

Accuracy analysis of teeth 3D model based on RE Technology

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Abstract. At present, the silicone rubber material is the best material to turn over the plaster model. This paper was aimed to explore the error and error magnitude between the plaster model and the original one. The silicone rubber materials were used to turn over the the standard resin dental model into plaster model. A large number of point cloud data were obtained by using a hand held scanner to scan the standard resin and the turning plaster model, and the data was saved as .Stl format. The Geomagic Studio software was used to complete the processing of point cloud data, and then the boundary of the two digital dental model was extracted. Finally, comparison of the 3D and 2D was undertaken by the Geomagic qualify 3D detection software, at the same time, the error analyzation was taken to text the anterior, middle, posterior segment of the dental arch, premolar and molar Pont Index. The analysis results showed that the error between gypsum model and standard resin teeth Model was 0.030 mm to 0.050 mm, although the error was very small and meet the clinical accuracy, but silicon rubber material will also affect the accuracy due to the shrinkage and other characteristics. This will lay a certain foundation for the development of oral medicine in the future.

Introduction

In recent years, in the wake of science and technology, electronic technology and advanced manufacturing technology introduced in the field of oral, prosthodontics field also undergone tremendous change. Accompanied by the growing community, walks of life becomes increasingly digitized, included oral clinical medicine .Digital impression technology has been recognized as the future of prosthetic mainstream trend. Quick, convenient and accurate is the biggest advantage of digital stamp. In the field of oral medicine, traditional stamp method is to use silicone impression material as the most ideal impression material, because of it's good fluidity, plasticity, elasticity, easy to shrink, smooth, small size and other advantages. Usually silicone impression material will be used to reproduce the maxillary and mandibularis female mold in the patient with tooth wear, tooth loss or the special orthodontic patient and the assistant then filling out the plaster model. Laboratory technician obtain some simple data on the plaster model measurement, make crowns or dentures on plaster model, and grinding the final actual wear. However, plaster model error is unkown. Slight deformation of the silicone rubber, plaster model of wear will lead to errors, especially in key parts of the plaster model of the human mouth. Then the patient dental pain will worsen and even lead to more serious side effects, so we explore silicone rubber material accuracy is necessary. To determine how much influence error of silicone rubber material, by comparison between the two methods . Geomagic Qualify , three-dimensional software, can be used to detect 3D, 2D comparison and contrast data , so you can fully detect possible scenarios. Standard resin model equivalent to oral digital impression, it is necessary to analyze .Standard resin model and plaster model set shown in Figure 1.



Fig.1 Standard resin model and plaster model

This paper mainly use handheld scanners to scan the standard model resin and plaster model, then obtain a digital model call for .stl data format and determine how much the error is in the end [1-3].

Design ideas

Sample scanning. Use a name for the accuracy of 0.04 HANDYSCAN 3D handheld scanner to scan plaster dental cast model. The plaster model and the standard model of resin were placed in the table, then use hand-held scanner to sample the full range of scanning. Because the shape of the scan model will directly affect the subsequent comparison of accuracy, It is important to scan more comprehensive and accurate, Finally, the model data was stored for .stl format. Digital models shown in Figures 2 and 3:

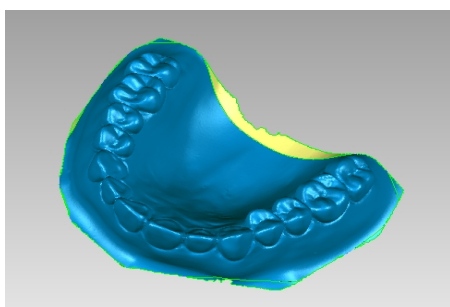


Fig.2 Standard resin model data

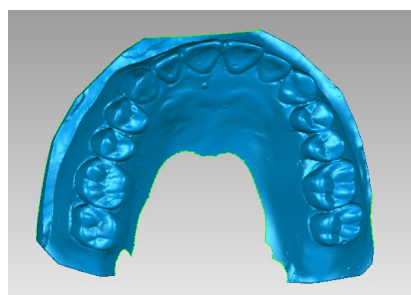


Fig.3 Dental plaster mold scan data

Boundary Extraction. Open .stl format model data in Geomagic Studio reverse software [4-7]. The first to use the grid doctors to automatically repair the model and remove the extra point to retain the important point to reflect the model profile, then make it mesh more smooth and remove a variety of operating noise to repair the model completely.

In the dental model, there are significant changes in curvature and irregularities between the teeth and gums, this change significantly as the basis for extracting the boundary. This boundary extraction usually have two things: first, based on the pattern of irregularities point select the point, and then use the curve to connect the dots to form a closed curve, so that the initial boundary extraction is completed. The second step of extracting boundary curve is corrected, the main advantage of the unique characteristics of dental, appropriate to add some constraints and determine the length of the boundary curve surrounded by a variety of methods and the size of the long axis of the teeth. Finally, the use of cutting curves to retain teeth portion, save for the encapsulation .stl file format of the data shown in Figure 4 and 5:

