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Evaluation of Accuracy of OPG in Determining Root Morphology of Lower Third Molar When Compared with Gross Examination

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Abstract

Dentists widely use Orthopantomogram (OPG). The accuracy of this device in providing information on root number and morphology has been the point of concern for many years.

Aim: to evaluate the accuracy of OPG in determining the root morphology of the lower third molar (LTM).

Patients and method: During 6 months, thirty-five cases of patients who needed surgery for LTM removal were included. A single machine OPG was used to take X-rays for all patients. On OPG and by gross examination after surgery, information about the number of roots, the relation of roots to each other, and the pattern of a single root was evaluated and put in the Excel sheet. Statistical analysis was carried out using accuracy, sensitivity, and specificity.

Results: OPG had an accuracy of 50.72% for one-rooted, 79.55% for two-rooted, and 50.00% for three- and four-rooted teeth. The relation of roots to each other had an accuracy of 55.56% for fused roots, 58.33% for convergent roots, 50.00% for divergent roots, and 58.33% for other forms. The mesial root pattern accuracy was 54.69% for straight, 77.73% for distally, and 50.00% for buccally and lingually curved. Distal root pattern accuracy was 100.00% for straight, 58.18% for mesially, 55.56% for distally, and 50.72% for buccally curved. The other roots' accuracy was 50.00% for mesially, distally, and buccally curved.

Conclusion: The OPG can be considered accurate in determining the number of roots only for two-rooted teeth and the mesial curvature of the mesial roots. Its accuracy is at a low level in all other morphological specifications of the lower third molar.

Keywords: Panoramic Radiography, Third Molar, Root Morphology, Radiographic accuracy

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INTRODUCTION

The orthopantomogram (OPG) is a tool widely used in dental clinics. One of the indications of OPG is the lower third molar (LTM) surgery. When examining this area, surgeons try to determine the degree of difficulty of surgery using the Winter, Pell & Gregory classification and root configuration. According to Khrwatany KAK (2019), surgery for LTM without radiographs can be considered safe in just 19% of cases; in the rest, it may lead to injury of the inferior alveolar nerve.[1] Accessibility, low radiation, and cost are three points that make OPG the tool of choice if it gives the necessary information.

Accuracy of OPG is a point of concern for all fields of dentistry. Those suspicions are about the ability to show bone deposition after orthodontic treatment, the morphology of pulp canals, and some linear measurements.[2-4] Compared to cone beam computed tomography (CBCT), the OPG can provide only two-dimensional images, and its inferiority in showing detailed, accurate data should be considered.[2, 5]

Root numbers and morphology are some of the most important factors for determining the difficulty of surgery. Those parameters are variable between individuals. In their study, Barzanji et al. (2018) found that the proportions of two or more roots reached 88.26% and one root 11.74%. All single-rooted teeth showed no curvature; however, two-rooted teeth tended to have convergent roots in most cases and divergent roots in some cases. The mentioned study used OPG as the evaluation tool.[6]

Since the OPG is a two-dimensional X-ray machine, it is difficult to show extra roots and some root curvatures. The accuracy of data obtained from orthopantomograms (OPGs) concerning the number of roots, their spatial relationships, and the root morphology patterns of lower third molars (LTMs) is an important topic warranting detailed discussion.

The study aims to evaluate the accuracy of OPG in determining the root morphology of the lower third molar when compared with gross examination.

MATERIALS AND METHODS

This diagnostic accuracy observational study included 35 cases that needed surgery for LTM removal. The inclusion criteria for this study were (1) clinical indication for surgical removal of the lower third molar (LTM), (2) patient consent to participate in the study, and (3) availability of a high-quality orthopantomogram (OPG). Patients who presented with visible pathological findings in the retromolar area or the mandibular angle were excluded from the study.

The study was carried out in the Nova Dental Centre in Erbil city in the Kurdistan region of Iraq from June 2022 to January 2023. To give standardization to the study, one OPG machine was selected to take x-rays, which was the Gendex digital panoramic x-ray machine (2014) operating at 10 mA, 70 kV, and 12 seconds exposure time, manufactured by PaloDex Group, 180 Fl-04300 TUUSULA, Finland. Patient positioning was done according to the manufacturer's guidelines and the mounted head positioning tools.

