

Volume 1 | 2015

COMPENDIUM OF
ORAL SCIENCE

The Official Journal of The Faculty of Dentistry



COMPENDIUM OF ORAL SCIENCE

The Official Journal of The Faculty of Dentistry

Volume 1|2015
ISSN: 2489-1102

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Contents

ORIGINAL ARTICLE

- Digitalized Bite Mark Analysis for the Undergraduate Dental Students** 1
Mohd Yusmialdil Putera Mohd Yusof
- Feasibility of Using Latex Examination Gloves as Dental Dam: A Tensile Strength Study** 6
Budi Aslinie Md Sabri, Nur Hidayah Mohd Radzi, Fatimatuz Zahira Abdul Hadi, Ikmal Hisham Ismail
- Assessment of Interradicular Spaces for Miniscrew Placement in Class I Subjects** 14
Naghah Mohammed Abdullah, Rohaya Megat Abdul Wahab, Mohamed Ibrahim Abu Hassan
- Detail Reproduction of Elastomeric Materials: Effect of Viscosity and Groove Geometry** 21
Nik Zarina Nik Mahmood, Noor Hayaty Abu Kasim, Mamat Azuddin, Noor Lide Abu Kassim
- Muscular Pain Among Dentists- A Pilot Study** 32
Faezah Sabirin, Siti Sarah Abdul Ahmad, W. Zahira Akmal W. Kamarudin
- Detection of Metabolomic Profile of Saliva In Healthy Malaysian Adults** 40
Han Hing Lee, Lee Chee Yen, Yoshinobu Shoji, Chin Hoe The

CASE REPORT

- Blending The Appearance Of All-Ceramic Crowns In Fluorosis Condition With Direct Chair-Side Technique** 47
Siti Mariam Ab Ghani, Ahmad Syahir Ahmad Zu Saifudin, Muhammad Aliff Ikram Noor Zari, Teh Adilla Mustaza

LETTER TO EDITOR

- Adopting Law School Pedagogy Into Teaching and Learning of Dentistry- my Melbourne Experience** 52
Mas Suryalis Ahmad

- SUBMISSION GUIDELINES** 55

Original Article

Digitalized Bite Mark Analysis for the Undergraduate Dental Students

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Abstract

In legal system, the admissibility of bite mark injury has proven to give more positive impact when current technologies are adapted to its analysis. The early exposure of the digitalized bite mark analysis during the undergraduate dental program is beneficial to stimulate interests and provide guidance among the professional dentists. The step-by-step bite mark analysis partly adapted from KU Leuven, Belgium is emphasized by delivering the illustrated practical techniques using computer software Adobe Photoshop®. The overlays analysis demonstrated its practicality as easy to use and offered opportunities to learn through unconventional mode of teaching. The incorporation of bite mark injury analysis to the undergraduate dental learning is highly recommended.

Keywords: *Bite mark analysis, overlay technique, dental education*

Introduction

Bite mark injury has been admissible in legal court as secondary evidence. Although its use is associated with subjective analysis largely due to impressions of the early works by discredit scientific personals, the modern techniques seem to provide a remedy to the missing link^{1, 2}. The use of overlays in computer software such as Adobe Photoshop® is easy to adapt and numerous results demonstrated that the techniques involved were accurate and reliable³⁻⁵. Therefore, it offers a potential platform for the undergraduate dental students

to learn the concepts and steps involved in bite mark injury analysis. In addition, due to the lack of forensic odontologists in Malaysia, the incorporation of this module into the undergraduate dental program may contribute great fundamentals and interests among dentists to work on bite mark injury analysis. However, maintaining contacts with experts are highly recommended as the court of law required the analysis to be conducted in a way that fulfilling the concept of beyond reasonable doubt.

The aim of this article is to introduce the practical delivery of digitalized bite mark analysis to the undergraduate dental students and to get them familiarize with the techniques involve in the analysis.

