

Sex-Dependent Differences of the Greater Palatine Foramen and the Greater Palatine Canal

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ABSTRACT

The study aimed to identify sex-dependent differences in the morphology of the greater palatine foramen and greater palatine canal in people of the first period of adulthood. The object of the study was 261 people aged 21 to 35 years (the first period of adulthood; 132 females and 129 males). Cone-beam computed tomograms were used to determine the number of greater palatine foramina, their shape, anteroposterior and medio-distal diameters, the length of the greater palatine canal, its shape, and its medio-distal and anteroposterior diameters in the upper, middle, and lower thirds of the canal. It was found that the most common form of the greater palatine foramen in persons of both sexes was the oval shape, elongated in the anterior-posterior direction, and the rarest form was the helical shape. The size of the medio-distal and anteroposterior diameters of the greater palatine foramen is larger in males than in females. In persons of both sexes, the most common form of the greater palatine canal is crescent-shaped, and the forms that occurred least of all were the zigzag-shaped canal and the funnel-shaped canal with a bend in the lower third. The great palatine canal is longer in males than in females. The anteroposterior and medio-distal diameters of the greater palatine canal in the lower, middle, and upper third are smaller in females than in males. The data obtained on the shape and size of the greater palatine foramen and the greater palatine canal are of great importance when providing conduction anaesthesia in the posterior part of the upper jaw, as well as during the blockade of the pterygopalatine ganglion by the palatal access.

Key words: Greater palatine foramen, Greater palatine canal, Cone-beam computed tomography, Morphometry

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foramen and the greater palatine canal in people of the first period of adulthood.

INTRODUCTION

Relevance and purpose. Data on the shape and size of the greater palatine foramen and the greater palatine canal are important for surgical interventions in the posterior part of the upper jaw, as well as for the blockade of the pterygopalatine ganglion by the palatal approach [1,2]. Currently, most foreign surgeons performing rhinoplasty use injection through the greater palatine canal to block the pterygopalatine ganglion, and conduction anaesthesia in the area of the greater palatine foramen is recommended in most nasal surgery guidelines [3,4]. However, there are currently no unified ideas about the topography and variability of the greater palatine foramen and greater palatine canal, which largely determines the development of complications such as ischemia of the facial skin, paresis of the soft palate, development of the gag reflex during surgery, and the development of bleeding [5].

In this regard, the study aimed to identify sex-dependent differences in the morphology of the greater palatine

MATERIALS AND METHODS

The object of the study was 261 people aged 21 to 35 years (the first period of adulthood; 132 females and 129 males). The study was carried out under the Good Clinical Practice standards and the principles of the Declaration of Helsinki (2013). Written informed consent was obtained from all participants before enrolment.

Study inclusion parameters: signed informed consent; females aged 20–35 years and males aged 21–35 years; the physical and mental capacity of patients to participate in the study; decay-missing-filled (DMF) index from 0 to 6; the absence of anomalies in the development of the dentition.

Exclusion parameters from the study: age less than 20 or more than 35 years (females), age less than 20 or more than 35 years (males); DMF index more than 6; alcohol and drug abuse; refusal to sign informed consent; pregnancy; anomalies in the development of the dentition.

Cone-beam computed tomography was performed on an ORTHOPHOSXG 3DSIRONA apparatus with Galaxis

software. The radiation dose was 0.693 μSv. Cone-beam computed tomograms determined the number of greater palatine foramina, their shape, anteroposterior and medio-distal diameters, the length of the greater palatine canal, its shape, its medio-distal and anteroposterior diameters in the upper, middle, and lower thirds of the canal. The quantitative data were processed by statistical variational methods using the Statistica for Windows v. 10.0 software package. All quantitative parameters were checked for normal distribution using the Kolmogorov-Smirnov test at a significance level of $p < 0.05$. All studied parameters had a distribution close to normal. The arithmetic means and standard deviation was calculated. The significance of differences between the groups was

assessed using the Kolmogorov-Smirnov test at a significance level of $p < 0.05$ [6,7].

RESULTS AND DISCUSSION

It was found that the greater palatine canal opened into the oral cavity with one palatal foramen in 100% of cases.

The value of the medio-distal diameter of the greater palatine foramen is 17% more in males than in females on the right, and 16% more in males than in females on the left ($p < 0.001$). The value of the anteroposterior diameter of the greater palatine foramen is 13% more on the right and 11% more on the left in males ($p < 0.001$) (Table 1).

