

## Classification and incidence of medial articular surface in Northeastern-Thai clavicles

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### Abstract

**Introduction:** The medial articular surface of dried clavicles have been studied to evaluate sex and age in many races. This morphological investigation in Thai population has never been reported. This study aimed to classify the clavicular medial surfaces and to provide their incidences. **Materials and Methods:** 454 dried clavicles (254 males and 200 females), averaged age (60.69±14.36 years), from KKU Osteological Collection Unit, Department of Anatomy, Faculty of Medicine, Khon Kaen University, were systemically investigated for types and incidence of their medial articular surface. **Results:** The showed that medial articular surfaces of Northeastern-Thais were classified into 6 types: smooth (type 1 = 7.71%), slight granulation (type 2 = 16.74%), coarse granulation (type 3 = 41.63%), nodule formation (type 4 = 1.54%), undulating (type 5 = 24.89%), and degeneration (type 6 = 7.49%), respectively. **Conclusion:** These basic data can be used for teaching the medical and paramedical students and also might be applied in forensic sciences especially identifying of Northeastern – Thai clavicle remains.

**Keywords:** classification, incidence, medial articular surface, clavicle, Northeastern-Thais.

### 1 Introduction

In anthropological sciences, the clavicle bone is a key bone that has been used as a sex determination in many races including English (PARSONS, 1916), USA Whites (SINGH and SINGH, 1972), USA Negrose (SINGH and SINGH, 1972), French (OLIVIER, 1951), India (North West) (KAUR, HARJEET SAHNI and JIT, 2002), India (Amntsar zone) (JIT and SINGH, 1966), Greek (PAPAIOANNOU, KRANIOTI, JOVENEAX et al., 2012), and Southern Nigerians (UDOAKA and NWOKEDIUKO, 2013). In addition, the appearance of rhomboid fossa on inferior clavicular surface could be used to distinguish the males from the females (JIT and KAUR, 1986; ROGERS, FLOURNOY and MCCORMICK, 2000; PRADO, SANTOS, CARIA et al., 2009). Moreover, the medial articular surface of clavicle could be used to estimate age of Europeans (KREITNER, SCHWEDEN, RIEPERT et al., 1998; FALYS and PRANGLE, 2015). The medial clavicular epiphysis is also known to be the last bone to fuse among all long bones (>21 years). Therefore, it is the best to be used in reliable age indicator. Previous studies found that complete fusion of the medial articular surface of the clavicle is greater than 18 years (SINGH and CHAVALI, 2011; PATTAMAPASPONG, MADLA, MEKJAIDEE et al., 2015; FALYS and PRANGLE, 2015; HOUPERT, REROLLE, SAVALL et al., 2016). In clavicular surface topography, Falys and Prangle (2015) have described and classified the medial articular surfaces of clavicle of Europeans in different ages into six types (Table 1, Figure 1). In Thai population, although age estimation from the medial articular surface in computed tomography (CT) has been reported (PATTAMAPASPONG, MADLA, MEKJAIDEE et al., 2015), human dried clavicle have been investigated. These morphological investigations

in Thai race have never been reported. Therefore, this study attempted to classify and investigate the types of medial surface morphology on Northeastern-Thai dried clavicles.

### 2 Methods and Materials

From identified Northeastern - Thai skeletons from KKU Osteological Collection Unit, Department of Anatomy, Faculty of Medicine, Khon Kaen University, the total 454 dried clavicles (left and right sides from 254 males and 200 females) were used to observe in this study. As described by Falys and Prangle (2015), additional types of clavicular medial articular surfaces investigated in this study except 6 types (smooth, slight granulation, coarse granulation, nodular formation, undulating, and degeneration types) were also observed and systemically recorded.

### 3 Results

The medial articular surface of 454 dried clavicles from Northeastern-Thai skeletons can be classified into 6 types as shown in Figure 1. Type 1 was smooth type showing flat and smooth (Figure 1). Type 2 was slight granulation type showing fine sand paper (a slightly roughened surface) (Figure 1). Type 3 was coarse granulation type showing very small grains of bone form on the surface, resembling coarse sand. This texture is very rough, like sandpaper (Figure 1). Type 4 was nodule formation type showing at least one round lump of bone which is present on the generally flat surface (Figure 1). Type 5 was undulating type showing irregular and undulating surface (Figure 1). Finally, type 6 was degeneration

type showing increased porosity and highly irregular contours (Figure 1).

The Table 1 shows the incidence of the medial articular surface investigated in this study. Of 454 samples (averaged age 60.69±14.36 years), it was found that the percentages of 6 types of medial articular surface observed in Northeastern - Thai clavicles were 7.71% (type 1 smooth), 16.74% (type 2 slight granulation), 41.63% (type 3 coarse granulation), 1.54% (type 4 nodule formation), 24.89% (type 5 undulating), and 7.49% (type 6 degeneration), respectively (Table 1). In males, it was found that the percentages of type 1, 2, 3, 4, 5 and 6 were 3.52%, 8.15%, 18.72%, 0.88%, 10.57%, and 2.20%, respectively

(Table 1). In females, the incidences of type 1, 2, 3, 4, 5 and 6 were 4.19%, 8.59%, 22.91%, 0.66%, 14.32%, and 5.29%, respectively (Table 1). Obviously, the percentages of the type 3 and type 5 were increased especially in females (22.91% and 14.32%). In contrast, numbers of type 4 were decreased in both males and females (Table 1).

