Berlińska Magdalena, Misiejuk Aleksandra, Komisarek Oskar. Evaluation of the position variation of mandibular foramen. Journal of Education, Health and Sport. 2019;9(7):185-194. eISSN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.3269410
http://ojs.ukw.edu.pl/index.php/johs/article/view/7120
https://pbn.nauka.gov.pl/sedno-webapp/works/917520

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26/01/2017).
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 20.06.2019. Revised: 25.06.2019. Accepted: 04.07.2019.

EVALUATION OF THE POSITION VARIATION OF MANDIBULAR FORAMEN

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ABSTRACT

INTRODUCTION: Mandibular foramen is located on the internal surface of the ramus of the mandible. Through this opening mandibular nerve and vessels enter the mandibular canal. As there are no palpable landmarks that allow determining the position of the mandibular foramen precisely, it is helpful to use radiological imaging methods for this purpose. Mainly X-ray techniques are used, especially panoramic radiograph for its accessibility and wide range of diagnostic applications.

Knowledge of the position of the mandibular foramen is essential for the correct and effective performance of the inferior alveolar nerve block, which is one of the most common anaesthesia in dental practice.

AIMS: The purpose of the study was to examine and find possible correlations between sex, age, posterior teeth loss and relative localization of the mandibular foramen.

SUBJECTS AND METHODS: Selected parameters were measured on 50 digital panoramic radiographic images of 50 patients, including 33 males and 17 females, hospitalized in the Maxillofacial Surgery Ward of the Heliodor Swiecicki Clinical Hospital in Poznan.

RESULTS: Localization of the mandibular foramen does not correlate with age, nor the posterior teeth loss and sex has only a slight impact on its vertical location.

CONCLUSIONS:
Since none of the parameters proved to be particularly useful in predicting the location of the mandibular foramen. The operator should administer inferior alveolar nerve anaesthesia in accordance with standard rules.

KEY WORDS: Mandibular foramen; panoramic radiography; anatomic variation; inferior alveolar nerve block

INTRODUCTION:
The mandibular foramen is a significant anatomical structure located on the ramus of the mandible. This is where the inferior alveolar nerve and vessels enter the mandibular canal. In the mandibular canal, inferior alveolar nerve gives off sensory branches to inferior dental plexus. The nerve exits the mandibular canal through the mental foramen as the mental nerve and branches to supply sensory branches to the skin of the chin and skin and mucosa of the lower lip.[1]
There are reported cases of bifid mandibular canals, which is associated with the presence of accessory mandibular foramen.[2]
Knowledge of the anatomy of the mandible is essential in dental practice. It is particularly important for proper placement of injection for inferior alveolar nerve block, which is necessary for accomplishing desired anaesthetic results.
As there are no palpable landmarks that allow to determine the position of the mandibular foramen precisely, it is helpful to use radiological imaging methods for this purpose. Mainly

X-ray techniques are used, especially panoramic radiograph for its accessibility and wide range of diagnostic applications. [3-7]
The main aim of the study was to determine the average location of the mandibular foramen and its correlation with other variables based on the measurements from reference anatomical points on the panoramic radiograph. Which would make it easier for an operator to place the needle for inferior alveolar nerve block during dental procedures.

MATERIALS AND METHODS:
The study was based on the analysis of digital pantomographic images of patients hospitalized in the maxillofacial surgery department of the Heliodor Swiecicki Clinical Hospital in Poznań. All photographs used in the study were taken by the same X-ray machine Soredex CRANEX NOVUS CRA-1 (exposure time 9s, 70kV, 7mA). Pictures of too low quality, which did not present anatomical structures clearly of the mandible and which presented significant injuries in the mandible were rejected. After the selection, a collection of 50 pictures of patients was obtained, including 17 female and 33 male, from the age of 12 up to 54 (average 32 years). In the study group, patients with missing posterior teeth were listed to see if there was a correlation between lack of these teeth and the characteristics of the mandibular foramen.
Image analysis was performed using the K-Pacs Workstation V 1.6.0 program. With an accuracy of 0.01 mm, the height and width of the foramen were measured, both on the right (P) and on the left (L) side (Figure 1). Then, the distances from the extreme points of the mandible were measured (Figure 2) as well as the difference in the height of the central points of foramina (denoted as c), taking into account which one is higher (P + / L +). The analysis was made both with the division into sites (right / left) and by treating all foramina equally.
Statistica 13.1 was used to interpret the obtained results and for descriptive statistics (significance level of $p<0.05$).