The first step was to evaluate the LTM on OPG views to determine all three elements of the study: number, relation of roots to each other, and pattern of single root. Evaluation of OPGs was done by a single examiner, and the data was entered into an Excel sheet. The evaluation was carried out on the desktop computer, using only the manufacturer's software with all available tools to clarify points of concern.

Then the surgery was done, and the removed tooth was reevaluated for the same parameters by gross examination. The same single examiner of OPG carried out the gross evaluation, too. For documentation reasons, all extracted teeth were put on OPG paper, and a photo was taken and saved in a specific folder.

Statistical analysis was done using sensitivity and specificity tests and the online site https://www.medcalc.org/calc/diagnostic_test.php, to determine the accuracy of data taken from OPGs.

RESULTS

The mean age was 28.4 years. The female-to-male ratio was 1:1.1875, with nineteen females and sixteen males in the sample. Twenty cases had LTM on the left and fifteen on the right side.

Regarding the number of roots (Figure 1), the OPG showed that the sample has only two categories: 6 (17%) one-rooted and 29 (83%) two-rooted LTM. On the other hand, the gross examination after surgery revealed four categories: one rooted (1 case, 3%); two rooted (26 cases, 74%); three rooted (5 cases, 14%); and four rooted (3 cases, 9%).

All above percentages have been approximated.

Figure 1. a, number of roots by OPG and b, by gross examination

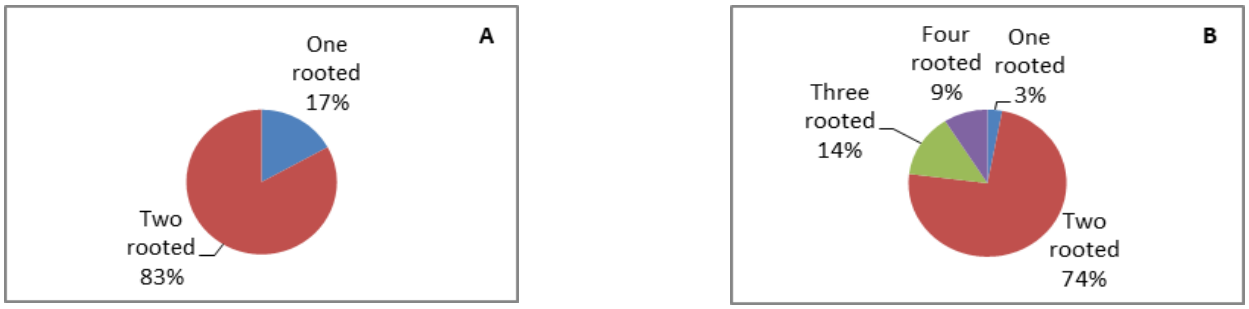

Table 1. Accuracy of identification of number of roots

Element of study	Accuracy %	Specificity %	Sensitivity %
One rooted	50.72	87.18	3.33
Two rooted	79.55%	75.00	81.25
Three rooted	50.00	100.00	12.50
Four rooted	50.00	100.00	7.89

(*) These values are dependent on disease prevalence.

Regarding the spatial relationship of roots to each other (Figure 2), the OPG revealed 7 (20%) fused, 17 (48.5%) converged, 1 (3%) diverged, and 10 (28.5%) had other relationships.

While gross examination showed 11 (31.5%) fused, 10 (28.5%) converged, no divergence, and 14 (40%) other relations.

Figure 2. a, root relation to each other by OPG, b, by gross examination

Table 2. Relation of roots of LTM to each other

Element of study	Accuracy%	Specificity%	Sensitivity%
General picture of relation of roots to each other	50.00	87.18	3.23
Fused roots	55.56	100.00	28.21
Converge roots	58.33	78.12	35.71
Diverge roots	50.00	97.22	0.00
Others	58.33	100.00	35.90

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Regarding the single root pattern (Figure 3), according to the OPG image, the mesial root was straight in 9 (26%) subjects and distally curved in 26 (74%). However, gross examination revealed that the mesial root was straight in 6 (17%), distally curved in 25 (71%), buccally curved in 3 (9%), and lingually curved in 1 (3%).