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Materials and methods

Two independent operators were working on this project. First operator simultaneously acted as victim and suspect by self-inflicting a bite mark injury on his forearm. The second operator (the author) acted as forensic odontologist who undertaking the whole process of bite mark identification and analysis. The outline of the self-inflicted bite mark must be clear and free from external marks such as scars, tattoos, and heavy hairs (Fig. 1). Prior to bite mark infliction, a forearm rest (blue arrow) was constructed to reproduce the same angulation during photography. The bite marks were digitally photographed according to ABFO recommendation for evident collection⁶ with the ABFO No. 2 ruler placed in-situ⁷. Impression casts were constructed on the suspect's dentition. The photographs were stored in JPEG format.

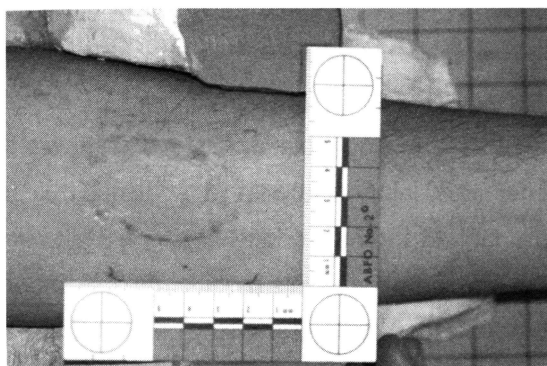


Figure: 1 – Digital bite mark photograph in forearm rest cast (blue arrow)

Digital analysis

The casts were scanned with a 2-D Canon PIXMA™ MG3220 scanner (Canon U.S.A., Inc., New York). The 2-D images were then imported to Adobe Photoshop® software and processed. The digital analyses were performed in the following steps. First, the detection and correction of digital photographic distortion were performed followed by photographs

resizing. Formula to measure the photographs resizing is as follows; the real size of scale = scale size (actual) and resize ratio = scale size (actual)/scale size (image)⁸. Suspect cast was scanned (Fig. 2) and overlay fabrication was made. The overlay comparison was then initiated. “Magic wand” tool was utilized to select the tooth edges. Non-metric overlay comparison procedures using manual digital analysis and spatial polygon were used in this trial. The spatial polygons of both bite mark image and scanned cast were manually compared by patterns and sizes.

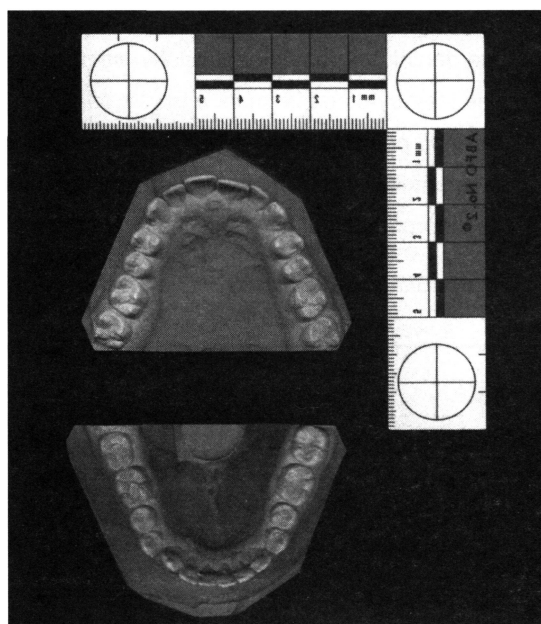


Figure: 2 – Scanned casts of upper and lower dentition

Results and Discussion

The image distortion was fixed using grid by equalizing the legs of the scale. Angular distortion was not fixed as the ruler circle perfectly fitted to each other (Fig. 3). The image height and width were obtained as 4.84cm and 8.33cm, respectively. The resize ratio was calculated as 0.735 where the scale size (actual) was 5mm (0.5cm) and scale size (image) was 6.8mm (0.68cm). Therefore, the height and

