STEP-BY-STEP

Construction of Dental Study Models

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There are several recommended methods for the construction of orthodontic gypsum models in the human dental literature. All methods have the objective to standardize the technique and produce a perfect reproduction of the dental and soft tissue structures of the oral cavity.[1,2]

The gypsum dental models provide valuable information that register and archive a representation of the oral cavity in clinical cases. They assist in the analysis and study of animal occlusion, malpositioned teeth, jaw characteristics, discrepancies of dental size, and osseous bases.[1] Dental models are used as a basis for diagnosis and treatment planning.[3] Dental models are also valuable in communicating oral and dental diseases with pet owners and veterinary dental colleagues. Finally, pre- and post-treatment models can be used to assess the efficacy of treatment.[4]

Materials and equipment required for the construction of dental models include: adjustable or custom-made mold trays, alginate, plaster or stone gypsum, bowls, spatulas, gypsum knife, vibrator, sheets of red wax, cutting model machine, ruler, extra fine sandpaper (400 or 500 grit), polish solution, a polish machine with felt disc, or panty hose silk.[1] The mold (negative or impression) is obtained by molding the oral cavity with alginate impression material and the model (positive) is obtained by filling the mold with gypsum. The model is then cut and polished to improve its final appearance.[2] Human methods were adapted for animal patients and the complete sequence of dental study model construction is described step-by-step.[1]

Figure 1

Photograph showing adjustable mold trays[a] used to provide a custom fit based on the size of the animal's dental arch (mandible and maxilla). The perforations help to create mechanical retention between the alginate and the mold tray. The preferred technique provides for 2 to 3-mm of alginate impression material between the tray and the structures to be molded. Excess impression material between the tray and dental structures may cause distortion of the impression material.

Figure 2

Photograph showing application of the mold tray and alginate impression material. A bite registration may be performed before intubation or after extubation using a sheet of red wax warmed previously in hot water. The teeth should be cleaned and dried before the impression is taken. The alginate is prepared according to the manufacturer's recommendations and applied into the mold tray, covering the entire tray surface. The final appearance of the impression is improved by smoothing the superficial surface of alginate with wet, gloved fingers before taking the impression. The alginate impression is obtained through the following sequence: mold tray and alginate introduced, centralized in the oral cavity, structures seated in the alginate, stabilization of the tray and impression material in the oral cavity, and removal after a solid alginate consistency.

Figure 3

Photograph showing a completed alginate impression. The alginate mold should have a smooth and brilliant surface including all oral anatomic details and no air bubbles.[4] In this impression, an excess of alginate material is located in the rostral and lateral areas, which can cause distortion of the alginate and subsequent gypsum model. Excess lateralization of alginate can be avoided by using a more appropriately sized tray. However, this may be difficult in dogs based on the variety of breeds and associated oral morphology, especially when using non-adjustable trays. Orthopedic cast resin materials can be used to form an inventory of mold trays of various sizes to reflect different skull morphology.

Figure 4

Photograph showing mixing of the stone (type III) gypsum to fill the alginate impression. In this case, stone gypsum was used for reconstruction of teeth and plaster (type II) gypsum was used to fill the mold and base of the impression. It is advisable to first place water in the mixing bowl and then add the gypsum powder to minimize the air formation in the mixture. After the first mixture, it is important to proceed with an energetic mix to ensure that all powder is combined with the water, until a homogenous and smooth texture is obtained (taking approximately 1 to 2-minutes).[5] When maximum model strength is required (e.g. canine tooth assessment), the ratio of water/stone powder can be altered based on the manufacturer's recommendations. The limiting factor will be the viscosity of the mixture, which if too great may impair the accuracy of the model.[6]

