these sports were observed owing to predominantly higher urban population.

In this study, it was observed that the fusion of trochlea in majority of the general population subjects occurred between the age 13 to 16 years and complete fusion was observed in cases of age 16 years and above. In majority of the sports person subjects it was observed between 12 to 14 years and complete fusion was detected in cases of age 14 years and above. Fusion of the lateral epicondyle in most of the general population subjects was observed in the age between 13 to 16 years with complete fusion in the age above 16 years. In most of the sports person subjects it was between12 to 14 years of age with complete fusion after the age of 14 years. Similarly, fusion of the medial epicondyle in majority of the general population subjects occurred between the age 13 to 16 years and complete fusion was observed in cases of age 16 years and above. In larger part of the sports person subjects it was observed in the age between 12 to 15 years and complete fusion was observed in cases of age 15 years and above. Fusion of the head of the radius and olecranon was observed in majority of the general population subjects in the age 15 to 17 years whereas in sports person subjects' fusion of the head of the radius occurred between the age 13 to 16 years and fusion of the olecranon occurred between12 to 16 years.

In this study, subjects were belonging predominantly from urban region i.e. 90.0% females in sports persons' category and 93.34% females in General Population category. This is attributed to the fact that most of the subject populations were referred from Mumbai region and urban western Maharashtra. The subject populations were belonging predominantly to Class-II, followed by Class-III of socioeconomic status according to Kuppuswamy's scale. In sports persons it was 40.0%

in the class-II, whereas in general population 56.67% in class-III. This could be because of the fact that most of the population belongs to urban region where better facilities and opportunities are available in the field of sport and higher socioeconomic class can be attributed to financial well-being, literacy and awareness.

The epiphyseal growth plate is a dynamic entity. Growth is dependent not only on intrinsic factors such as hormones and other regulatory factors but on extrinsic factors. These extrinsic factors are based totally on the biomechanical demonstrate. Exercise, a positive aspect for the epiphyseal growth plate needs to be moderated through carefully crafted activities especially during pubertal growth spurts. The effects of exercise on the epiphyseal growth plate needs further research to comprehend the entirety of this dynamic anatomical and physiological entity.

5. Conclusion:

From observation and discussion in study following specific scientific conclusions were drawn: Fusion at elbow joint occurs 1 to 2 years earlier in sports person than in general population which is consistent with the literature.

1) References for the estimation of age in the sports persons and general population should be standardized in order to prevent malpractices. This study can be used as one of those references in Mumbai region.
2) Estimation of the age from the X-rays can have inter-observer differences. Hence it is always desirable to conclude age after studying ossification in multiple joints.
3) The opinion about age should be given always in the range. From this study range of 1-2 years including margin of error can be concluded.
4) In this study, commencement of fusion was observed relatively earlier in some cases. This could be due to fact that study group involved sports persons and majority of them were from upper middle socioeconomic class. However, to establish strong co-relation, extensive research on larger study population is required.

6. Limitation of study

In present study sample size is limited, representative sample of general population shall be considered for the study. Owing to the variations in climatic, dietetic, hereditary and other factors affecting the people of different states of India, it cannot be reasonably expected to formulate a uniform standard for the determination of age of the union of epiphysis for entirely India.

References:

1. Demorest RA, Landry GL. Training issues in elite young athletes. Curr Sports Med Rep 2004;3(3):167-172.
2. HymerWC, Kraemer WJ, Nindl BC, Marx JO, Benson DE, Welsch JR, Mazzetti SA, et al. Characteristics of circulating growth hormone in women after acute heavy resistance exercise. Am J Physiol Endocrinol Metab2001;281(4): E878-887.
3. Akbarnia BA. Pediatric spine fractures. OrthopClin North Am 1999;30(3):521-536, x.
4. Maffulli N, Baxter-Jones AD. Common skeletal injuries in young athletes. Sports Med 1995;19(2):137-149.
5. Maffulli N, Bruns W. Injuries in young athletes. Eur J Pediatr2000;159(1-2):59-63.
6. Nilsson O, Marino R, De Luca F, Phillip M, Baron J. Endocrine regulation of the growth plate. Horm Res2005;64(4):157-165.
7. Putz R. Development and growth of the epiphysis, Z Orthoplhre Grenzgeb 1996;134(5):391-395.
8. Sangma WB, Marak FK, Singh MS, Kharrubon B. Age determination in girl of North- Eastern Region of India. JIAFM. 2007;29(4):102-108.
9. Dere RC, Kukde HG, Maiyyar, Dhobale SV. Age determination of female sport persons of age 9-18 years by radiological examination of elbow and wrist joint. Journal of Forensic medicine, Science and Law. 2014;23(2).
10. Ali AM, Hasan AI, Gameraddin M. Estimation of age from olecranon centre of the upper end of the ulna by using radiograph of 6 to 18 years age female subject. IJMPRS.2016; 3(3):14-18.
11. Dixit SP, Bansal RK. Study of ossification centres fusion of elbow jointin15 to 17 years Garhwali females of Dehradun region. J Indian Acad Forensic medicine. 2014 Jan-March; 36(4):396-398.
12. Memchoubi PH. Age determination of Manipuri girls from the radiological study of epiphyseal union around the elbow, knee, wrist joint and pelvis. JIAFM. 2006; 28(2):63- 64.
13. Kangne RN, Sami SA, Deshpande VL. Age estimation of adolescent girls by radiography. Journal of Forensic Medicine AndToxicology.1999;16(1):20-26