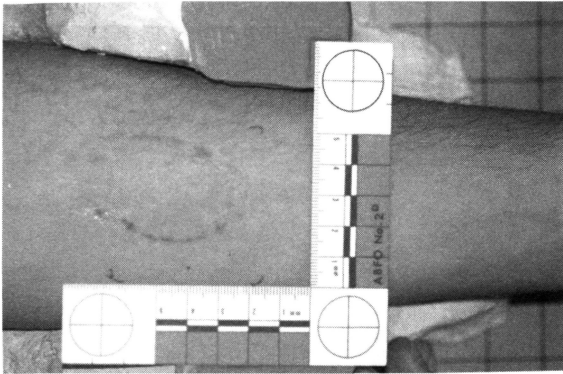


Figure: 3 – Digital bite mark photograph with coloured ruler circle on left (yellow) and top (blue)

width were adjusted to 3.56cm and 6.12cm, respectively by multiplying the resize ratio with the obtained values.

Fig. 4a exhibited the magic wand overlay added with marking texts. This overlay was then flipped for proper orientation of overlay (Fig. 4b). Rectangular marquee of the tooth edges overlay was transferred onto bite mark image by using free-transform technique for both upper (Fig. 5) and lower dentition (Fig. 6). A spatial polygon performed on bite mark image was shown in Fig. 7. The same procedure was also applied on the scanned cast (Fig. 8).

Undergraduate dental programs do not usually confer forensic knowledge and for that, more often than not, dentists resort to shunt cases

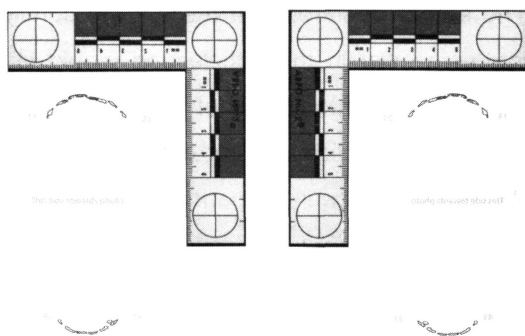


Figure: 4 – (a) “Magic wand” overlay added with marking texts (b) Flipped overlay for proper orientation

related to forensics and legalities. The referrals are scarce and reports are not being written sufficiently. The procedures expounded by this article were partly adapted from the curriculum imposed for advanced master in forensic odontology program in the department of forensic odontology in KU Leuven, Belgium. Thus, the theoretical and practical weight exhibited in this study is only represented about a third of total intensity of the bite marks module in the advanced master program. Ultimately, this article did not intend to replicate the full module set forth by the adapted program. It is important to note however, the procedures described in this article are accessible through literatures and paper works from various authors in the related area within research database.