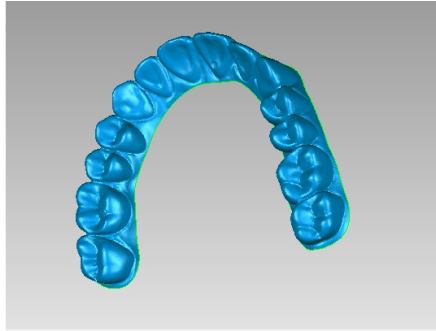


Fig.4 Standard resin modified model boundary extraction

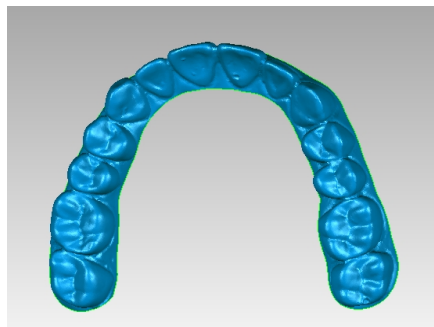


Fig.5 Plaster model modified boundary extraction

Implementation

2D and 3D contrast. Open the above file open in Geomagic Qualify software[8-10], the first to open standard resins digital models, extract the digital model boundary in Model Manager is set to Reference (Reference Model), and then import the extracted plaster model boundary is set to test (test model), performed best fit alignment, and then become 3D compare shown in Figure 6:

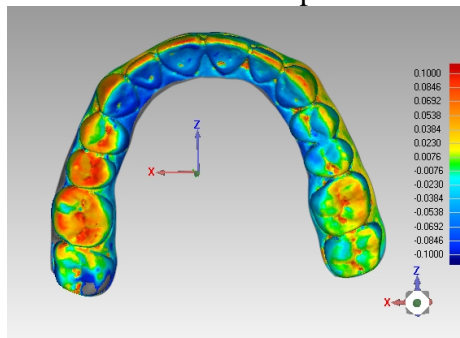


Fig.6 Difference distribution of tooth model

As shown in figure 6, through calculation, it can be concluded that the largest 3D deviation in the range of 0.1000 mm ~ 0.0999 mm, average error in the range of 0.0392 mm ~ 0.0294 mm, the standard deviation is 0.0410 mm, RMS Estimate is 0.0432 mm.

As can be seen from Figure Error and distribution of plaster models and resin standard digital models ,there are different color-coded,we can directly observe the error value of the image and see different teeth arrangement position.By fitting the image shows the contraction of gypsum in different position is different,the first premolar and first molar tooth fitting as effective as a few other, fitting

large deviation, indicating an impression when the error more appears here, there may exist here too deep undercut relevant when an impression is easily deformed, resulting error between a plaster cast and oral digital model , so we should pay attention to the concave position [11].

2D comparison after comparing the 3D, for the first premolar and the first grinding Teeth contrast, using plane symmetric intercept the first premolar and the first molar section diagram as shown in Fig. 7 and Fig.8:



Fig. 7 Distribution of cross-sectional differences in the first molar



Fig.8 Distribution of cross-sectional differences of the first molar

As shown in Fig. 7, through calculation, it can be concluded that the first premolar 3D deviation of maximum deviation in the range of 0.3771 mm ~ 0.1452 mm, average error in the range of 0.0399 mm ~ 0.0171 mm, the standard deviation is 0.0414 mm, RMS Estimate is 0.0487 mm. The Fig 8 shows that the first molars 3D deviation of maximum deviation in the range of 0.2797 mm ~ 0.2267 mm, average error in the range of 0.0473 mm ~ 0.0338 mm, the standard deviation is 0.0428 mm, RMS Estimate is 0.0387 mm, there is error between gypsum model and the standard resin digital model.

From the data we can see that the error is within the allowable range of clinical, but the larger error can be seen in the first premolars and in the middle of nest at the boundary. At the border may be large errors because of the improper boundary extraction process, as well as the difficulty to determine the irregular tooth mold , so the extraction process will inevitably produce errors. Pour concave error also as said above, when taking impression material due to the elastic impression materials, such as smoothness can also lead to error, but the error is less than 0.005 mm.

Data comparison. The main arch of the front (left and right side between canine cusp), middle (left and right side of the first premolar between the fovea), after paragraph (left and right side of the first molar central fossa between) width, premolars Pont index, molar Pont index measuring contrast, premolars Pont index equal to four incisor crown width divided by the sum of the left and right front side of the first molar central fossa distance between multiplied by one hundred to obtain the desired index, Pont index equal to 4 molar incisor crown width and divided by the distance between the left and right side of the first molar central fossa between multiplied by one hundred to obtain the desired index, measured data shown in table 1:

Table 1 Model data comparison

	Arch front (mm)	Middle arch (mm)	Arch rear section (mm)	Premolars Pont index	<i>Molar Pont index</i>
Standard Digital Model	35.3679	37.1359	47.4996	78.7224	59.6373
Plaster model	35.3227	37.1045	47.4596	78.3630	59.3561

Table 1 shows that the front of the dental arch distance difference is 0.0452 mm, dental arch in the middle distance difference is 0.0314 mm, tooth bow in the back of the distance difference is 0.0400 mm .From this data, the three sets of plaster casts were less than the resin model, because when taking impression material, an elastic impression material will shrink, although it will be expanded plaster model solidified but not enough to offset the contraction of the impression material , so the overall data is small, as well as due to the irregularities of the teeth and the measurement point is not accuracy , the measuring distance based method will also bring some error to the measured results, even if they would see the plaster model compared with the standard digital model there are many shortcomings.

Conclusions

By comparing the standard resins digital model and data plaster dental cast model , the maximum error is 0.0428mm, the smallest error is 0.0314mm, although the error is very small, the plaster model accuracy is worse than standard digital models.Due to plaster models is not easy storage, accuracy is not high, a long time will be deformed, then it must be stored in a dry environment, or seriously affect the operation of some follow-up, and some data can not be measured directly. Standard models are easy to store the resin, by comparing the two accuracy, which can cause errors during the operation and the characteristics of the silicone rubber material itself can also cause errors, while the error is very small will not affect the clinical operation, but can fully know the characteristics of the silicone rubber material, also has laid the foundation for further clinical development.

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