Evaluation Of Bone Quality In Dental Socket Using Two Different Approaches For Ridge Preservation Using A Novel Micro CT

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Abstract

The current study is focused on comparing the healing and bone quality after using two different approaches to ridge preservation in the mandibular arch. The study also highlights the recent development of rapid technique to compare bone quality in regenerated human bone using resorbable bioscaffolds and those obtained from using HA/TCP or xenograft and allograft sources in dental alveolar sockets. Conventional methods use analysis of healing using a OPG which gives very little information on the bone quality. Despite developments such as Dental CT, which pose concerns on radiation exposure of patient it is very difficult to assess the bone quality and most of the implant procedures are done based on assessment of the surgeon. Implant stability is largely dependent on the bone quality and currently most common method of assessment is using histopathological assessment. Conventional histology studies can take up to a few weeks and the results are often operator dependant. Moreover, the results are only available as individual 2D slices and so many slices are required from the bone sample before making a decision on the quality of bone. In the current work, we have used a novel Micro CT with histology resolution and superior contrast as a rapid means to evaluate bone quality in 2D and 3D between bone samples extracted from patients who used a synthetic resorbable bioscaffold against conventional grafting materials.

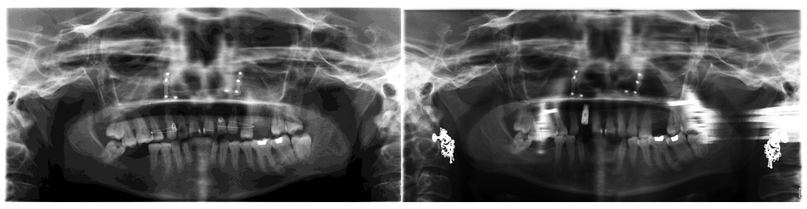
Introduction

After tooth extraction, the extraction socket heals by forming a blood clot which leads to the formation of new bone within 3-4 months. Although bone deposition in the socket will continue for several months, it will not reach the crestal level of the neighbouring teeth. The resulting alveolar bone loss may lead to problems such as poor aesthetic appearance and difficulty in placement of implants or prostheses for partially or totally toothless patients. Various techniques have been proposed to limit alveolar bone loss such as atraumatic extraction, immediate post-extraction removable prosthesis, immediate placement of dental implant and immediate bone-filling of extraction socket. Guided bone regeneration (GBR) and guided tissue regeneration (GTR) has been gaining attention in recent years for repair of bone defects and had been used in patients after tooth extraction with the aim of preserving alveolar bone. In the current work, two different methods of ridge preservation techniques is compared for the healing and quality of bone regenerated after grafting**.**

Methods

In the current study, patients who were having multiple extractions in the same jaw were selected and after the tooth extraction, the adjacent sockets were treated with two different solutions. One of the socket was grafted with commercially available xenograft and covered with a membrane while Bioscaff™ Alvelac™ (a synthetic scaffold made of polylactic-co-glycolic acid) was placed and was closed with a simple interrupted suture.

The OPG of the patient was taken immediately after the procedure and was subsequently followed up after 3 months. Figure 1 and 2 shows a typical OPG taken on the patient immediately after placement of scaffold/grafting the socket size and after 3 months.



a) b)

Fig. 1a & b 1st and 3rd month OPG of 31/41 (Xenograft/ Bio-scaffold)

The above picture shows a typical healing of the anterior socket with Xenograft and Bioscaffold respectively. The conventional xenograft was placed in the extraction socket 31 and Bioscaffold was placed in socket 41. The xenograft was radio opaque to certain extent and the granules occupy the space to a certain extent. So clear indication of healing could not be obtained from the OPG. In order to get a better picture of healing a bone sample was extracted from both the sockets and were examined using a novel micro CT Technique which gives a 3 dimensional picture of the bone.

For ultrastructural evaluation of Osteocytes lacunae and its canal network using the Micro CT, a piece of cortical bone about 500 microns in diameter was prepared .–The sample was scanned with the Micro CT and the results are shown below

