



# **Reduction of Metal Artifacts Produced by Dental Implants in CBCT Images**

Thesis submitted to Oral Medicine, Periodontology, Oral Diagnosis and Radiology Department in partial fulfillment of the requirements for the Doctorate Degree in Oral Radiology

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2016

## *Acknowledgement*

*I would like to thank **Dr. Mary Medhat Farid**, Professor of Oral Radiology, Faculty of Dentistry, Ain Shams University, for her valuable consultation, expertise, and patience throughout the course of this work.*

*Also, I would like to thank **Dr. Walaa Mohamed Hamed**, Lecturer of Oral Radiology, Faculty of Dentistry, Ain Shams University, for her revision of this manuscript and her support.*

*I would like to show my gratitude to my esteemed colleagues **Dr. Mostafa Saad ElDin Mostafa**, Lecturer of Oral Radiology, Faculty of Dentistry, Ain Shams University.*

*I would like to extend my sincere thanks to **Dr. Mahmoud el Fahdawy**, for the statistical analysis part of the study.*

*I would also like to thank **Dr. Manar Mohsen**, MSc. Pedodontics, Ain Shams University.*

*Last but not least, I would like to thank my colleagues at Oral Radiology Department, Ain Shams University; Raghdaa Abu el Kheir, Fatma Mostafa for their continuous support*

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## List of Abbreviations

2-D	: Two-dimensional
3-D	: Three-dimensional
AAOMR	: American Association of Oral and Maxillofacial Radiology
ALARA	: As Low As Reasonably Achievable
a-Se	: Amorphous selenium
a-Si	: Amorphous silicon
aSi:H	: Hydrogenated amorphous silicon
CBCT	: Cone-beam computed tomography
CCD	: Charged-couple device
CNR	: Contrast-to-noise ratio
CsI	: Cesium iodide
CT	: Computed tomography
DECT	: Dual-energy computed tomography
DQE	: Detector quantum efficiency
DVR	: Direct Volume Rendering
FBP	: Filtered back projection
FDK	: Feldkamp
FOV	: Field of view
FPD	: Flat Panel Detectors
HU	: Hounsfield unit
IIT/CCD	: Image intensifier system tube/charge-coupled device
IVR	: Indirect Volume Rendering
KVp	: Kilo voltage peak
lp/cm	: Line pairs per centimeter
MAR	: Metal artifact reduction
MARli	: Linear interpolation metal artefact reduction

MARSS	:	Metal artifact reduction by sequential substitution
MDCT	:	Multidetector computed tomography
MPR	:	Multiplanar reformation
MSCT	:	Multislice computed tomography
MTF	:	Modulation transfer function
NMAR	:	Normalized metal artefact reduction
SNR	:	Signal-to-noise ratio
SSCT	:	Single slice computed tomography
TFT	:	Thin-film transistor
WFBP	:	weighted filtered back-projection

## المخلص العربي:

الأشعة المقطعية المخروطية توفر صور واضحة ثلاثية الابعاد وتستخدم بصورة واسعة في تشخيص الراس والرقبة.

الغرض من هذه الدراسة لتقييم الحد من التحف المعدنية التي تنتجها زراعة الأسنان في الصور الأشعة المقطعية المخروطية باستخدام الحقول الصغيرة والمتوسطة للعرض وذروات فولتية مختلفة مع وبدون تخفيض الحرفية الخوارزمية مع الهدف النهائي المتمثل في إيجاد ان كانت قيمة مستوى الرمادي وجودة الصور هي أكثر عرضة للتغيير إحصائيا مع هذه المتغيرات.

تم حفر ثلاثة ثقب زرع في مواقع الزرع المقترحة؛ في الناب والضاحك ومناطق الرحي من الفك السفلي عديم الاسنان. كمجموعة ضابطة فحص الفك السفلي دون وضع الزرعة باستخدام مجال العرض صغير (4\*5) والمتوسطة (5\*8). تم إجراء التصوير لكل مجال عرض في 70 و 80 و 90 كيلو فولت. تم وضع الزرعات في المواقع المحفورة وتم فحص الفك السفلي مرة أخرى باستخدام المقاييس السابقة. تم تقييم الصور باستخدام برنامج ميمك 10.01 لحساب متوسط مستوى اللون الرمادي المحيط بالزرعات للتقييم الكمي في حين شارك التقييم النوعي كتقييم شخصي للمنطقة المحيطة بالزرعات.