Figure 3. a, single root pattern of mesial root by OPG, by gross examination

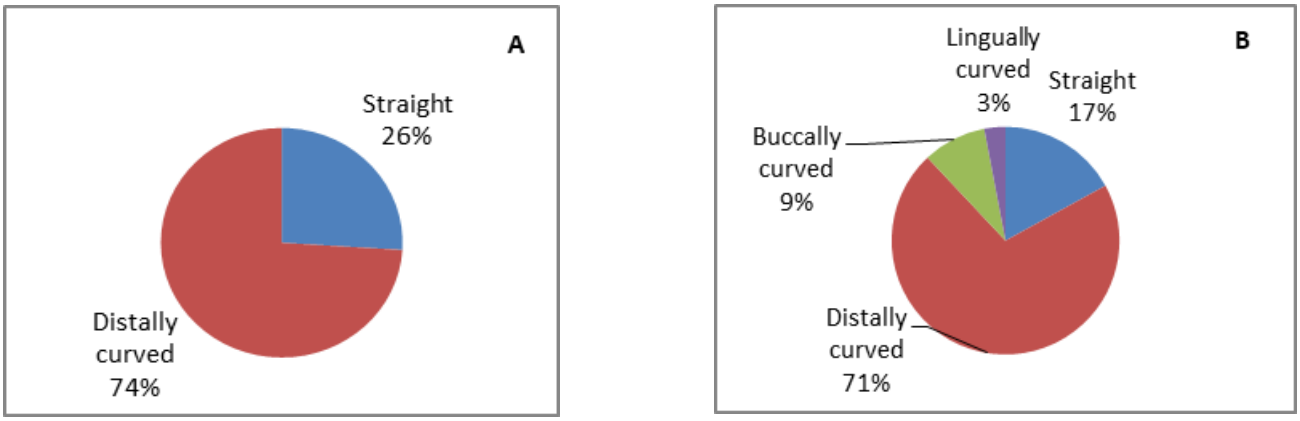

Table 3. Single Root Pattern Mesial root

Element of study	Accuracy	Specificity	Sensitivity
Straight form	54.69	90.62	18.75
Distally curved	77.78	90.91	73.53
Buccally curved	50.00	100.00	7.89
Lingually curved	50.00	100.00	2.78

The distal root of the third molar was absent in the OPG of 6 cases, while gross examination showed a missing distal root in only 3 cases (Figure 4). Cases in which the distal roots were fused in the coronal portion but separated in the apical third were still considered to have separate distal roots for the aim of this study. All parameters were applied to these roots as if they were independent. The single root pattern of the distal root on OPG was straight in 6 (20%), mesially curved in 15 (51%), distally curved in 7 (25%), and buccally curved in 1 (4%) of cases, with no lingual curvature. However, by gross examination, there was a straight root in 6 (19%); mesially curved in 12 (37.5%); distally curved in 9 (28%); and buccally curved in 5 (15.5%) of cases with no lingual curvature.

