Violetta Lesniewski

Possibility of Reconstruction of Dental Plaster Cast from 3D Digital Study Models

Section D200

March 15, 2017

Part I

Extended Annotated Bibliography

**1. When was the work published?**

The article “Possibility of Reconstruction of Dental Plaster Cast from 3D Digital Study Models” from *BioMedical Engineering OnLine* was published May 31, 2013.

**2.** **What are the main points of the article? Write a 150- 200 word summary of the article that accurately conveys the content of the article.**

The article examines the accuracy and benefits of 3D scanning and 3D printing to potentially replace traditional dental plaster casts. Ten randomly selected and completely reproduced full arch plaster casts with common various orthodontic anomalies were digitally scanned and 3D printed. All models were scanned with inEos Blue, saved as STL files and prepared for 3D printing. An open source RepRap printer was compared to the commercial ProJetHD3000 for quality. A single trained individual evaluated the measurements taken twice using a hand held digital caliper. Measurements included the intercanine distance, the distance of tips of the canine and mesio-palatal cusp of the first permanent molar in jaw, the clinical crown height of the canine, and a mixed distance between mesial edge and the first incisor and cusp of the canine. Collectively, there were 160 measurements statistically evaluated. In conclusion, the results had depicted that the 3D printed copies from RepRap are precise and can replace plaster casts. It is low in cost and can produce a faster 3D model of the teeth anatomy.

1. **Does the work meet the standards to be considered an appropriate/academic/scholarly source? Justify your choice.**

The research meets the standards and is considered an appropriate scholarly source because it has all the sections that should be present in a research paper. Included are an abstract, the introduction, the material and methods, the results, the discussion, and the conclusion. *BioMedical Engineering OnLine* is an open access, peer-reviewed journal that exclusively publishes research from all areas of biomedical engineering. The journal allows independent researchers that are experts in field to analyze submitted work for quality control. It is a single-blind peer-review system permitting the reviewers to know the names and the affiliations of the authors.

**4. Are the qualifications of the author(s) appropriate for an academic article? Briefly describe the authors’ qualifications.**

All of the authors have some experience in the medical field; and therefore, their statements are credible. Magdalena Kasparova is an expert in dentistry, dental surgery, and forensic science. She has published 17 articles and 5 conference papers on dental related topics, which makes her a qualified candidate for a scholarly article.

**5. Is the purpose clearly stated? Restate the purpose of the paper in your own words.**The purpose of the article is clearly stated in three clear points. The study is implemented to determine whether or not 3D models of plaster casts can be replicated in 3D shapes, if RepRap 3D printer is accurate enough to produce the same measurements as the plaster models, and to propose that the open source 3D printed models can replace the process of plaster casts.

Experimental Design and Execution

1. **Is the experimental design clearly described? Describe the design in your own words.**

The experimental design was stated fairly clear, described as 10 randomly selected plaster casts taken from Orthodontic clinic of the Department of Stomatology, 2nd medical Faculty, Charles University, Prague. All patients from the orthodontic treatment had provided an informed consent and no personal data were shared on the casts. Each of the casts were numbered from 1 to 10 and reproduced with no surface damage or breakage. Positions of the teeth were taken into consideration and represented common anomalies of orthodontists’ cases. When obtaining 3D digital models from the casts, the same protocol for all samples was used. The models were 3D printed using an open source RepRap 3D printer and a commercial ProJetHD3000 3D printer. A single trained evaluator acquired the linear measurements in millimeters of the plaster casts and the 3D printed copies by using a hand held digital caliper. All measurements were taken twice with one-week intervals delivering a total of 160 measurements to be statistically examined. The distances of the measured dimensions selected were described and identified as x-plane, y-plane, z-plane, and mixed distance. Results were tested by paired t-test of the null hypothesis on the plaster models and RepRap 3D printed copies.

1. **Have the possible influences on the findings been identified and controls instituted? Describe and evaluate the use of controls and possible influences (spurious variables).**

The control was the plaster casts. The article reports that the same protocol being used for all samples. Each distance of measurement were measured the same for all plaster casts and 3D printed copies. However, only a single trained individual took the measurements and there was no way to find if the training was legit. By not giving a more valid explanation of the missing data from ProJetHD3000, the outcome was influenced by only the data shown from the measurements of RepRap 3D printed models. This could have been done to show a better outcome or to prove the point of their objectives.