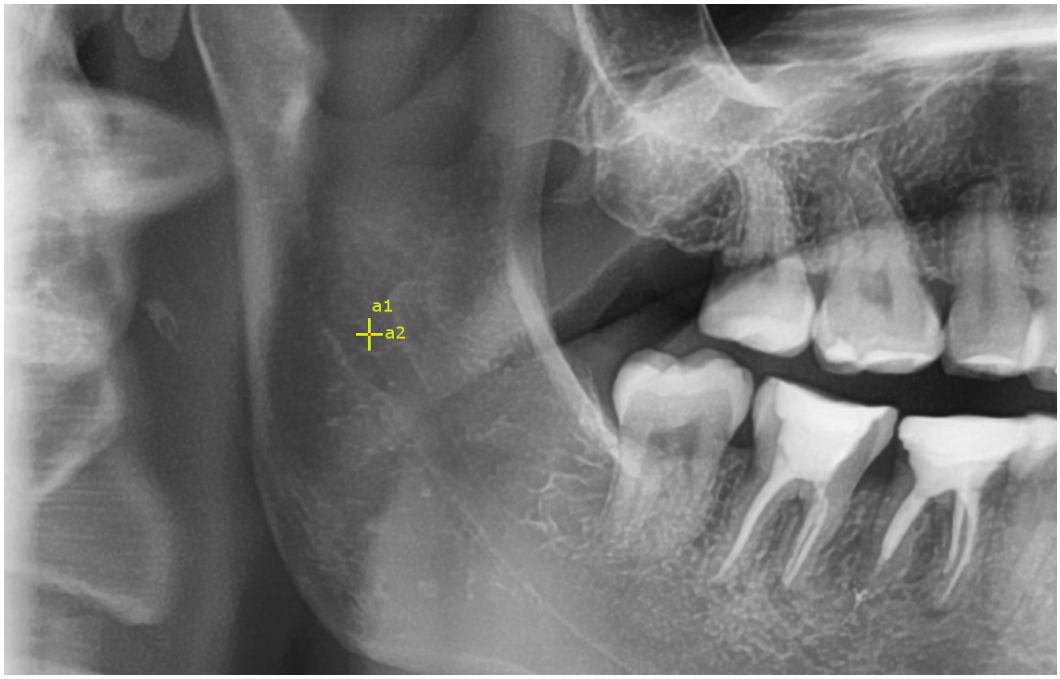

Fig. 1 An example of a panoramic radiograph with the method of measure for width and height of the foramen.