Figure 4. a, single root pattern, distal root by OPG, b, by gross examination

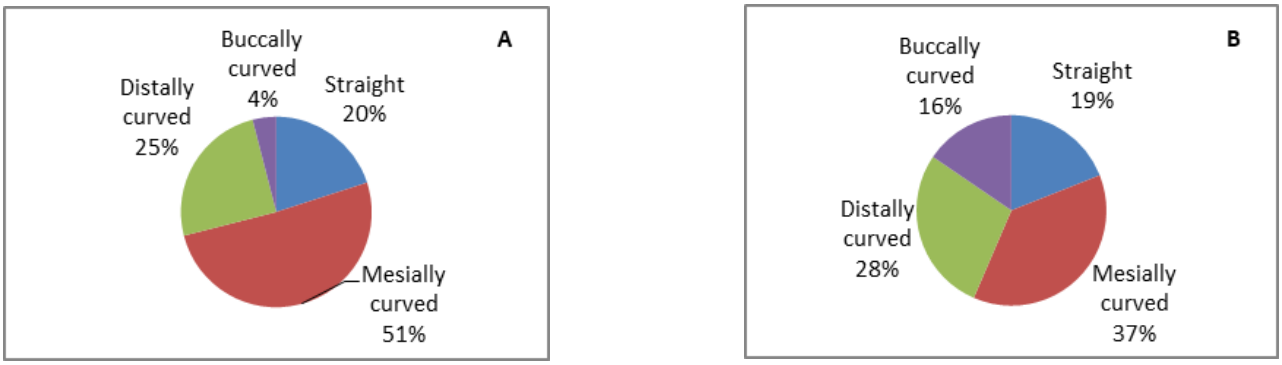

Table 4. Single Root Pattern, Distal Root Pattern

Element of study	Accuracy	Specificity	Sensitivity
Straight form	100.00	100.00	100.00
Mesially curved	58.18	100.00	34.29
Distally curved	55.56	100.00	24.32
Buccally curved	50.72	100.00	12.82

On OPG, there were no extra roots (only mesial and distal roots), while gross examination revealed 7 (20%) with additional roots (figure 5). Out of these seven cases, one case (14.5%) had mesially curved roots, 4 (57%) cases had distally curved roots, and 2 (28.5%) cases had buccally curved roots.

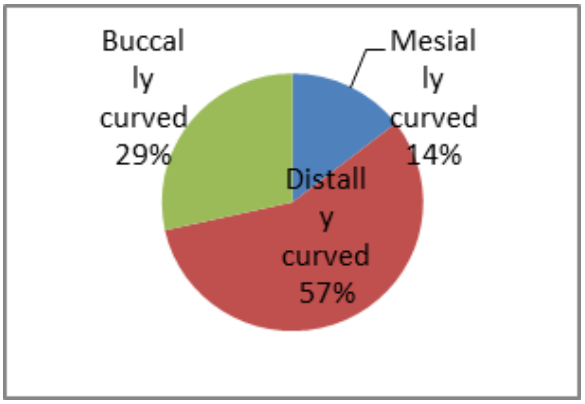

Figure 5. extra root pattern

Table 5: Single Root Pattern Extra Root Pattern

Element of study	Accuracy	Specificity	Sensitivity
Mesially curved	50.00	100.00	2.78
Distally curved	50.00	100.00	10.26
Buccally curved	50.00	100.00	5.41

DISCUSSION

Since it was first introduced in the 1950s, the OPG (orthopantomogram) has become very popular in dental practice. Its main advantage is that it can show all the structures of both jaws in a single image. However, image distortion and overlapping of structures made it less reliable compared to other types of X-rays.

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Today, these issues have been largely addressed through digital technology and software enhancements.[7] Still, many dentists are concerned about how accurate OPG is when it comes to showing fine details. This study found that while OPG can be very accurate for certain things, it may not be reliable for others.

This study demonstrated that the OPG can be fairly accurate in identifying the number of roots in lower third molars (LTM), with an accuracy of up to 79.55% for two-rooted teeth. However, its accuracy significantly drops to 50.00% when assessing teeth with three or four roots. Even in cases with a single root, the OPG showed a relatively low accuracy rate of 50.72%. Interestingly, the OPG suggested that 17% of the cases were single-rooted, while actual examination showed only 3%, indicating a tendency to overestimate this category. When attempting to compare our results with international studies, we found no literature specifically evaluating the accuracy of OPG in determining the number of roots in LTM (data not available). This highlights a gap in the existing research and underlines the need for further studies in this area to confirm or challenge our findings.

The relationship between roots is one of the key factors that determines the level of surgical difficulty. In cases involving partially impacted teeth with a single root, surgeons often attempt a closed extraction, anticipating an uncomplicated procedure. However, our study revealed that the image provided by the OPG does not always match intraoperative findings (as illustrated in Figures 6a and 6b). When it comes to identifying root relationships such as fusion, convergence, divergence, and other variations, the OPG demonstrated a maximum accuracy of only 58%. Its ability to detect the presence of these root relationships was particularly limited, with a sensitivity of just 3.23% and a specificity of 87.18%. These results differ significantly from those reported by Ali et al. (2015), who found a sensitivity of 33.3% and a specificity of 92%.[8] This discrepancy may be attributed to the presence of additional roots with their unique curvature patterns, resulting in radiographic appearances that did not meet our classification criteria (Figure 2). Additionally, the proportion of root relationships outside the common fused, convergent, or divergent patterns was 29% based on OPG assessment, compared to 40% on gross examination. These findings suggest that OPG should not be solely relied upon for determining the anatomical relationship between roots.

