

# Sex determination based on the analysis of palatine bones

Iwona M. Tomaszewska<sup>1</sup>, Mateusz Pliczko<sup>2</sup>, Paulina Frączek<sup>2</sup>, Martyna Gomulska<sup>2</sup>, Michał Średniawa<sup>2</sup>, Kinga Sałapa<sup>3</sup>, Ewa Mizia<sup>2</sup>, Robert Chrzan<sup>4</sup>, Krzysztof A. Tomaszewski<sup>2</sup>

<sup>1</sup>Department of Prosthodontics, Institute of Dentistry, Jagiellonian University Medical College, Krakow, Poland  
<sup>2</sup>Department of Anatomy, Jagiellonian University Medical College, Krakow, Poland  
<sup>3</sup>Department of Bioinformatics and Telemedicine, Jagiellonian University Medical College, Krakow, Poland  
<sup>4</sup>Department of Radiology, Jagiellonian University Medical College, Krakow, Poland

## INTRODUCTION

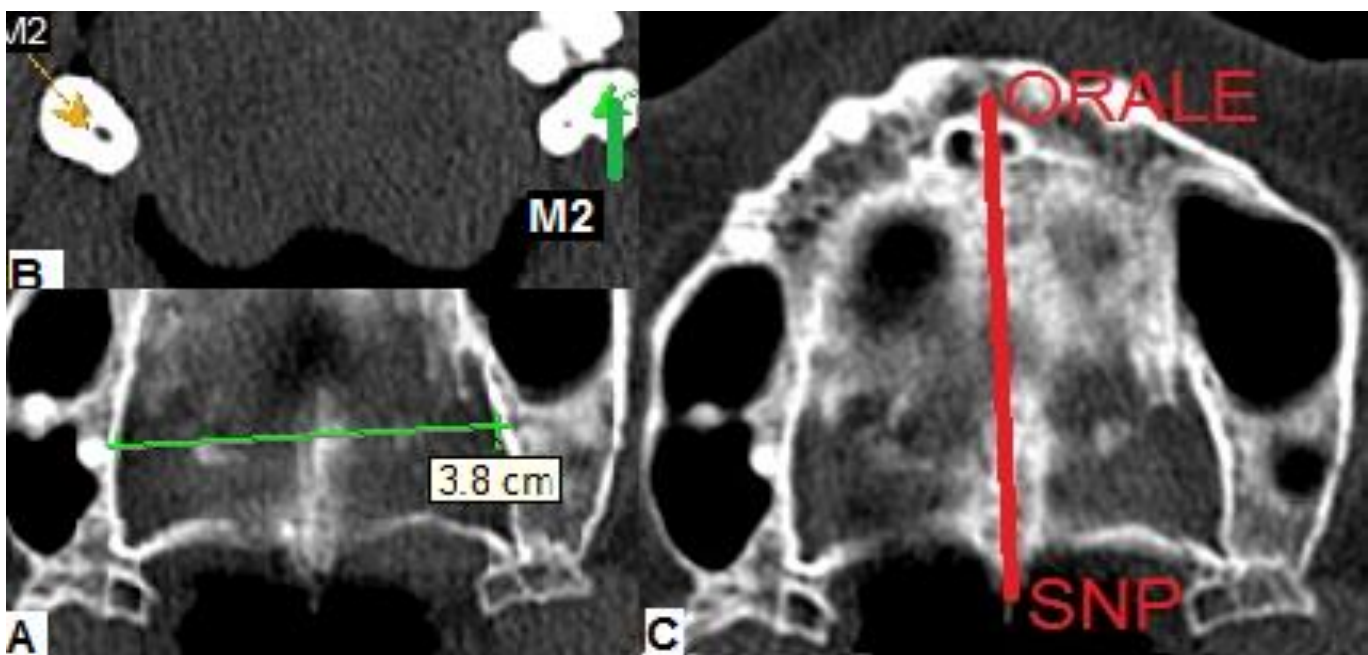
Human remains identification is often a long process and consists of many procedures individualizing one’s identity step by step. Correct sex evaluation reduces the amount of people needed to be identified by one half. The morphology of the skull bones, including the hard palate, exhibits characteristic differences according to sex. The more elements of sexual dimorphism are known, the more credible and easier to conduct the sex determination process is.