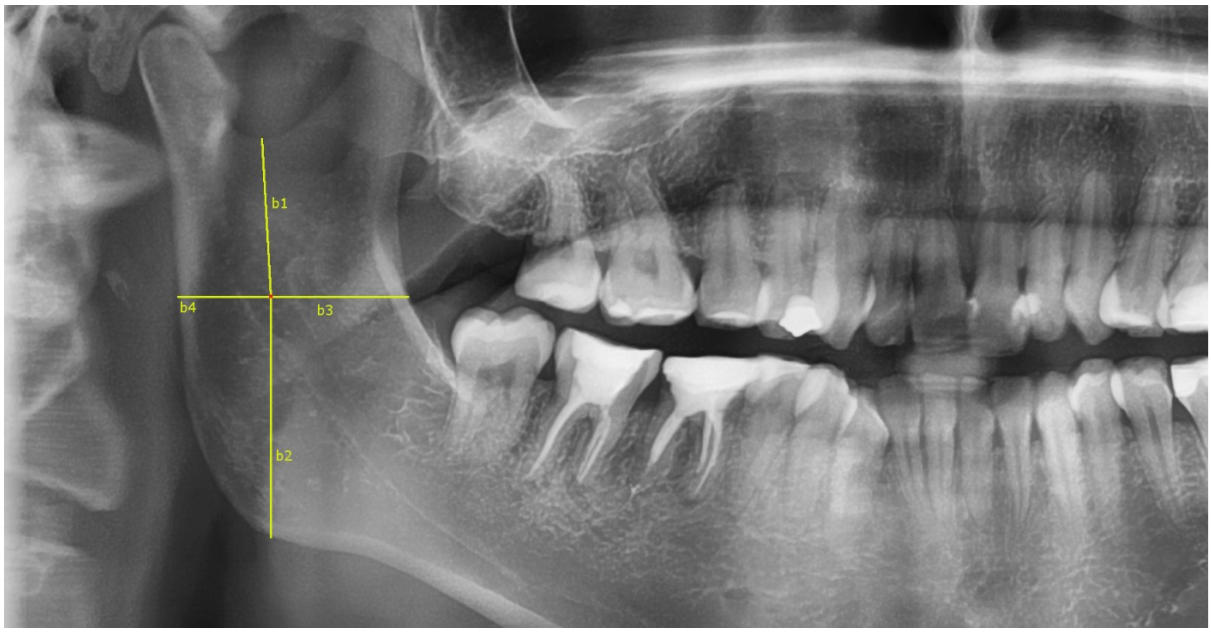

Fig. 2 An example of a pantomographic picture showing the method of measuring. Corresponding: b1 - the smallest distance from the center of the foramen to the lowest point of the mandibular incision, b2 - the distance in a straight line from the center of the foramen to the inferior edge of the mandible, b3 - the distance in a straight line from the center of the foramen to the anterior margin of the mandible, b4 - the distance in a straight line from the center of the foramen to the posterior margin of the mandible.

RESULTS:

Tables 1 to 3 and figures 3 to 12 present the results obtained in the examination. The study showed that the mandibular apex has an average height of 3.55 mm and width of 3.99 mm. It is located at a distance of 26.64 mm from the lowest point of the mandibular incision, 33.56 mm from its inferior edge and correspondingly 14.33 mm and 18.86 mm from the posterior and anterior edges.

There was no occurrence of bifid mandibular foramen on any of the examined images.

Variable	Posterior Teeth Loss	Valid N	Mean	Median	Minimum	Maximum	Standard Deviation
a1 L	Absent	37	3,65	3,60	2,50	4,80	0,56
a1 R	Absent	37	3,53	3,40	2,30	4,60	0,61
a2 L	Absent	37	4,27	4,30	3,20	5,70	0,69
a2 R	Absent	37	3,82	3,80	2,50	5,00	0,63
b1 L	Absent	37	26,15	26,90	14,10	38,00	4,99
b1 R	Absent	37	27,49	29,00	17,20	36,70	5,27
b2 L	Absent	37	34,53	33,80	22,00	52,30	5,55
b2 R	Absent	37	33,92	33,30	23,50	51,20	5,93
b3 L	Absent	37	19,14	18,20	13,00	26,20	3,28
b3 R	Absent	37	18,50	18,00	13,40	25,30	3,08
b4 L	Absent	37	14,45	14,10	10,90	21,20	2,64
b4 R	Absent	37	14,31	13,90	9,60	20,50	2,58
c	Absent	37	3,63	3,40	2,50	5,00	0,66
a1 L	Present	13	3,52	3,40	2,50	5,00	0,66
a1 R	Present	13	3,36	3,40	2,50	4,30	0,53
a2 L	Present	13	3,95	3,80	2,70	5,50	0,66
a2 R	Present	13	3,70	3,80	2,70	4,80	0,63
b1 L	Present	13	26,10	25,50	14,70	34,70	6,43
b1 R	Present	13	26,17	28,00	13,30	33,60	5,84
b2 L	Present	13	32,12	31,50	21,00	43,60	5,67
b2 R	Present	13	31,19	31,00	23,70	40,20	5,37
b3 L	Present	13	19,12	18,90	13,90	26,50	4,13
b3 R	Present	13	18,81	18,20	14,80	24,20	2,80
b4 L	Present	13	14,48	14,80	11,10	17,10	2,19
b4 R	Present	13	13,90	14,10	8,60	19,40	2,74
c	Present	13	4,40	3,20	0,40	12,30	3,72

