

# Age estimation based on appearance of pisiform bone in selected Nepalese children of Gandaki Province Nepal

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## ABSTRACT

**Background:** Age estimation is based on general physical examination, radiological examination of bones and dental examination. The appearance of ossification center of pisiform bone is one of the important evidence for estimating age among young children between nine to 13 years. The objective of this study is to estimate the age of appearance of pisiform among the Nepalese children. **Materials and methods:** It is a cross sectional descriptive study conducted at the department of Radiology, Pokhara Academy of Health Sciences, Western Regional Hospital on the month of July 2020. The Antero posterior view of X Rays of either hand (left or right) including the carpal bones of the patients aged seven to 15 years of 183 Nepalese children archived at the department of Radiology were taken as samples. The X rays were checked for the appearance or non appearance of Pisiform and the age of appearance analysed. **Results:** One hundred and twenty seven (69.40%) of total 183 cases were males and 56 (30.60%) were females. The minimum age of appearance of pisiform was 9 years in females and 10 years in males. All the subjects had pisiform bone appeared at the age of 13 years and above. **Conclusion:** The minimum age of appearance of Pisiform in the study subjects was 9 years in females and 10 years in males. All the cases have pisiform ossified at the age of 13 years and above.

**Key words:** Age estimation, ossification center, Pisiform

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## INTRODUCTION

The bones of the human skeleton are pre-formed in hyaline cartilage. This soft tissue model is gradually converted into hard osseous tissue by the development of osteogenesis, mostly from the center, from which the process of transformation spreads, until the whole skeleton is ossified. The appearance of such centres of ossification is spread over a long period of time. A large number are first seen in embryonic life, some appear much later in prenatal life, and others after birth. Some bones are ossified from a single center, for example, carpus and tarsus. Most bones are ossified from several separate centres, one of which appears near the middle of the future bone. This center is concerned with progressive ossification towards the bone ends. These terminal regions are ossified by separate centres, sometimes multiple; they are said to be secondary centres.<sup>1</sup>

There are variations in the age dependent changes and there may be maturity imbalance between bones from different parts of the same individual. There is only a central tendency with a normal range of variability and the variability increases with age. As a rule, the ageing

of bones is more accurate with respect to the appearance of centres of ossification, that is with respect to the union of epiphyses.<sup>1</sup>

In most of the countries, the proof of an individual being under or over the age of legal definition is needed for several legal decisions and proceedings. If there are any doubts about the age of individual, authorities and courts may request a medical age certificate issued by an expert.<sup>2</sup> In our setting, age reports are prepared mainly by forensic physicians, and they may consult radiologists and dentists as well.

Age estimation is based on general physical examination, radiological examination of bones and dental examination. The assessment of bone age is most commonly based on X-rays of the hand and wrist, which are compared to one of two different but similar reference atlases by Greulich and Pyle (GP)<sup>3</sup> and Tanner and Whitehouse (TW3).<sup>4</sup>

Pisiform is ossified at the age of nine to 13 years as evident from different studies.<sup>5,6</sup> The appearance of ossification center of pisiform bone is one of the important evidence for estimating age among young children between nine to 13 years. The objective of this study is to estimate the age of appearance of pisiform among the Nepalese children. Our part of the world are also using the same data as used by other countries but we don't have enough researches in our part of world. Therefore, this study was deemed important for our context.

## MATERIALS AND METHODS

The present cross sectional descriptive study was conducted at the department of Radiology, Pokhara Academy of Health Sciences, Western Regional Hospital. The duration of study was in the month of July 2020. We studied 183 digital X Rays of the hand archived in the department. Males comprised of 127 and females 56 cases for the study purpose. The age of the study participants were categorized in the range of one year. Separate analysis was done for males and females.