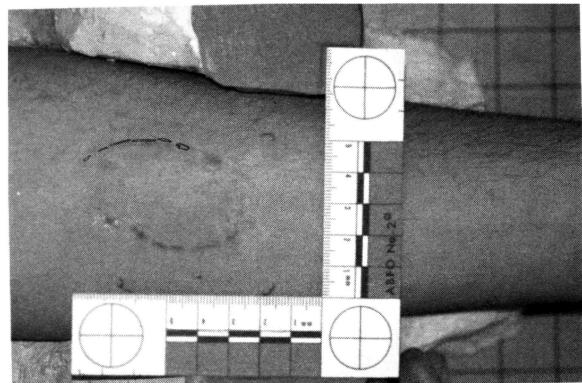


Figure: 5 – Tooth edges overlay on upper dentition mark

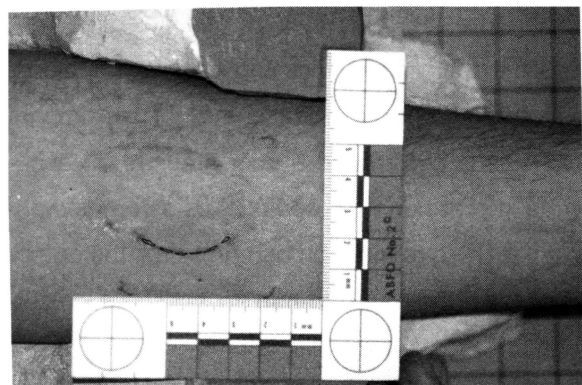


Figure: 6 – Tooth edges overlay on lower dentition mark

The theoretical part is not explained in great details in the current article due to scope of this article to familiarize the undergraduate dental students with terminologies and practicalities behind digitalized bite mark injury analysis. Despite gaining knowledge on how to handle bite mark evidence, the students may also appreciate that there are plenty of room for error should one is not careful enough to examine the whole aspects of error probabilities. The use of non-metric spatial polygons should always be measured with other criteria such as the measurement of arch width, shape of dental arches, labiolingual and rotational position, interdental spacing and curvatures of incisal edges.

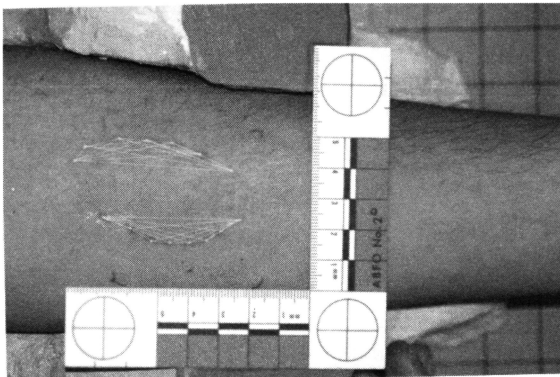


Figure: 7 – Spatial polygon on bite mark image for upper and lower dentition

Therefore, the bias can be minimized and reduce the likelihood of having a mono-directional interpretation due to inaccuracy of bite imprint as skin is considered a poor medium for accurate impressions⁹. In addition, as a complementary to the bite mark on human skins, the author suggests the use non-human substrate or perishable items such as apples, cheese¹⁰⁻¹² or pencils to measure the comparison accuracy for teaching and learning purposes.

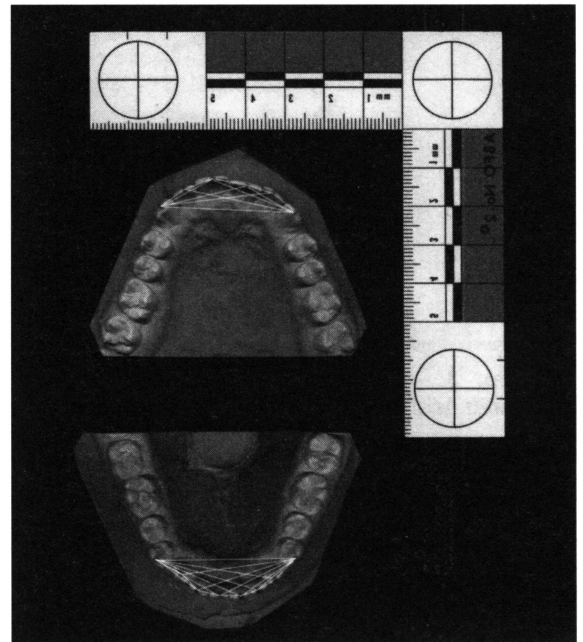


Figure: 8 – Spatial polygon on scanned cast image for upper and lower dentition

Conclusion

As the field of forensic odontology is expanding, the need for trained personnel in handling and reporting evident is increasing. The aid of current technologies should be made available from the beginning to nurture interest in the young ones for dental education.

Acknowledgements

The author declares that there is no conflict of interests exist in this article and would like to thank Dr. Ademir Franco of The Pontificia Universidade Católica do Paraná, Curitiba, Brazil for his assistance in preparing the photographs.

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