Table 1: Sex-dependent diameters of the greater palatine foramen (mm).

Parameters	On the right (mm), M ± σ		Validity of differences	On the left (mm), M ± σ		Validity of differences
	males	females		males	females	
Medio-distal diameter	3.67 ± 0.79	3.02 ± 0.63	$p < 0.001$	3.64 ± 0.80	3.04 ± 0.64	$p < 0.001$
Anteroposterior diameter	5.79 ± 0.86	5.09 ± 0.74	$p < 0.001$	5.73 ± 0.84	4.99 ± 0.72	$p < 0.001$

We have distinguished 11 shapes of the greater palatine foramen: round; drop-shaped; semi-circular; rhomboid; oval, elongated Antero posteriorly; helical; ovoid; triangular; oval, elongated in the medio-distal direction; bean-shaped; crescent-shaped.

In females, the oval shape of the greater palatine foramen, elongated in the anteroposterior direction, was observed most often (43%), while the helical shape (2%) and oval shape, elongated in the medio-distal direction (1%) were observed the least (Figure 1).

In males, the oval shape of the greater palatine foramen, elongated in the anteroposterior direction, was observed most often (40%), and the helical (2%) and crescent shape (2%) were observed least often. It should also be noted that in males, unlike females, the oval shape of the greater palatine foramen, elongated in the medio-distal direction, was not found at all (Figure 1).

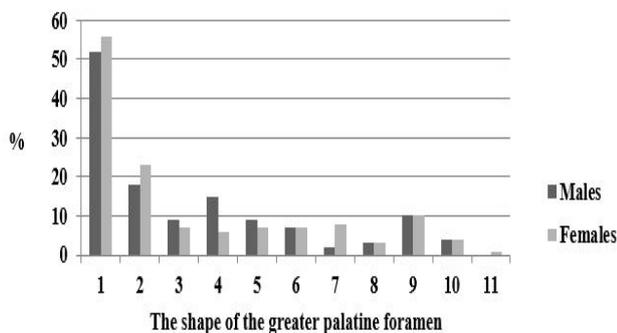


Figure 1: Sex-dependent frequency of occurrence of greater palatine foramen shapes (%). 1-Oval, elongated in the anteroposterior direction; 2-Drop-

shaped; 3-Semicircular; 4 - Ovoid; 5-Bean-shaped; 6-Rhomboid; 7-Crescent-shaped; 8-Helical; 9-Rounded; 10-Triangular; 11-Oval, elongated in the medio-distal direction.

It was statistically reliably established that the length of the greater palatine canal in females was 7.1% on the right and 7.5% on the left less than in males ($p < 0.001$).

The anteroposterior diameter of the greater palatine canal in the lower third in females was 20% on the right and 15% on the left less than in males ($p < 0.001$).

The medio-distal diameter of the greater palatine canal in the lower third in females was 8% on the right and 4% on the left less than in males. The anteroposterior diameter of the greater palatine canal in the middle third in males was 21% on the right and 20% on the left larger than in females ($p < 0.001$).

The medio-distal diameter of the greater palatine canal in the middle third in males was 20% larger on the right and 15% larger on the left than in females ($p < 0.001$).

The anteroposterior diameter of the greater palatine canal in the upper third in males was 9% larger on the right and 7% larger on the left than in females ($p < 0.001$).

The medio-distal diameter of the greater palatine canal in the upper third in females was 18% smaller on the right and 29% smaller on the left than in males ($p < 0.001$) (Table 2).

Table 2: Sex-dependent variability of the dimensional characteristics of the greater palatine canal (mm).