Tab. 1 Comparison of the results with the distinction of the left/right side and posterior teeth loss.

Variable	Valid N	Mean	Median	Minimum	Maximum	Standard Deviation
Age	50	32,10	32,0	12,0	54,0	10,26
a1	100	3,55	3,4	2,3	5,0	0,59
a2	100	3,99	3,8	2,5	5,7	0,69
b1	100	26,64	27,8	13,3	38,0	5,36
b2	100	33,56	33,1	21,0	52,3	5,73
b3	100	14,33	14,1	8,6	21,2	2,54
b4	100	18,86	18,2	13,0	26,5	3,24

Tab. 2 Comparison of the results without distinction for the left/right side.

Variable	Sex	Valid N	Mean	Median	Minimum	Maximum	Standard Deviation
a1	M	66	3,58	3,5	2,3	4,8	0,59
a2	M	66	4,02	3,8	2,7	5,7	0,71
b1	M	66	27,73	28,2	14,1	38,0	4,89
b2	M	66	35,25	35,0	21,0	52,3	5,64
b3	M	66	18,79	18,1	13,0	26,2	3,38
b4	M	66	14,67	14,5	10,0	20,5	2,53
a1	F	34	3,50	3,4	2,5	5,0	0,60
a2	F	34	3,92	3,9	2,5	5,2	0,65
b1	F	34	24,53	25,1	13,3	33,0	5,66
b2	F	34	30,26	30,0	22,0	40,2	4,33
b3	F	34	18,98	18,2	13,9	26,5	2,98
b4	F	34	13,67	13,4	8,6	21,2	2,47

Tab. 3 Comparison of the results between sexes without distinction for left/right.

