

Dental X-ray imaging: the construction of a novel teeth phantom

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Abstract

The majority of teeth pathological abnormalities are indicated by dental X-ray imaging. However, research on real teeth phantoms is still an open issue requiring further progress. In this work, we present the construction of a novel phantom representing realistic teeth jaws with purpose to assess the image quality for different irradiation conditions. The main components of the phantom are briefly summarized as follows: (a) female silicone molds for the jaw shape creation, (b) resin for the simulation of the soft tissue X-ray attenuation and (c) natural anterior and posterior teeth of mandible and maxilla. In order to implement the aforementioned components we used two silicone modules (base and catalyst), iron molds that served to obtain both jaw imprints and plasticine for the teeth integration within the resin. Several teeth were used with corresponding characterization in terms of their anatomy and pathological features, such as fillings, caries, fractures, etc. The phantom was irradiated within the common range of dental X-ray imaging (X-ray voltage: 60-70 kVp, Current: 4-8 mA). The acquisition of medical images were found to be of high quality, especially in higher X-ray voltage values (higher image contrast). As a conclusion, the present phantom could be a useful tool for future dental X-ray imaging investigations for different teeth pathological abnormalities.

Introduction

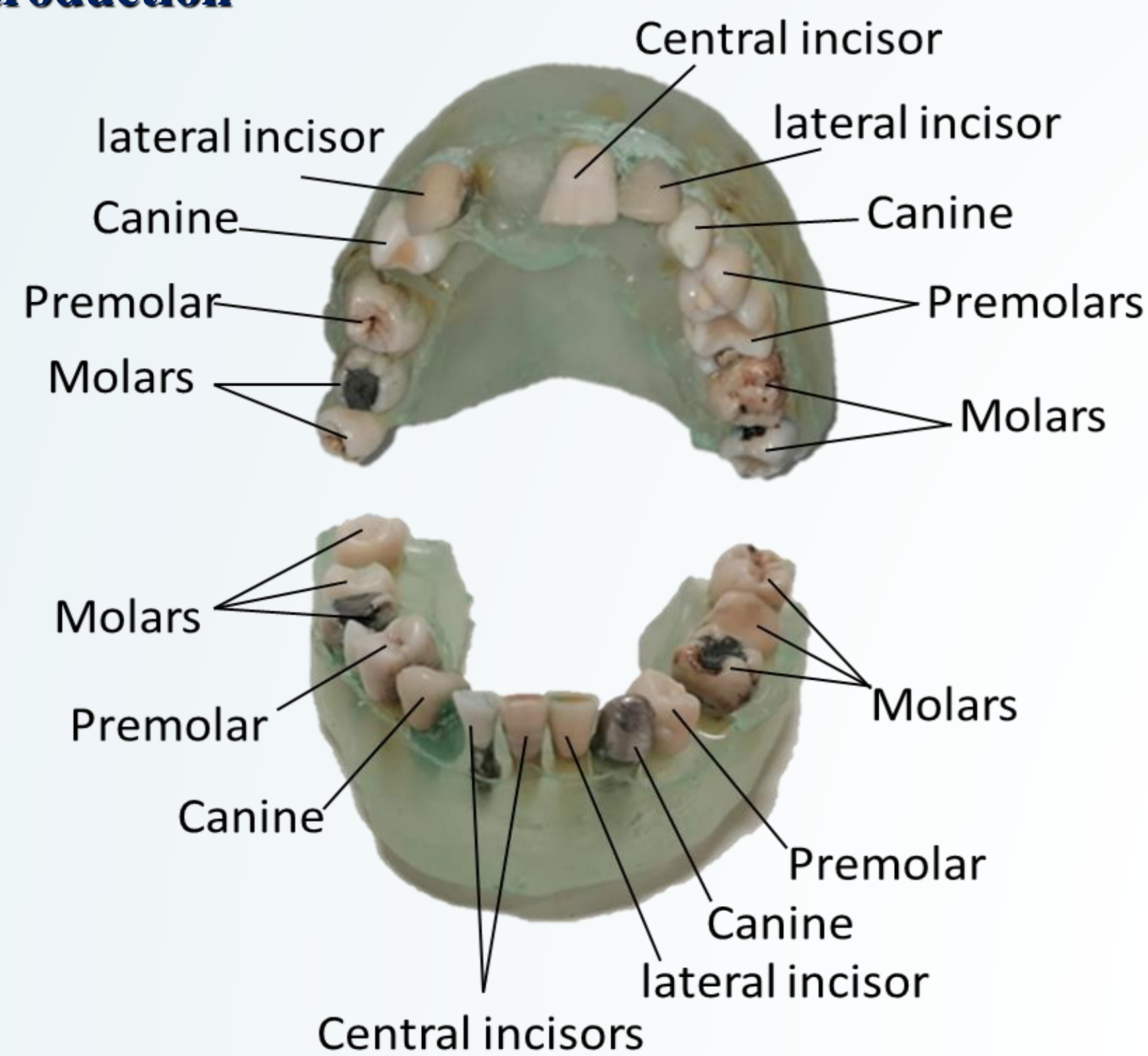


Figure 1. The phantom and the characterization of the teeth

In dentistry, the phantoms that are usually created aim to simulate the oral cavity in order to familiarize dental students with the main interventional methods. In this work, the development of the phantom aims to introduce the contribution of imaging in dental pathological features and apply research protocols of further techniques. In our study, the phantom was tested under several irradiation conditions in order to determine the optimized set of parameters.