The Antero posterior view of X Rays of either hand (left or right) including the carpal bones of the patients aged seven to 15 years archived at the department of Radiology were taken as samples. The X rays were done for various surgical and orthopedic problems of the hand. There is provision of inclusion of name and age of the patients in the digital X rays which were retrieved for research proposes. As the study was conducted based on the review of records, the patients' information is not revealed and the consent was not required. Ethical approval was taken from the Institutional Review Committee of Pokhara Academy of Health Sciences.

Inclusion criteria: Nepalese Children in the age group of above seven to 15 years of both sexes were included in the study. Exclusion criteria: The X rays with obvious congenital and other skeletal

abnormalities of the hand were excluded. The cases with fracture of carpal bones were also excluded from the study.

The X ray was read by a Radiologist for the appearance of pisiform. When the ossification center of pisiform was evident, it was categorized as "Appeared", and if there was no any evidence of the appearance in the X ray, it was categorized as "Not appeared".

The data was collected in a standard proforma. The proforma was validated by experts in the field of Radiology and Forensic Medicine and suggested changes were implemented. The interobserver reliability was checked. A total of 20 radiographs were reassessed by another radiologist without any knowledge of the scoring by earlier radiologist. To assess intra-observer reliability, 20 X rays were re-observed after a week. The data so obtained was entered in Microsoft Excel spreadsheet and further analysis was done using SPSS version 16.0. Descriptive statistics was used to determine mean and standard deviation. The appearance and non-appearance of the center of ossification was expressed in the form of frequency and percentage. Wilcoxon signed ranks test was performed to assess the difference of inter and intra examiner variability. P value of <0.05 was regarded significant.

## RESULTS

The present study aimed to estimate age from appearance of ossification center of pisiform consisted of 183 X rays of hand of Nepalese children. The Wilcoxon signed ranks test showed no significant intra-observer and interobserver differences on evaluation of X rays. One hundred and twenty seven (69.40%) of them were males and 56 (30.60%) were females. Mean age was 11.2022 years with standard deviation of 2.032. As there is difference in punishment depending upon the age of the culprit, a narrow range of age group was done. The distribution of age group and sex is represented in table 1.

**Table 1:** Distribution of age and sex of the participants

Age (Years)	Sex		Total n(%)
	Male	Female	
7-8	10	4	14 (7.65)
8-9	6	2	8 (4.37)
9-10	15	5	20 (10.93)
10-11	9	5	14 (7.65)
11-12	28	6	34 (18.58)
12-13	24	12	36 (19.67)
13-14	24	12	36 (19.67)
14-15	11	10	21 (11.47)
Total	127	56	183 (100)

Table 2 shows the age of appearance of Pisiform in males.

It is evident that the center of ossification of pisiform is not formed in male child up to the age of 10 years and it has started to appear in the children of above 10 years. It has appeared in all the children of age more than 13 years.

**Table 2:** Age of appearance of Pisiform in males

Age in years	Appeared Number (%)	Not appeared Number (%)	Total
7-8	0 (0)	10 (100)	10
8-9	0 (0)	6 (100)	6
9-10	0 (0)	15 (100)	15
10-11	3 (33.3)	6 (66.67)	9
11-12	5 (21.74)	23 (78.26)	28
12-13	14 (58.34)	10 (41.67)	24
13-14	24 (100)	0 (0)	24
14-15	11 (100)	0 (0)	11

Table 3 shows the age of appearance of Pisiform in females. It is evident that the center of ossification of pisiform is not formed in female child up to the age of nine years and it has started to appear in the children of above nine years. It has appeared in all the female children of age more than 13 years.

**Table 3:** Age of appearance of Pisiform in females

Age in years	Appeared Number (%)	Not appeared Number (%)	Total
7-8	0 (0)	4 (100)	4
8-9	0 (0)	2 (100)	2
9-10	2 (40)	3 (100)	5
10-11	3 (60)	2 (40)	5
11-12	3 (50)	3 (50)	6
12-13	6 (50)	6 (50)	12
13-14	12 (100)	0 (0)	12
14-15	10 (100)	0 (0)	10

**DISCUSSION**

This present study is aimed to estimate the time of appearance of ossification of Pisiform in Nepalese children. This will contribute to the existing literature and be useful for forensic age estimation targeted to the age group of nine to 14 years or so. Importantly the age of ossification of bones may differ in different population and hence data from different population has to be generated.