Parameters	On the right (mm), M ± σ		Validity of differences	On the left (mm), M ± σ		Validity of differences
	males	females		Males	Females	
Length	33.59 ± 2.87	31.19 ± 2.70	p<0.001	32.94 ± 2.92	30.35 ± 2.90	p<0.001
Anteroposterior diameter of the greater palatine canal in the lower third	4.25 ± 0.58	3.37 ± 0.55	p<0.001	4.11 ± 0.51	3.47 ± 0.49	p<0.001
Medio-distal diameter of the greater palatine canal in the lower third	2.25 ± 0.28	2.43 ± 0.45	p<0.001	2.24 ± 0.34	2.33 ± 0.39	p<0.001
Anteroposterior diameter of the greater palatine canal in the middle third	3.23 ± 0.59	2.65 ± 0.55	p<0.001	3.34 ± 0.58	2.66 ± 0.58	p<0.001
Medio-distal diameter of the greater palatine canal in the middle third	1.64 ± 0.24	2.05 ± 0.37	p<0.001	1.67 ± 0.21	1.98 ± .035	p<0.001
Anteroposterior diameter of the greater palatine canal in the upper third	5.51 ± 0.58	4.98 ± 0.68	p<0.001	5.52 ± 0.61	5.12 ± 0.69	p<0.001
Medio-distal diameter of the greater palatine canal in the upper third	3.24 ± 0.64	3.98 ± 0.64	p<0.001	3.23 ± .059	4.78 ± 0.59	p<0.001

In males of the first period of adulthood, the length of the crescent-shaped greater palatine canal is 8% more on the right and on the left than in females; the length of the undulated canal in males is 5% on the right and 6% on the left more than in females; the length of the straight greater palatine canal in males is 7% on the right and 8% on the left more than in females; the length of the funnel-

shaped canal with a bend in the lower third in males is 13% on the right and 11% on the left more than in females; the length of an hourglass-shaped greater palatine canal in males is 11% on the right and 14% on the left more than in females; the length of the greater palatine canal is 4% on the right and 2% on the left more than in females (p <0.001) (Table 3).

Table 3: Shape- and sex-dependent variation in the length of the greater palatine canal (mm).

Length	On the right (mm), M ± σ		Validity of differences	On the left (mm), M ± σ		Validity of differences
	Males	Females		males	females	
crescent shape	33.3 ± 2.5	30.8 ± 2.7	p<0.001	32.8 ± 2.6	30.1 ± 3.0	p< 0.001
undulated shape	34.1 ± 3.2	32.4 ± 2.8	p<0.001	33.0 ± 3.4	31.0 ± 3.0	p< 0.001
straight shape	33.2 ± 2.9	30.8 ± 2.9	p<0.001	32.8 ± 2.9	30.2 ± 3.2	p< 0.001
funnel shape with a bend in the lower third on the right	35.3 ± 2.6	31.2 ± 2.1	p<0.001	34.3 ± 2.0	30.9 ± 2.2	p< 0.001
hourglass shape on the right	4.2 ± 3.0	0.6 ± 0.9	p<0.001	34.0 ± 3.0	29.4 ± 1.6	p< 0.001
zigzag shape	32.2 ± 2.0	30.8 ± 1.1	p<0.001	30.4 ± 3.0	30.0 ± 0.7	p< 0.001

In males of the first period of adulthood, the undulated greater palatine canal was combined with an oval (28%), drop-shaped (22%), ovoid/semi-circular (10%), rhomboid, round, bean-shaped (6%), or helic (3%) greater palatine foramen. The straight greater palatine canal opened in the palate with an ovoid (28%), semi-circular (12%), triangular, round, or bean-shaped (4%) greater palatine foramen. The hourglass-shaped greater palatine canal was combined with an oval (55%), bean-shaped (27%), ovoid or helical (9%) greater palatine foramen. The zigzag-shaped greater palatine canal was combined with oval (50%), drop-shaped (33%), or bean-

shaped (17%) greater palatine foramen. The undulated greater palatine canal was combined with oval (49%), rounded (15%), rhomboid (10%), ovoid or drop-shaped (8%), triangular or bean-shaped (4%), or helical (2%) greater palatine foramen.

The observed forms of the greater palatine canal were the following: funnel-shaped with a bend in the lower third; hourglass-shaped; crescent-shaped; undulated; straight; zigzag-shaped.

In males, the crescent-shaped form of the great palatine canal was most often found (39%); and the form found

least often was the zigzag shape (2%). In females, the crescent-shaped form of the greater palatine canal was most often observed (38%); the least frequently observed form was the funnel-shaped canal with a bend in the lower third (2%) (Figure 2).