Figure 5

Photograph showing the pouring of the stone gypsum into the alginate impression. It is preferable to fill the individual tooth impressions (negatives or holes) one by one. A spatula is used to help guide the stone gypsum into the desired location. All teeth and the primary gypsum surface are then poured over the impression. A vibration machine helps to eliminate bubbles in the stone gypsum.
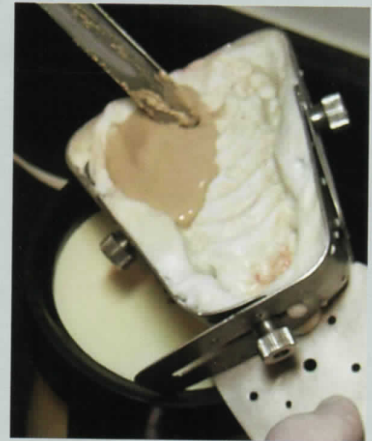

Figure 6

Photograph showing construction of a model base using sheets of red wax around the mold tray and fixed with adhesive tape. This method serves as an alternative to rubber bases used in human dentistry. Small gypsum stone "towers" (arrows) are created to increase retention between the first and second layers of gypsum.
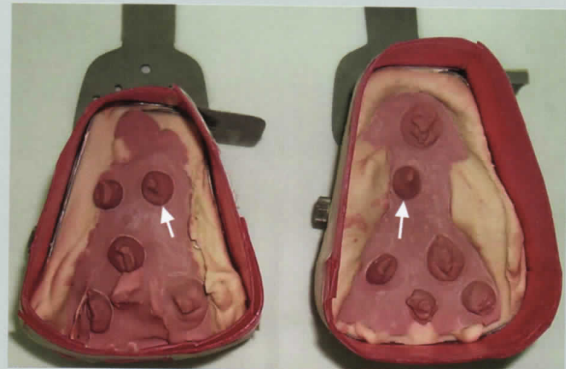

Figure 7

Photograph showing application of the plaster gypsum base measuring at least 4-cm in height and placed on the stone gypsum layer.

Figure 9

Photographs showing alginate removal and model appearance following curing of the gypsum. The wax and the models are removed from the mold tray after the gypsum has hardened (approximately 30 to 60-minutes).[5] All alginate can not be removed at the same time as in human dental models since alginate retention is enhanced by the divergent orientation of the canine teeth. It is necessary to carefully cut the alginate in small pieces with a scalpel (A), removing it fragment by fragment, to avoid crown fractures and obtain a clean, intact model (B).
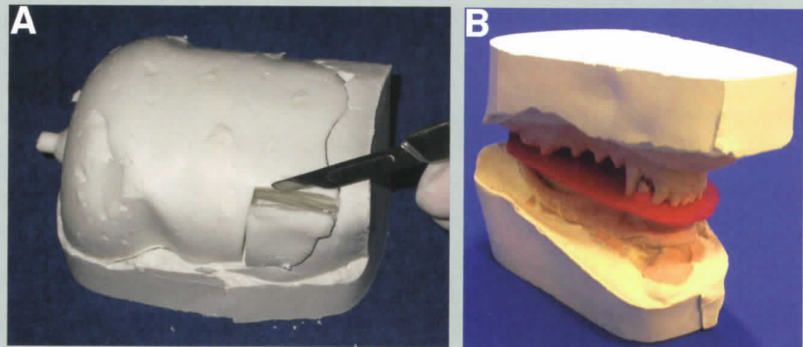

Figure 9

Photographs showing cutting of the model using a cutting model machine (A). The cutting action is initiated on the mandible model. The base should be parallel to the table and 3-cm in height (B).[1] The caudal aspect of the mandible model should be cut to within 5-mm of the last tooth (C).
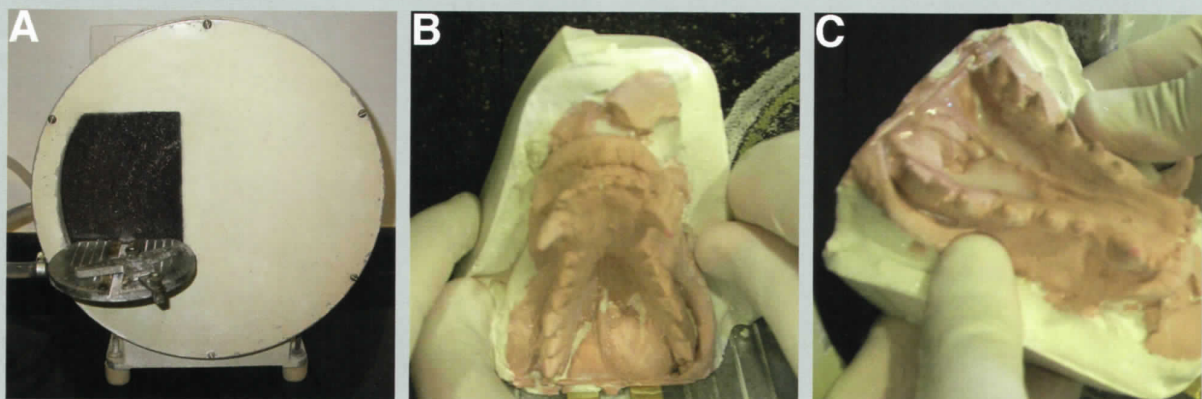