Materials and Methods



Figure 3. Materials for the manufacture of female silicone molds for the jaw shape creation and the resin for the simulation of the soft tissue X-ray attenuation. (i) Base of the silicone, (ii) catalyst for the hardening of silicone, (iii) WWB4 EPOXY HARDENER, (iv) WWA EPOXY RESIN.

For the final reconstruction of the replicas we used again the iron molds for making the impression, in order to give again the shape of the dentures on the plasticine. We then inserted the tooth crown (outer piece) into the plasters in the correct anatomical positions with the help of a dentist (Figure 4,i). Finally, we placed the molds with the plasticine and the teeth upside down, so that the roots of the teeth to be in the recesses of the molds, which were filled with the thermosetting resin, and left for 4 days to set (Figure 4,ii).



Figure 4. Image on the left: Iron molds that served to obtain both jaw imprints and plasticine for the teeth integration within the resin. Image on the right: Female molds with epoxy resin inside them and the molds placed on top to immerse the roots of the teeth.

Results and Discussion



Figure 5. The final result of the phantom. Periscopic views of the rear part of the phantom and diagram - range of grey levels.

Settings	Image	Settings	Image
Voltage (kV)		Voltage (kV)	
60		60	
mAs		mAs	
8		6,3	
Small focus		Small focus	
Settings	Image	Settings	Image
Voltage (kV)		Voltage (kV)	
60		60	
mAs		mAs	
4		2,8	
Small focus		Small focus	

Table 1. Table provides the results on the data used for the dental imaging and the corresponding derived images.

Conclusions

The Image with the best features was found to be for 60kV and 6.3mAs. In this image you notice: (i)The limits of the root, (ii) The endodontic treatment in all three root canals and its boundaries, (iii) The two different materials of the filling, (iv) The limits of the Filling.

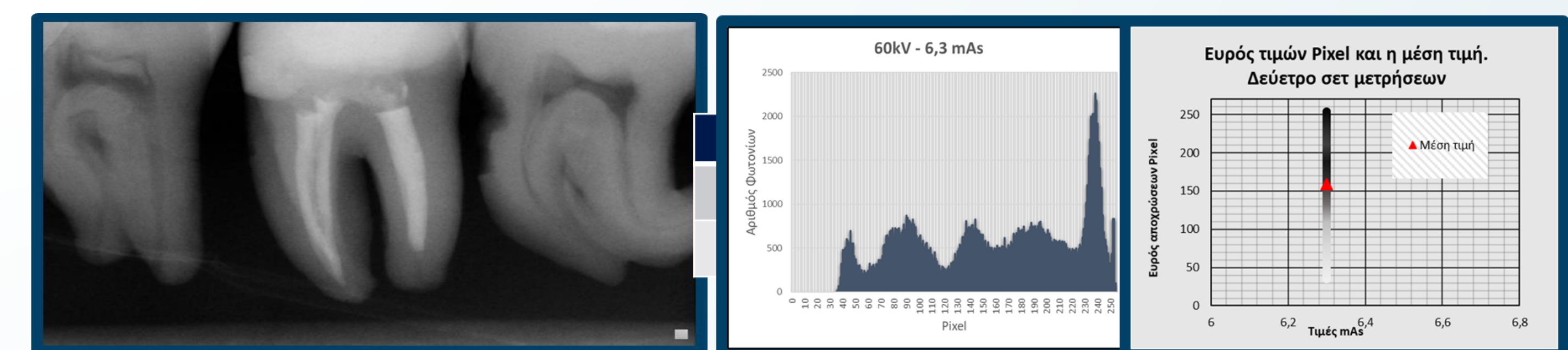


Figure 6. Image - Charts and quantitative measurements of 60kV - 6.3mAs imaging

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