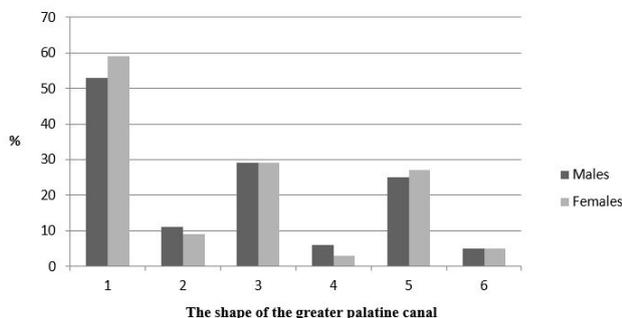


Figure 2: Sex-dependent frequency of occurrence of forms of the greater palatine canal (%). 1-Crescent-shaped; 2-Hourglass-shaped; 3-Undulated; 4-Zigzag-shaped; 5-Straight; 6-Funnel-shaped with a bend in the lower third.

In females of the first period of adulthood, the straight canal was combined with an oval (46%), drop-shaped (12%); semi-circular (12%); ovoid (8%); bean-shaped (4%); rhomboid (12%); or rounded (8%) greater palatine foramen. The funnel-shaped canal with a bend in the lower third was combined with an oval (25%); drop-shaped (25%); semi-circular (25%), or bean-shaped (25%) greater palatine foramen. The crescent-shaped palatine canal was combined with an oval (41%); drop-shaped (17%); semi-circular, ovoid, bean-shaped, rhomboid (5%); crescent-shaped, rounded (7%); helical or triangular (3%) greater palatine foramen. The hourglass-shaped greater palatine canal was combined with an oval (56%); drop-shaped, ovoid, bean-shaped, or rounded (11%) greater palatine foramen. The undulated canal was combined with an oval (38%); drop-shaped (21%); ovoid, bean-shaped, rhomboid (3%); crescent-shaped (14%); rounded (10%); or triangular (7%) greater palatine foramen. The zigzag-shaped palatine canal was combined with an oval (33%) or drop-shaped (6%) greater palatine foramen.

According to A.A. Semenova, three forms of the greater palatine foramen have been identified, namely round, oval, and drop-shaped ones [8]. In our study, 11 forms of the greater palatine foramen were identified, namely oval, elongated in the anteroposterior direction, drop-shaped, triangular, helical, oval, elongated in the medio-distal direction, round, crescent-shaped, ovoid, bean-shaped, rhomboid, and semi-circular. These contradictions are related to the fact that the work of A.A. Semenova was carried out on dry skulls, while we conducted studies on cone-beam computed tomograms.

According to Borodulin, the length of the greater palatine canal ranged from 27 to 42 mm [9]. In our studies, the length of the greater palatine canal in males varied from 27.77 to 45.19 mm on the right, and from 26.35 to 44.09 mm on the left. In females, the length of the greater

palatine canal ranged from 26.05 to 39.87 mm on the right, and from 25.99 to 39.43 mm on the left.

According to Aoun, et al. [10], the diameter of the greater palatine canal in the lower third was 5.85 ± 1.24 on the right and 5.82 ± 1.27 on the left; in the middle third 2.4 ± 0.71 on the right and 2.45 ± 0.55 on the left; in the upper third 6.85 ± 1.24 on the right and 6.82 ± 1.27 on the left. According to our data, the diameter of the greater palatine canal averaged 3.80 ± 0.71 mm on the right and 3.79 ± 0.59 mm on the left; the diameter of the greater palatine canal in the middle third was 2.94 ± 0.64 mm on the right and 3.00 ± 0.64 mm on the left; the diameter of the greater palatine canal in the upper third was 5.24 ± 0.68 mm on the right and 5.29 ± 0.68 mm on the left. Our data differ from the data of other studies, which may be since our studies were conducted only in persons of the first period of adulthood.

CONCLUSION

The greater palatine foramen and the greater palatine canal have pronounced sex-dependent differences. The size of the medio-distal and anterior-posterior diameters of the greater palatine foramen in males is 11-17% greater than in females ($p < 0.001$). In persons of both sexes, the most common forms of the greater palatine foramen are oval, drop-shaped, and rounded; the rarest forms are crescent-shaped, triangular, rhomboid, and helical. The length of the greater palatine canal in males is 7.1-7.5% more than in females. The diameter of the greater palatine canal in the lower, middle, and upper third in females is less than in males by 4-29%. In persons of both sexes, the most common form of the greater palatine canal is crescent-shaped, and the forms that occurred least of all were the zigzag-shaped canal and the funnel-shaped canal with a bend in the lower third.

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