1. **Has the sample been appropriately selected (if applicable)? Describe the sample used in the study, and evaluate its appropriateness.**

The sample size was small and depending on the anomalies, might not have presented the 3D printer with the appropriate challenges. The plaster casts used for the study were randomly selected, however, there was no further information on the process. The sample was taken from only one clinic and therefore might have been a limiting factor. The lost data from the ProJet30000 3D printed copies also had given me the inclination that there was not enough samples made for accurate evaluation.

1. **Has the reliability and validity of the article been assessed? Evaluate, and state the test/diagnosis results.**

The statistical calculations were assessed using Matlab Statistical Toolbox to prove the accuracy of 3D printed copies by evaluating the distance measurements between the plaster casts and the RepRap 3D prints. Standard deviation values were less than 0.5mm suggesting very little significant difference between the plaster models and the RepRap 3D printed copies. The article also mentioned that data collected from the printed copies in the commercial 3D printer could not be statistically evaluated due to the lack of data. The inadequate number of data was not explained thoroughly and therefore causes suspicion that those numbers were the few outlier measurements that were not included in the study. There was not enough data presented and therefore it was not a reliable or valid study. Regardless, the measurements of the plaster models and the RepRap 3D printed copies had no significant differences concluding that the RepRap 3D printing is precise enough to replace plaster models. In addition, Table 4 displayed the advantages and disadvantages between the plaster model, RepRap 3D printed model and the ProJetHD3000 3D printed model. A few advantages that were highlighted on the open source 3D printer were the low costs and its light, reusable material. As opposed to the plaster models, a digital model made in preparation for 3D printing can also eliminate storage problems as well as future replicas of the arches. These were presented agreeably in Table 4.

1. **Is the experimental therapy compared appropriately to the control therapy? Describe and evaluate the use of the control group.**

The evaluation was appropriately compared to the RepRap 3D printed models, unlike the ProJetHD3000 that had inadequate data. Plaster models were used as the control due to it being the traditional way of presenting 3D form of teeth anatomy. In this study the control is compared to the digital model as well as the RepRap 3D printed models. The experimental group was the RepRap 3D printer and the ProJetHD3000 since they were the comparison to the plaster casts. However, there was no evaluation on ProJetHD3000 due to lack of information.

1. **Is the investigation of sufficient duration? Evaluate, and explain your reasoning.**The article involved a short longitudinal study that obtained two measurements in a one-week interval to produce an accurate reading of the distance measurements between the plaster models and the 3D printed models. The investigation should have had more time to experiment and to review the lack of data. It would have been helpful to use more 3D printers to assure a better collection of accurate measurements.

Results and Critique

1. **Have the research questions or hypothesis been answered? Restate the research questions and/or hypotheses in your own words, and describe if or how they are answered.**

The objective of the research was to compare plaster dental casts into digital models in order to reproduce precise 3D printed copies of the plaster casts. The article concluded that the scans can be used as a template for 3D printing and that 3D printers can replace plaster casts. The 3D printed copies of the plaster casts were accurate enough to support their objective goals. However, not enough study or information was given to make it a valid statement.

1. **Do the interpretations and conclusion logically follow the experimental finding?**

**Restate the conclusion, and explain if or how they follow the experimental findings.**

The interpretations and conclusion logically followed the experimental findings. The conclusion found was that digital data could be collected and used for 3D printers. The measurements between the plastic casts and the RepRap 3D printed copies were equivalent in their data findings; and therefore, a great advantage over plastic casts. 3D printing can be a cheaper and faster option than plaster casts.

1. **Do you agree or disagree with the article and findings? Explain why?**

I agree with what the article is trying to accomplish but I don’t think they executed the study where it would be most valid. I agree with the article and its findings, as there are significant technological advantages to digital scanning and 3D printing. Although the sample was small, the 3D printed models were equivalent to the plaster models regarding the distance measurement readings. Other benefits that prevailed were the digital storage, lightweight material and reusable options. I believe that the article has a valid point, but it does not show enough numbers to back up their statement. I think technology is the future, but there are still improvements to be made. The data must be justified.

1. **What would you change in the article? Why? Think outside of the box. What would you add or delete.**

I would change this article by adding a more adequate explanation of missing data and the process of random selection. I would have used different types of dental plaster models from different clinics to get a better sense of diversity. The project needed more time and more samples to have valid distance measurements. Since the project measurements must be precise, I would consider having inter-examiners to verify that the measurements can be replicated. The hypothesis was not even in a question form; only goals were given to discover possibilities of 3D printed models. I would have wanted them to specify the hypothesis in a question form allowing room for error. The fact that they had already planned for an outcome could have influenced their interpretations and conclusion of the research.