As compared Table 1 (N=454) to the samples known both sexes and ages (N=243), it was found that the percentages of 6 types of clavicular medial articular surface were similar. There were 9.06% (type 1), 14.4% (type 2), 40.33% (type 3), 2.05% (type 4), 25.92% (type 5), and 8.23% (type 6), respectively (Table 2). In contrast to type 4, the percentages of the type 3

**Table 1.** Incidence of medial clavicular articular surface types observe in Northeastern-Thais clavicle with known sexes (N=454).

Gender	Age average	N	Type1	Type2	Type3	Type4	Type5	Type6
Males	61.39±15.25	254	16 (3.52%)	37 (8.15%)	85 (18.72%)	4 (0.88%)	48 (10.57%)	10 (2.20%)
Females	60±13.46	200	19 (4.19%)	39 (8.59%)	104 (22.91%)	3 (0.66%)	65 (14.32%)	24 (5.29%)
<b>Total</b>	<b>60.69±14.36</b>	<b>454</b>	<b>35 (7.71%)</b>	<b>76 (16.74%)</b>	<b>189 (41.63%)</b>	<b>7 (1.54%)</b>	<b>113 (24.89%)</b>	<b>34 (7.49%)</b>

**Table 2.** Incidence of medial articular surface of clavicle between male and female clavicle with known both ages and sexes (N=243).

Gender	Age average	N	Type1	Type2	Type3	Type4	Type5	Type6
Males	61.39±15.25	135	12 (4.94%)	16 (6.58%)	57 (23.46%)	2 (0.82%)	36 (14.81%)	12 (4.94%)
Females	60±13.46	108	10 (4.12%)	19 (7.82%)	41 (16.87%)	3 (1.23%)	27 (11.11%)	8 (3.29%)
<b>Total</b>	<b>60.69±14.36</b>	<b>243</b>	<b>22 (9.06%)</b>	<b>35 (14.4%)</b>	<b>98 (40.33%)</b>	<b>5 (2.05%)</b>	<b>63 (25.92%)</b>	<b>20 (8.23%)</b>



**Figure 1.** Photographs showing 6 different types of medial articular surface observed in Northeastern - Thai clavicles. (A) smooth (type 1); (B) slight granulation (type 2); (C) coarse granulation (type 3); (D) nodule formation (type 4); (E) undulating (type 5); and (F) degeneration (type 6), respectively.

and type 5 were increased especially in males (23.46% and 14.81%) and those of type 4 were decreased in both sexes (Table 2).

#### 4 Discussion

In Thailand, the classification and age estimation of medial articular surface of dried clavicle have never been reported. In recent study, the types of medial articular surface were similar to that investigated in European clavicles (FALYS and PRANGLE, 2015) which were also classified into 6 types (smooth, slight granulation, coarse granulation, nodule formation, undulating and degeneration). Age estimation of medial articular surface of dried clavicle has been studied from radiographs (GALSTAUN, 1937; JIT and KULKARNI, 1976), computed tomography (CT) (KREITNER, SCHWEDEN, RIEPERT et al., 1998; PATTAMAPASONG, MADLA, MEKJAIDEE et al., 2015; HOUPERT, REROLLE, SAVALL et al., 2016), dry bones (MCKERN and STEWART, 1957; WEBB and SUCHEY, 1985), and fresh bones (SINGH and CHAVALI, 2011). On maturation of the medial clavicle, previous studies have reported the age estimation in many populations observing in epiphyseal development of Germany (KREITNER, SCHWEDEN, RIEPERT et al., 1998), Northwest Indian (SINGH and CHAVALI, 2011), Serbian (MILENKOVIC, DJUKIC, DJONIC et al., 2013), Thais (PATTAMAPASONG, MADLA, MEKJAIDEE et al., 2015), European (FALYS and PRANGLE, 2015) and French (HOUPERT, REROLLE, SAVALL et al., 2016). They suggested that medial clavicular epiphysis started to be completely closed between 16 to 30 years (average 23 years). In this study, medial clavicular epiphysis was not observed because it cannot be clearly investigated on dry bones as described in Falys and Prangle (2015). For this study, type 3 (coarse granulation) and type 5 (undulating) were mostly found in the age range between 60 to 79 years (data not shown). It is possible that the old clavicles had the changing of medial articular surface than the younger one. Also, this changing may associate with local careers such as agricultural occupations mostly found in rural areas of Northeastern Thais. Such careers, the shoulder movements from agricultural activities might also involve in the degeneration of medial articular surface. These accumulated affects from shoulder movements might appear over age of 50 years. In addition, many reports showed that the medial articular surface of clavicle has bone remodeling after injuries (SFEROPOULOS, 2003; BARTONÍČEK, FRIC and LUNÁČEK, 2008; KOCH and WELLS, 2012). Similar to injury effects, it is also assumed that the extreme activities at upper extremities from careers such as farm or none farm labors may induce the remodeling of medial articular surface of clavicle. Previous studies reported that ossification completion of medial clavicle epiphysis was from 18 to 30 years (KREITNER, SCHWEDEN, RIEPERT et al., 1998; ZHAO, DONG, ZHENG et al., 2011). Besides all basic data of dried clavicles observed in this study can be used for teaching the medical and paramedical students, these fundamental knowledges can also be applied in sex and age determinations of forensic sciences especially identifying of Northeastern – Thai clavicle remains.

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