وقد أجريت الدراسة على بيانات من مسح الأشعة المقطعية المخروطية للفك السفلي. تم قياس قيم مستوى الرمادي كبيانات حجمية على مقاطع محورية لقبل وما بعد وضع الزرعات (4 مسحات لكل مجموعة مع 70 و 80 و 90 ذروات فولتية) ب 4 صور بالأشعة لكل قيمة ذروة فولتية (4) بمجالين عرض بمعدل صورتين لكل مجال مع وبدون استخدام اختزال الأخطاء المعدنية بمعدل 12 صورة بالأشعة لكل مجموعة). وقد تم تحليل العلاقات المتبادلة والارتباط بين هذه البيانات.

أظهرت مجموعة 70 ذروة الفولتية قيمة مستوى الرمادية أكبر بكثير من كل من ذروتي الفولتية 80 و 90. كما ظهر الفرق ضئيل في قيم مستوى الرمادي بين مجموعتي 80 و 90 ذروتي الفولتية. أظهرت منطقة الرحي قيمة مستوى الرمادي أصغر بكثير من كل من منطقتي الضاحك والناب. أظهر الضاحك والناب اختلافات ضئيلة في قيم مستوى الرمادي. أظهرت مجموعة ما بعد الزرعات قيمة مستوى الرمادية أكبر بكثير من مجموعة ما قبل

الزروعات. أظهرت 5\*8 مجموعة مجال العرض قيمة مستوى الرمادية أكبر بكثير من 5\*4 مجموعة مجال العرض. أظهرت مجموعات مع أو بدون اختزال الاثرية المعدنية فروقا معنوية في قيم مستوى الرمادي.

وفيما يتعلق تحليل الأثرية المعدنية المتتالية في مجال العرض الاكليبي كانت العلاقات بين القطع الأثرية المتتالية والمناطق المختلفة ومجموعات اختزال الاثرية المعدنية اظهرت وجود فروق ذات دلالة إحصائية بين المجموعات.

وفيما يتعلق بتحليل الأثرية المعدنية المتتالية في مجال العرض السهمي كانت العلاقات بين القطع الأثرية المتتالية والمناطق المختلفة وتطبيق اختزال الاثرية المعدنية كبيرة. لا توجد فروق ذات دلالة إحصائية للمقارنات المتبقية بين المجموعات. كانت هناك دلالة إحصائية جيدة جدا للمصادقية لقرارات الباحث وبين الباحث الابتدائي وباحث مستقل.

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## Introduction

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Cone-beam computed tomography (CBCT) was developed and introduced specifically for dento-maxillofacial imaging. CBCT is now the modality of choice in oral implantology.<sup>1</sup> Nevertheless, when CBCT is used in regions containing dense objects as metallic implants, X-ray radiation is drastically attenuated because of the effect of these metallic implants. Artefacts are inevitable. Often, resulting in data distortion of the corresponding projection and artefacts in reconstructed images. An artefact is any distortion or error in image that is unrelated to the object being examined.<sup>2</sup> These artefacts induced by metal implants are all referred to as metal artefacts, as they are only one of several types of artefacts found in all types of computed tomography (CT) imaging.<sup>3</sup>

Distortion, especially in close proximity to the implants, will inevitably override the diagnostic value of an image.<sup>2</sup> Without doubt, this in turn would affect the accuracy of the clinicians' interpretation of the entire image volume as well as their judgment on dental illness or treatment outcome.<sup>3</sup>

Therefore, in order for CBCT examination to be clinically accepted in the follow-up of implants in the dento-maxillofacial region, diagnostic value of images obtained is encouraged. For that reason, it is essential to investigate various technical parameters which affect the inevitable appearance of artefacts. Studying the combined effect of such factors will contribute to knowing typical regions of artefacts, their shape and intensity which would ultimately help in planning and interpretation of CBCT examinations.<sup>2</sup>