## OBJECTIVE

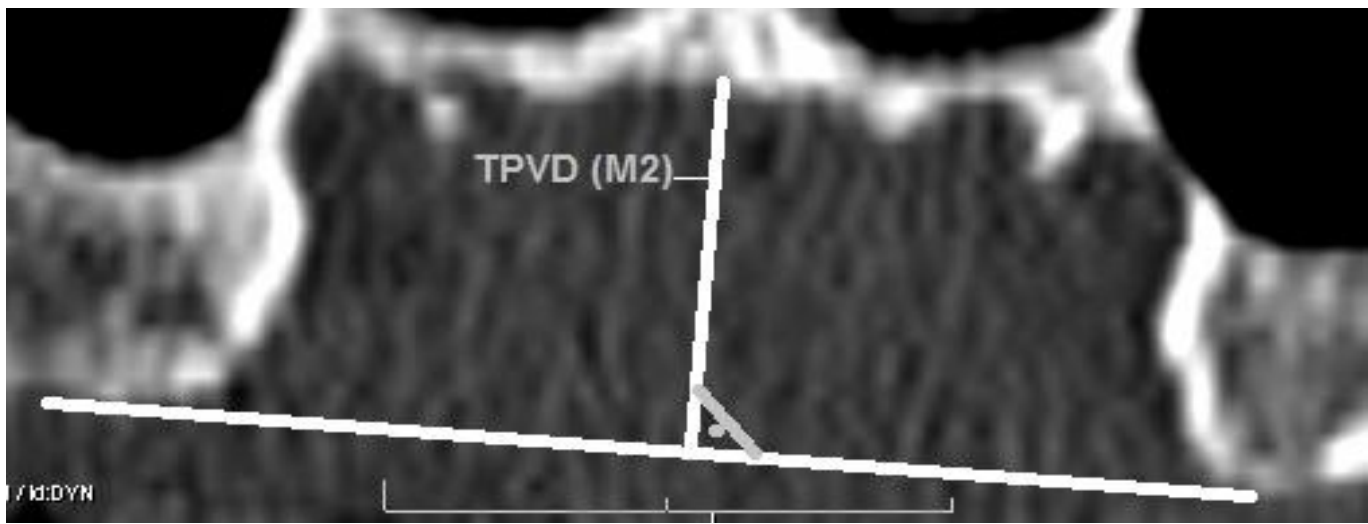
The aim of the current study is to present the diversity of the shape and dimensions of the hard palate and their application in forensic medicine and anthropology.

## MATERIALS AND METHODS

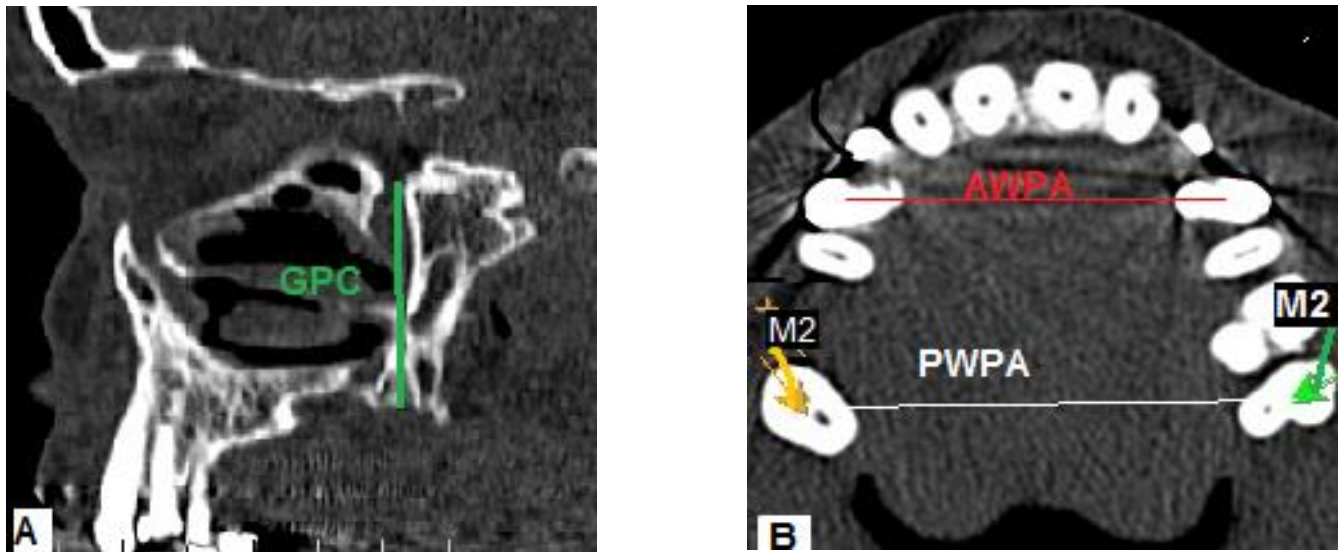
368 skulls (including 141 males and 227 females) of patients from Kraków, Poland were analyzed using the eFilm Wokstation program. The following measurements were taken: the distance between orale (O) and the spina nasalis posterior (SNP), the anterior width of the palatal arch (AWPA) - the distance between the transverse sulci of the first premolars, the posterior width of the palatal arch (PWPA) - the distance between the points of crossing the transverse and buccal sulci at the level of the second molars, the total palatal vault depth at the level of the second molar teeth (TPVD-M2), the depth of the greater palatine canal (GPC) of both right (R) and left (L) sides. Additionally, the palatal index (PI) was calculated by dividing the O-SNP value by the width of the palate measured between the 2<sup>nd</sup> molar teeth. Statistical analyses were conducted using STATISTICA 10.0 PL. Mean values and SD were calculated. Finally, the logistic regression models of data were used for derivation of two mathematical formulas which enable to calculate the probability of skull being male.