Results & Discussion

Bone Quality Evaluation: Xenograft vs Bioscaffold

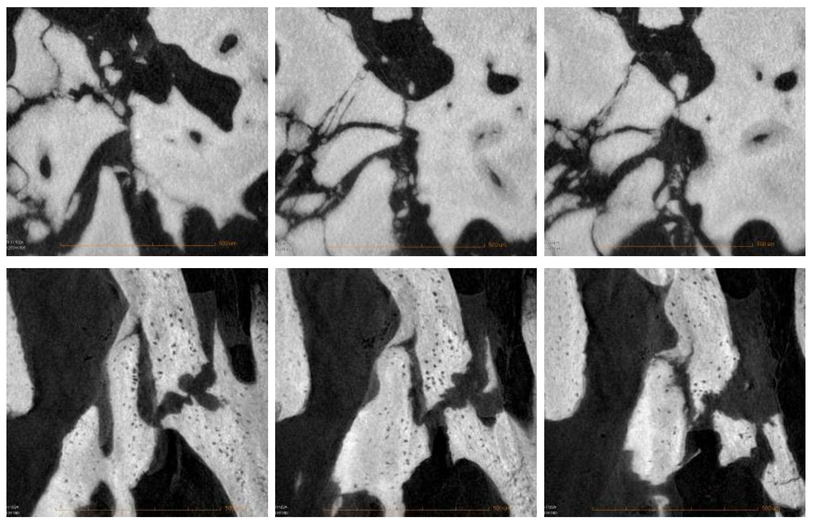


Fig. 2 Images on the top rows are CT slices of bone sample retrieved from socket grafted with Xenograft showing a lack of new bone growth while images in the bottom row shows new bone regeneration through evidence of osteocytes, which the lighter regions shows compacted mineralized bones in the sample extracted from the socket preserved using Bioscaffold

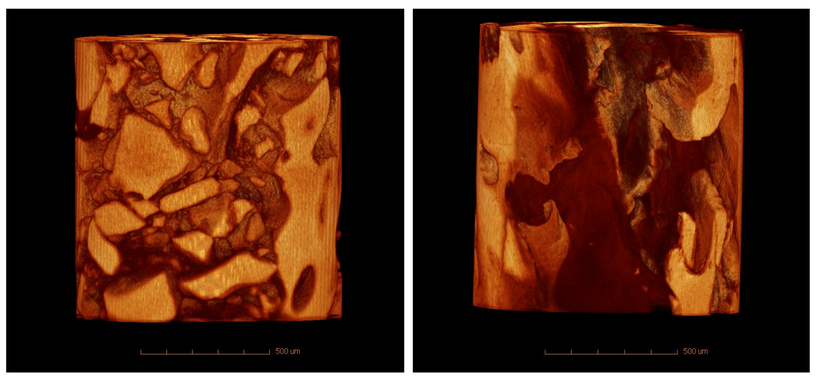


Fig. 3 3D render image comparing Xenograft (left) and Bioscaffold (right). There is greater presence of soft tissues in the bone sample grafted with bioscaffold

It can be clearly seen that the Micro CT is able to clearly distinguish between the bone extracted from the two different sockets. The socket with the bioscaffold had natural bone with the osteocytes while the bone sample from the socket which had Xenograft shows lack of osteocytes. In addition sample grafted with bioscaffold shows greater presence of soft tissues. The correlation between the conventional histology and novel Micro CT was demonstrated in the earlier paper by the authors on comparison of histology of bone extracted and the correcponding Micro CT. The picture below provides a typical example of correlation between histology and Micro CT

Human Bone Quality Evaluation: Micro CT vs Histology

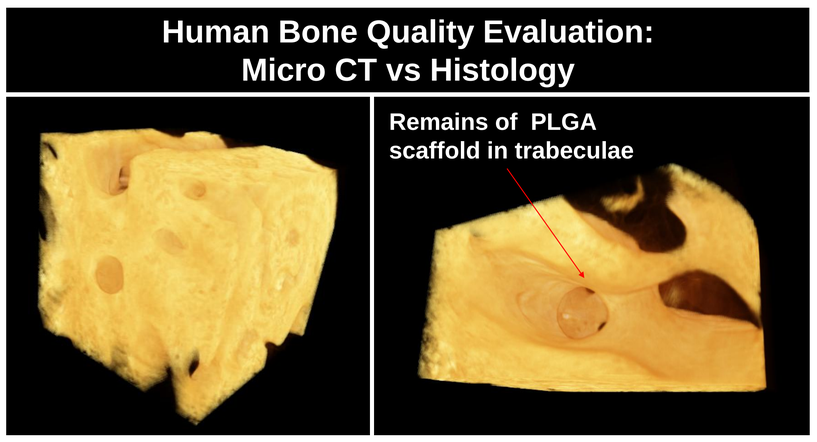


Fig. 4 Micro CT 3D image of Bioscaffold regenerated bone sample @ 1 μm resolution