The age group of our interest has several medico legal importances. The outstanding importance of this age group in Nepal is presented in the table 4.<sup>7,8</sup>

**Table 4:** Medico legal importance of age of 10 to 14 years in Nepal

Age	Importance	Relevant Law
Below 10 years	If a child below 10 years commits any act, it is not considered as an offence	National criminal code 2074, No 13
	No punishment is awarded to the person if at the time of committing the crime, the age is less than 10 years.	National criminal code 2074, No 45 (1)
Above 10 years	If the victim of rape is below 10 years, the punishment for the offender: imprisonment for 16 to 20 years	National criminal code 2074, No 219 (3)
	A person of age 10 years and above should not expose his or her genitals or perform any sexual activities at public except that require for medical or treatment purposes.	National criminal code, 2074: No 122
10 to 14 years	If the age is 10 to 14 years, if imprisonment is done, it should be for maximum six months or kept at reform homes for up to one year only.	National criminal code, 2074 No 45 (2)
	If the victim of rape is above 10 and below 14 years, the punishment for the offender: imprisonment for 14 to 16 years	National criminal code 2074, No 219 (3)
14 to 16 years	For a child of age 14 to 16 years, the punishment will be half as of the adults and for the child aged 16 to 18 years, it will be two thirds to that of adults.	National criminal code 2074 No 45 (2) and (3)
	If the victim of rape is above 14 and below 16 years, the punishment for the offender: imprisonment for 12 to 14 years	National criminal code 2074: No 219 (3)

Age estimation is based on the observation of multiple parameters. The age of ossification of Pisiform can also be an important evidence to supplement for the estimation of age at the range of 9 to 14 years from our observation at our setting. The hand – wrist region consists of numerous small bones which have a predictable and scheduled pattern of appearance of centers of ossification and union of epiphysis from birth to maturity. Hence, this region is one of the important parts to be examined for the proposes of age estimation.<sup>9</sup>

The usefulness of carpal bones in estimation of age has been demonstrated in other settings also.<sup>10-15</sup> Srivastav et al<sup>6</sup> carried out radiographic study on pediatric subjects of Rajasthan, India from birth to 12 years of age of both sexes. They observed that Pisiform was the last carpal bone to appear. It had appeared in age of 10 years and above in both sexes, which is comparable to our study.

As presented by Patil et al,<sup>5</sup> the minimum age of appearance of Pisiform was eight years in both sexes, in the children of Vijaypur, India. Although the proportion of females which had the appearance of the carpal bone at the age of eight to nine years was more than that of males. All the boys of age 12 to 13 years had appearance of the bone and all the girls of age 11 to 12 years had appearance of Pisiform. Overall, this study has shown that the Pisiform appears earlier in female than in male children. Our study has also shown that the minimum age for appearance of Pisiform is earlier in females

(nine to 10 years) than in males (10 to 11 years). Although the age to have all the children of both sexes to have pisiform bone appeared is more (13 to 14 years) in our study than in the Indian counterparts.<sup>5,6</sup>

The delayed appearance of Pisiform in the study population could be related to genetic and environmental factors. It can also be attributed to biological inter-ethnic differences, so it can be a major bias in age estimation if database from different population is used. This is also an important trigger to conduct larger and inclusive population based study in our settings.

## CONCLUSION

The minimum age of appearance of Pisiform in the study subjects was nine years in females and 10 years in males. All the cases have pisiform ossified at the age of 13 years and above. The information from the present findings can be used as an additional parameter for forensic age estimation in Nepal.

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