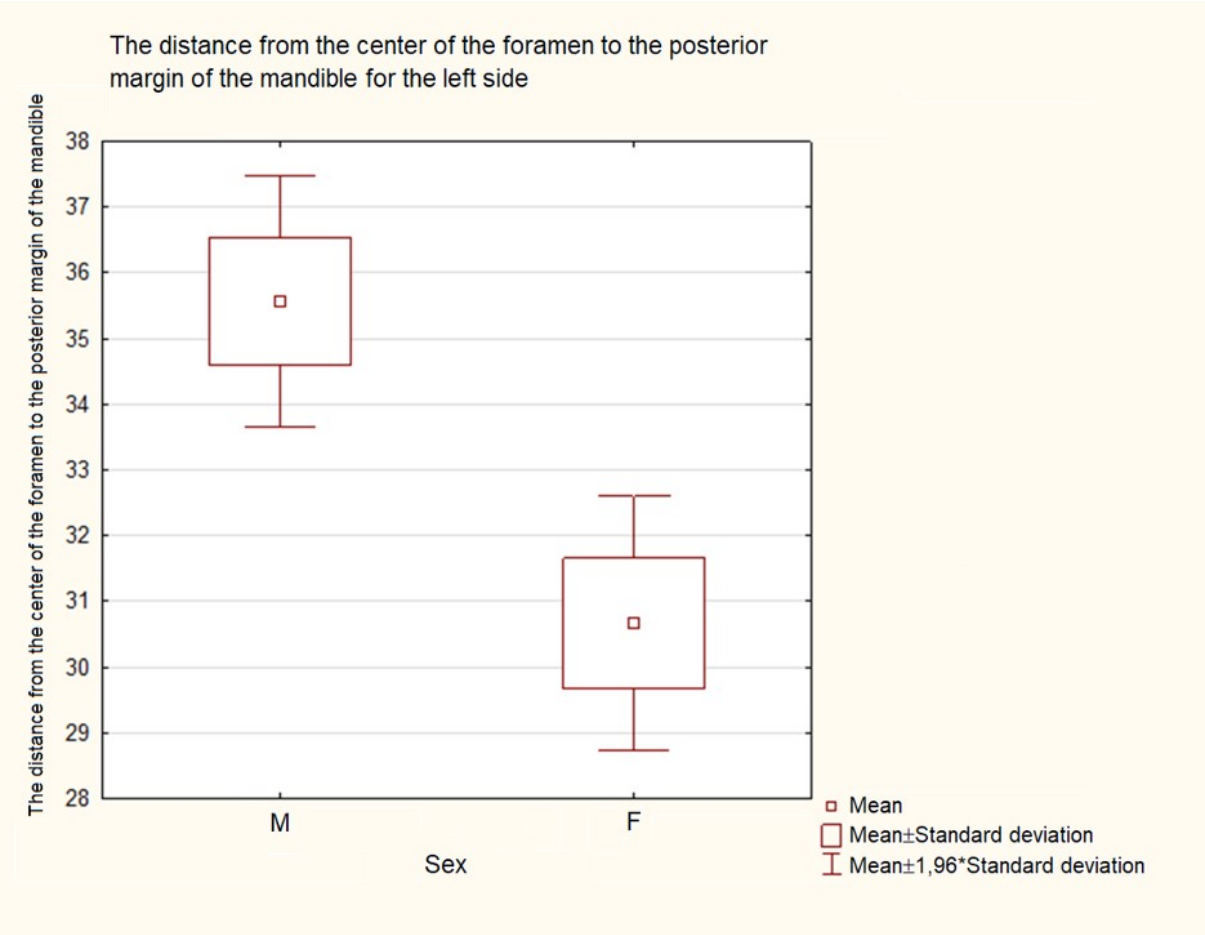

Fig. 3 The difference in distance from the centre of the foramen to the posterior margin of the mandible for the left between sexes with confidence intervals.