Figure 10

Photograph showing the caudal aspect of the maxilla model cut even with the caudal aspect of the previously cut mandible model while the models are in occlusion. The layer of red wax helps to counteract forces against the models which might cause crown fracture.[1,7]

Figure 11

Photograph showing the maxilla model cut to a height of 4-cm. This maneuver is performed with the models in occlusion and the caudal aspects over the machine table.[1]

Figure 12

Photographs (A and B) showing lateral cutting of the mandible and maxilla models. A lateral angulation of 80° (humans = 65°) in relation to the caudal plane [arrowheads] is recommended.
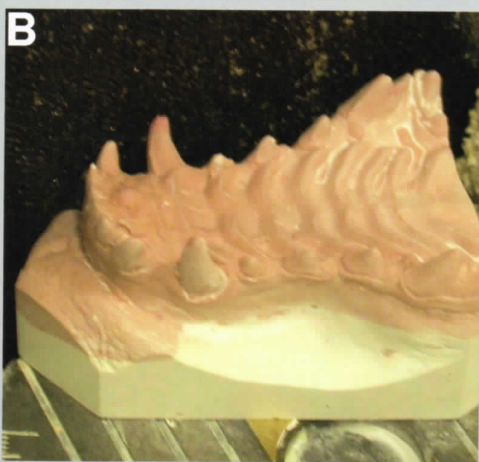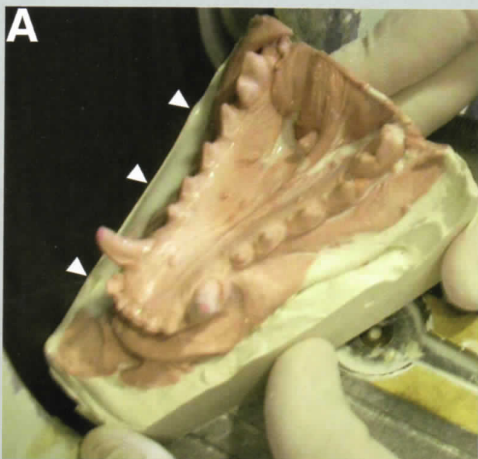

Figure 13

Photographs showing the recommended rostrolateral and caudolateral cuts. The recommended rostrolateral angulation for the maxilla is 145° (as in humans) [white arrow] forming a rostral "V" angle, with the palatine sagittal plane centralized (A). The rostrolateral cut for the mandible is rounded or circular. The recommended caudolateral angulation for both the maxilla and mandible (B) is 120° (black arrow) with the cuts performed while the models are in occlusion. Angulations for delineating the cut on the gypsum models can be based on the table guide of the cutting machine or using a pencil and protractor. Angles are modified from recommendations in humans based on the long, more rectangular shape of the mandible and maxilla in small animals.
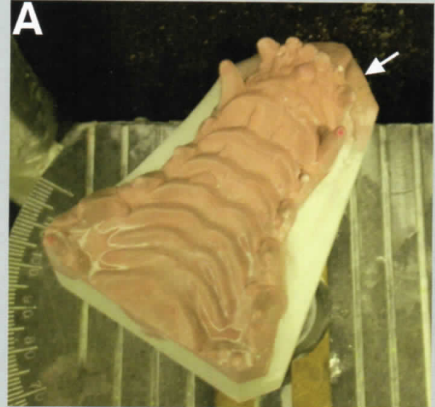