**Figure 1** – Measurement of the O-SNP distance (C) and PI (A and B – the level of 2<sup>nd</sup> molars)



**Figure 2** – Measurement of the TPVD at the level of 2<sup>nd</sup> molars.



**Figure 3** – Measurement of the depth of GPC (A) and the width of anterior and posterior palatal arches – AWPA, PWPA (B).

## RESULTS

The O-SNP distance was significantly longer in males than in females ( $49.6 \pm 4.3 \text{ mm}$  vs.  $45.7 \pm 4.4 \text{ mm}$ ;  $p<0.0001$ ). The posterior and anterior widths of the palatal arches were greater in males than in females ( $37.2 \pm 2.1 \text{ mm}$  vs.  $35.0 \pm 1.9 \text{ mm}$ ;  $p<0.0001$  and  $47.5 \pm 2.7 \text{ mm}$  vs.  $45.9 \pm 2.6 \text{ mm}$ ;  $p<0.0001$ ). The TPVD-M2 distance also revealed significant differences between males and females ( $14.3 \pm 2.6$  vs.  $12.4 \pm 2.7$  respectively;  $p<0.0001$ ). Males showed greater PI values as compared to females ( $133.2 \pm 17.1 \text{ mm}$  vs.  $127.6 \pm 16.3 \text{ mm}$ ;  $p=0.0018$ ). Also, the GPC depths revealed differences between sexes – in male skulls the GPC was bilaterally deeper than in female ones (GPC (L):  $40.8 \pm 3.2 \text{ mm}$  vs.  $37.9 \pm 2.8 \text{ mm}$ ;  $p<0.0001$ ; GPC (R):  $40.5 \pm 4.2 \text{ mm}$  vs.  $38.0 \pm 3.3 \text{ mm}$ ;  $p<0.0001$ ).

Variable	Male		Female		p-value
	mean	SD	mean	SD	
O-SNP	49,6	4,3	45,7	4,4	<0,0001
PWPA	37,2	2,1	35	1,9	<0,0001
AWPA	47,2	2,7	45,9	2,6	<0,0001
TPVD-M2	14,3	2,6	12,4	2,7	<0,0001
PI	133,2	17,1	127,6	16,3	<0,002
GPC- R	40,5	4,2	38	3,3	<0,0001
GPC- L	40,8	3,2	37,9	2,8	<0,0001

**Table 1** – Comparison of mean values in male and female.

Based on the measured parameters two mathematical models for sex determination were obtained: (A) with a reliability rate of 71,1% (probability based on the O-SNP distance) and (B) a reliability rate of 77,8% (probability based on GPC (L) depth, the O-SNP distance and AWPA).

A.
$$P_{(Y=M|O-SNP)} = \frac{e^{-10,50+0,21O-SNP}}{1+e^{-10,50+0,21O-SNP}}$$

B.
$$P_{(Y=M|O-SNP, GPC(L), AWPA)} = \frac{e^{-31,02+0,15O-SNP+0,35GPC(L)+0,28AWPA}}{1+e^{-31,02+0,15O-SNP+0,35GPC(L)+0,28AWPA}}$$

## CONCLUSION

The most prominent sexually dimorphic parameters are the O-SNP distance, the GPC depth and the AWPA. The measurements and the mathematical models presented in the current study can be used to distinguish between sexes in the fields of forensic medicine and anthropology.

## ACKNOWLEDGEMENTS

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