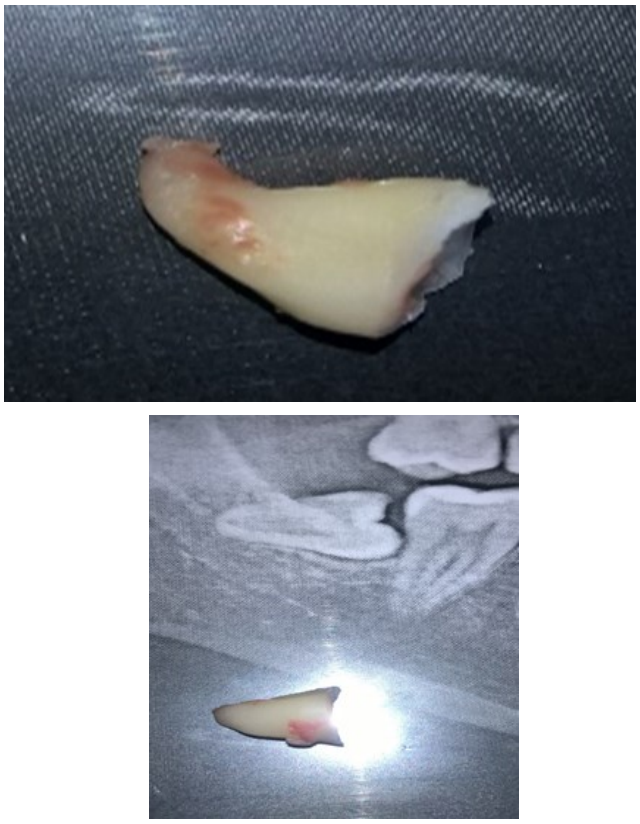

Figure 6. a, LTM on OPG has straight root; b, same tooth after extraction

In this study, the presence of a single-root pattern was considered one of the factors in determining the difficulty of lower third molar (LTM) surgery. If the OPG can reliably show this pattern, it could potentially become a key tool in helping clinicians decide on the surgical approach. This potential is especially noticeable when assessing distal curvature of the mesial root, where OPG showed high accuracy (77.78%), with sensitivity and specificity of 73.53% and 90.91%, respectively (Figure 7).

Unlike distal and extra roots, the mesial root is always present in LTMs, making it a more consistent landmark for radiographic evaluation. In a previous study by Ali et al. (2015), straight roots were observed in only 26% of cases, with the re-

maining 74% showing curved roots.8 In contrast, our study found the opposite: 77% had straight roots and only 23% were curved. Differences in ethnicity, the type of OPG machine, and the software used for image enhancement may explain this variation.

One consistent concern in LTM surgery is the frequent distal curvature of roots, especially the mesial root (Figure 7). Upon gross examination, we found that 71% of mesial roots, 28% of distal roots, and 57% of extra roots were curved distally (Figures 2a and 2b). This tendency may be related to the growth and eruption path of third molars. Notably, the OPG results closely matched the clinical findings for distally curved mesial roots: 74% seen on OPG vs. 71% confirmed during surgery, with an overall accuracy of 77.73%.

Our findings on root curvature of lower third molars align with those of Fuentes et al. (2018), who reported that 84.72% of mandibular first and second molar roots exhibited some degree of curvature. They observed the greatest curvature in the middle third of roots (mean angles of 11°–14°), while the cervical third remained largely straight. Their reported low frequency of dilacerations (0.73%) supports our similar observation of few extreme root curvatures. Although their study excluded third molars, the consistent curvature trends suggest shared developmental influences. Furthermore, the minimal gender differences they found (except in one root segment) reinforce our suggestion that imaging methods and ethnic factors may play a greater role in morphological variation than gender.[9]