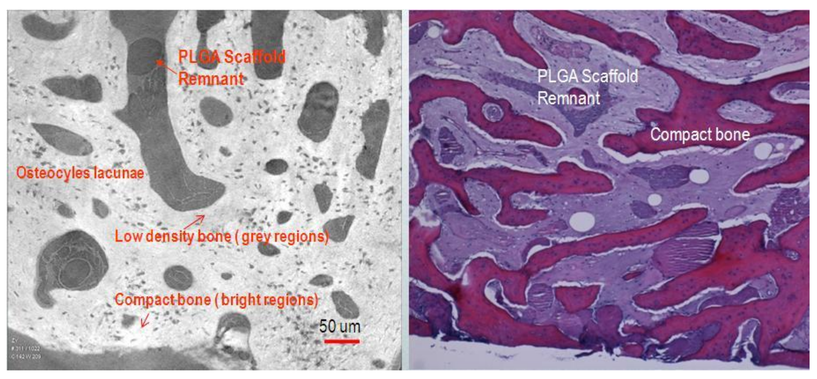


Fig. 5 Micro CT slice of bone sample @ 1 μm resolution, compared with conventional histology

It can be seen from the above pictures that Micro CT is able to clearly identify the osteocytes and the compact bone and even to the extent of remnants of PLGA scaffold with similar resolution if not better than the conventional histopathology. In addition to it, the Micro CT is able to distinguish between the type of bone and stages of healing when different grafting materials were used. In addition to this, the power of 3 D Micro CT is its ability to render 3 D image with clear indication of bone density distribution and soft tissue presence across the three dimension which is not possible wit conventional histology.

OPG of Posterior tooth socket treated with Xenograft/ Bio-scaffold

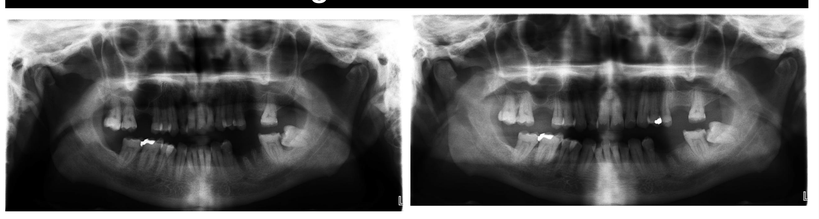


Fig. 6a & b 1st and 3rd month OPG of socket 35/36 (Bio-scaffold/Xenograft)

The OPG shows the distinguished healing difference between xenograft used 36 and bio-scaffold used 35 in a posterior lower jaw segment. The 7 day post extraction OPG shows does not show a significant difference between these two sockets but 3 month follow up OPG clearly shows a good radio opacity at the root socket site of 36 where the root socket site of 35 still shows radiolucency proving the healing and bone growth difference between the two site after 3 month. This radiographic comparison re enforce the ability of synthetic bio-scaffold to allow a more natural healing than xenografts. In order to verify the observation, image analysis was done to check the average grey value distribution and the standard deviation. Figure 7 shows the typical grey value for the sockets after 7 days and Figure 8 shows the grey value distribution after 3 months

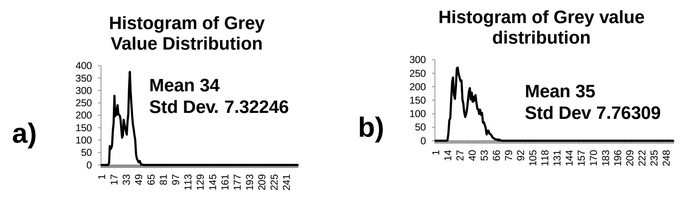


Fig. 7a & b Area histogram analysis of socket 35 & 36 after 7 days

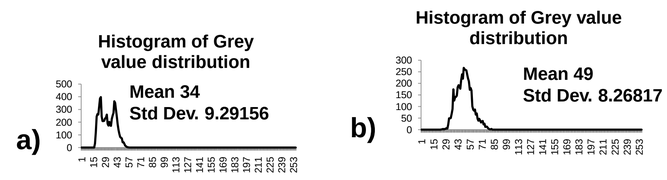


Fig. 8a & b Area histogram analysis of socket 35 & 36 after 3 months

From the above histograms we can clearly see that the mean value is more or less same initially but there is significant difference after 3 months. However, the standard deviation increases for the grey values for socket 35 compared to socket 36 which does not show significant difference in standard deviation compared to initial value. Moreover, the socket 36 has a normal distribution of grey values while the socket 35 has initially positive skew in distribution but the 3rd month OPG grey shows a negative skew and increase in width of the histogram. The standard deviation of distribution also increases which possibly indicates new bone at site.

Conclusion

From the above figures and discussion, it is evident that the synthetic Bio-scaffold is able to better assist the natural healing process and provides a better bone quality while preserving the ridge after extractions in the anterior segment. The posterior segment indicates new bone growth but needs further analysis to yield conclusive evidence. Micro CT provides a good insight in to the bone healing and the bone quality in 3 dimension compared to conventional histopathology.

References

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