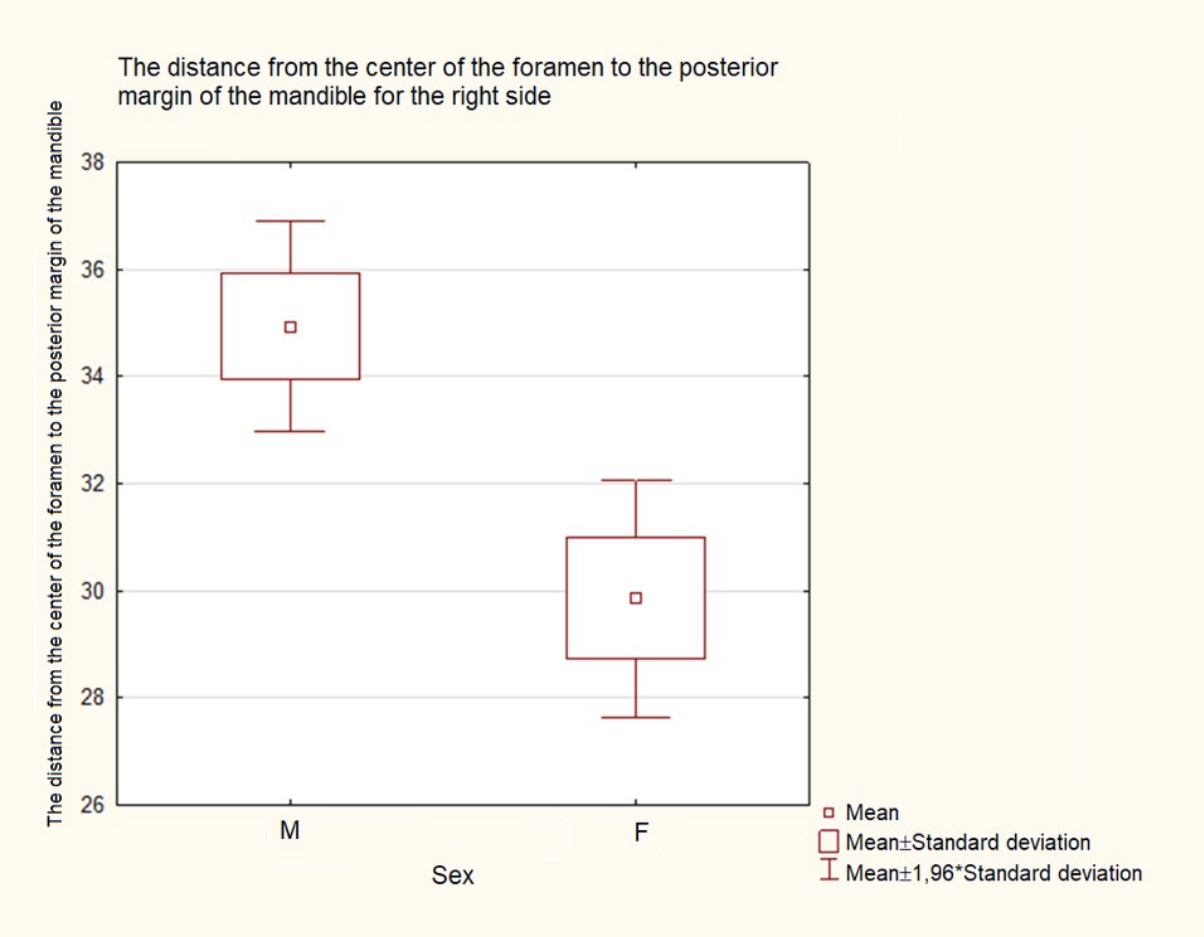

Fig. 4 The difference in distance from the centre of the foramen to the posterior margin of the mandible for the right side between sexes with confidence intervals.

CONCLUSIONS:

We were looking for a dimension that undergoes the smallest fluctuations in the population and will thus be the most reliable coordinate for determining its location in dental practice. However, the analysis of the coefficients of variability of our data sets showed only slight differences in this respect (Table 2). None of the dimensions proved to be particularly stable and particularly useful in the position prediction. [8]

Comparing the coefficients of variation of the same dimensions in both sexes (Table 3), we can see that in women the distance of the opening from the incision of the mandible (b1) is much more fluctuating than in men. It may, however, be related to the sexual dimorphism described by V. Sairam et all. [9]

The study of the correlation between parameters and sex showed significant differences in the distance from the mandibular incision on the left side and the distance from the lower margin of the mandible on both sides (Figure 3,4). They amounted to 5 mm. In all cases, these distances in women were smaller than in men, which may be related to the above-mentioned sexual dimorphism. Their confidence intervals do not overlap, which suggest that it may be useful in determining patient's sex.

The correlations between age and the measured parameters were examined. They did not show the significance for most of the parameters, except for the width of the left mandibular foramen. However, this correlation was still very low.

The analysis confirmed that there is no significant correlation between the lack of corresponding molars and the placement and dimensions of the foramen. Thus, the alveolar atrophy in the lateral segment and the teeth condition do not affect the position of the foramen

In the majority of patients (94%), there were differences in the height of the centre of foramina between left and right sides. For comparison purposes, the symmetry axis was a vertical line passing through the anterior nasal spine. In 60% of the patients, the left mandibular foramen was located higher, and in 34% it was the right one. The difference in vertical dimension was in some cases up to 12.3 mm. Sex, lack of posterior teeth or age do not affect the symmetry of the height of the foramina.

The collected results can be compared with similar studies carried out in other groups. [10-14]

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