Figure 14

Photograph showing the base view of the models. Note the "V"-shaped rostral aspect of the maxilla compared with the rounded rostral aspect of the mandible.
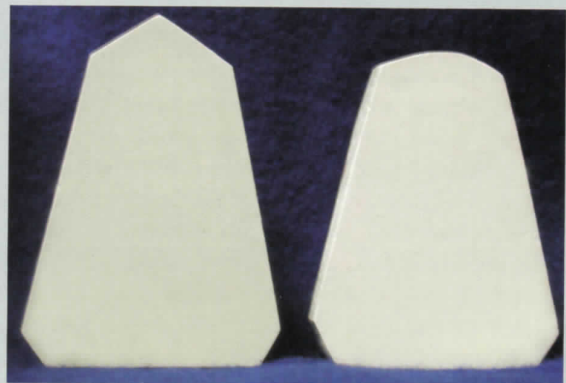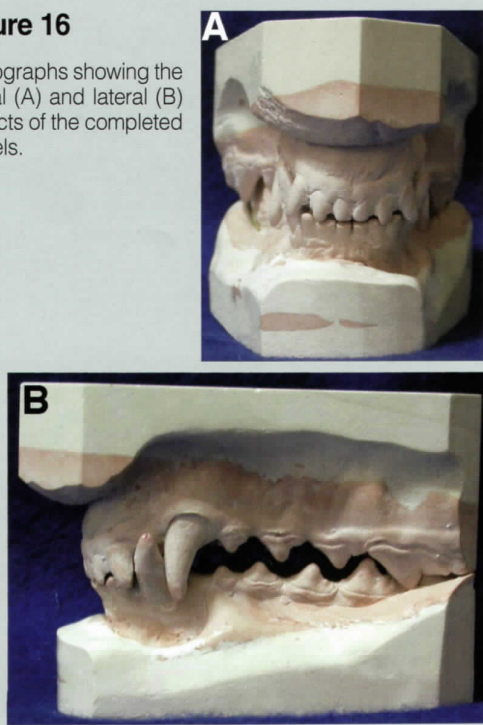
Figure 15

Photographs showing final model preparation. Bubbles or defects may be filled or "caulked" with gypsum stone that has a more liquid consistency (A). A gypsum knife may be used to remove excess stone and sculpt the border of the models (B). Extra-fine sandpaper (400 or 500 grit) is used to smooth the cut surfaces (C).

Figure 16

Photographs showing the rostral (A) and lateral (B) aspects of the completed models.

formula: 250g of coconut soap bar, 10g of borax[b], and 1000ml of water. In order to formulate this solution, it is necessary to dissolve the coconut soap at 60° C. After the water and soap solution becomes cold, the borax is added and mixed constantly. [3,9] The models are submerged in the solution for 3-hours, washed with water, and polished with wet cotton. Finally, the models are polished with silk panty hose. This polishing procedure increases the gypsum superficial resistance, provides shine, makes the models easy to clean, and produces the best possible appearance.

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[a] Mold tray, Ortovet – Ortopedia Veterinária Comercial Ltd, Brazil

[b] Bórax, Quimidrol Comércio Indústria Importação Ltd, Brazil

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The characteristics of gypsum products are based on their chemical and physical nature. Gypsum plaster or type II dental stone has calcium sulfate hemihydrate crystals that are irregularly shaped and porous. This material serves as an appropriate model base. The hydrocal variety of gypsum or type III dental stone has a higher density and is more crystalline. This material is preferred for the impression model based on its compressive strength and resistance to abrasion.[7]

The superficial hardness can be intensified by dehydrating the models in a 60° C drying oven and removing the models when they are a uniform white color. The models should cool gradually during 24 to 36-hours to avoid cracking artifact.[8] The final polishing is accomplished with a polish solution

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