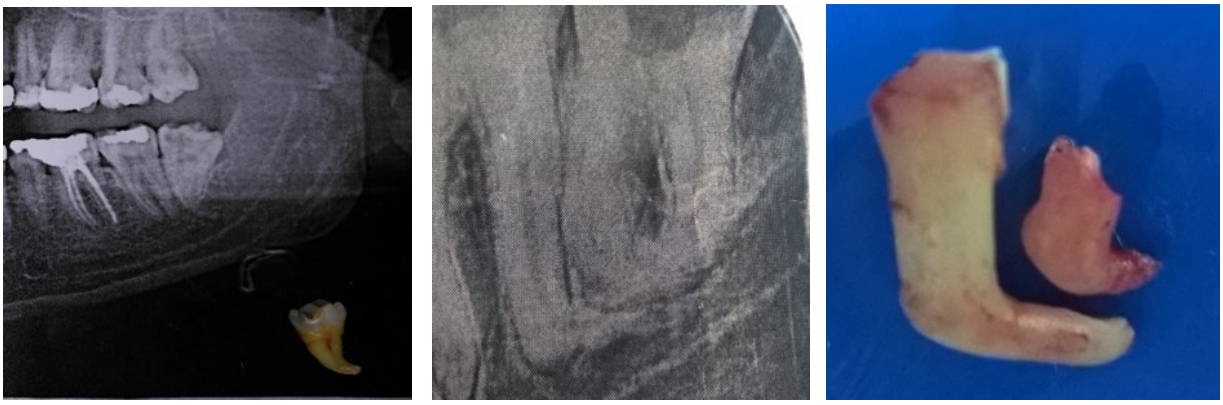

Figure 7: a, distally curved mesial root; b, unobvious apical area of tooth; c, same tooth after extraction

Mesial curvature is typically associated with distal roots, whereas it is relatively uncommon in mesial or additional (extra) roots. In the current study, orthopantomograms (OPGs) revealed mesial curvature exclusively in the distal root. However, gross anatomical examination confirmed the absence of mesial curvature in the mesial root, while such curvature was observed in 37% of distal roots and 14% of extra roots.

Lingual root curvature was found to be rare across all root types. In contrast, buccal curvature was more frequently observed, with prevalence rates of 9%, 16%, and 29% in mesial, distal, and extra roots, respectively. This buccal deviation may increase the complexity of surgical procedures by opposing the direction of applied force and engaging with adjacent cortical bone. Therefore, careful evaluation of root curvature—especially in buccally curved roots—should inform surgical planning to minimize intraoperative challenges (see Figure 8).

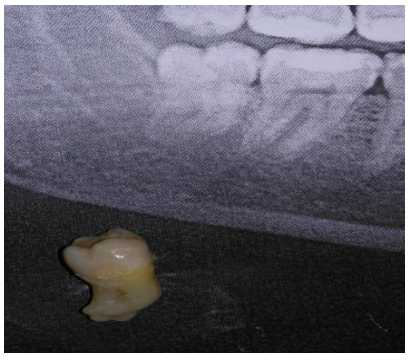

Figure 8. buccal curvature of extra roots.

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Although the orthopantomogram (OPG) is a two-dimensional imaging modality subject to superimposition of surrounding anatomical structures, it remains a valuable tool for obtaining a general overview of third molar anatomy. However, its limitations in accurately depicting complex root configurations, particularly in cases involving multiple curvatures or buccolingual angulations, should be acknowledged during diagnostic and surgical planning.

CONCLUSION

Orthopantomograms (OPGs) demonstrate acceptable accuracy in identifying the number of roots in mandibular third molars, but primarily in cases with two-rooted configurations. When assessing root curvature, OPGs tend to be reliable only for detecting mesial curvature in mesial roots. However, their diagnostic accuracy significantly diminishes for other morphological characteristics, including root curvature in single-rooted molars and complex multi-rooted patterns. As such, OPGs offer limited value in the comprehensive assessment of root morphology in lower third molars and should be supplemented with three-dimensional imaging techniques when detailed anatomical evaluation is required.

ACKNOWLEDGMENT

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DATA AVAILABILITY

Datasets related to this article will be available upon request to the corresponding author.

CONFLICT OF INTEREST

This study has not been supported by any individual and/or organizations and we are announcing no conflict of interest.

This study was registered and conducted by the scientific and ethical guidelines of the Kurdistan High Council of Medical Specialities and was approved by the corresponding ethical committee.

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