# Comparative Study of Osteoblastic Activity of Same Implants (Endopore) in the Immediate Extraction Site Utilizing Single Photon Emission Computerized Tomography: Peri-implant Autogeneous Bone Grafting with GTR *versus* No Peri-implant Bone Grafting – Experimental Study in Pig Model

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***ABSTRACT***

*The study was designed to exploit the single photon emission computerized tomography (SPECT) to compare osteoblastic activity of two implant systems: an Endopore® implant (Beaded implants) placed immediately into an extraction socket in conjunction with peri-implant autogenous grafting supplemented with a guided tissue regeneration (GTR) technique, and an Endopore® implant placed immediately into the extraction socket without peri-implant grafting and GTR. Endopore® implants of the same size (12 mm x 4.1 mm INT-Hex) were placed in fresh extraction sockets in the canine-tooth region of the pigs jaw. The implant on the right side had peri-implant bone grafting utilizing autogenous bone together with cytoplast resorbable GTR membrane, whilst the implant on the left side received no peri-implant bone grafting.*

*Osteoblastic activity was evaluated 81 days (11 weeks and 4 days) post implantation using the SPECT imaging technique. The SPECT imaging revealed more osteoblastic activity on the side with peri-implant bone grafting as compared with the site without peri-implant bone grafting. The result suggests that peri-implant bone grafting with GTR around the immediate implant showed more osteoblastic activity and thus enhanced osseointegration when compared with the implant without bone grafting and GTR. Bone grafting and GTR should be encouraged as a standard procedure with dental implants.*

**Keywords:** Guided tissue regeneration, immediate implant, peri-implant grafting

# Estudio Comparativo de Actividad Osteoblástica de los Mismos Implantes (Endopore) en el Sitio Inmediato de Extracción Utilizando Tomografía Computarizada por Emisión de Fotones Individuales: Injerto de Hueso Autógeno Peri-Implantario con RTG Frente al Injerto de Hueso no Peri-implantario – Estudio Experimental en un Modelo de Cerdo

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***RESUMEN***

*El estudio fue diseñado para aprovechar la tomografía computarizada por emisión de fotones individuales (SPECT) con el propósito de comparar la actividad osteoblástica de dos sistemas de implante: un implante Endopore® (implantes con cuentas) colocado inmediatamente en una cavidad de*

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*extracción en conjunción con el injerto óseo autógeno peri-implantario complementado con una técnica de regeneración tisular guiada (RTG), y un implante Endopore® colocado inmediatamente en la cavidad de extracción sin injerto peri-implantario y RTG. Implantes Endopore® del mismo tamaño (12 mm x 4.1 INT-Hex) fueron colocados en cavidades de extracción frescas en la región del canino de la mandíbula de los cerdos. El implante del lado derecho tuvo un injerto óseo peri-implantario utilizando hueso autógeno junto con una membrana (RTG) reabsorbible Cytoplast, en tanto que el implante del lado izquierdo no recibió injerto óseo peri-implantario.*

*La actividad osteoblástica se evaluó 81 días (11 semanas y 4 días) tras la implantación usando la técnica de procesamiento de imágenes por SPECT. Esta técnica reveló más actividad osteoblástica en el lado del injerto óseo peri-implantario, en comparación con el sitio sin injerto óseo peri-implantario. El resultado sugiere que el injerto óseo peri-implantario con RTG alrededor del implante inmediato tiene más actividad osteoblástica, y por ende mayor oseointegración, si se le compara con el implante sin injerto óseo y RTG. Tanto el injerto óseo como la RTG deben estimularse como procedimientos estándar de los implantes dentales.*

**Palabras claves:** Implante inmediato, injerto peri-implantario, regeneración tisular guiada

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## INTRODUCTION

Todescan *et al* (1) used histological/histomorphometric methods to investigate the effect of graft materials on healing of endosseous, porous-surfaces implants placed in a fresh extraction socket in a small animal model. Immediate implantation faces severe challenges which need to be understood if they are to be dealt with when encountered (2). Such corrective action appears to be possible with surface engineered implants (2); however, the placement and augmentation of dental implants in a tooth extraction socket has broader indication than was first considered. Guided Tissue Regeneration (GTR) is a principle for the accomplishment of bone regeneration and it is based on the hypothesis that different cellular components in the tissue have varying rates of migration into a wound area during healing (3). A membrane can serve as a mechanical hindrance or 'filter', which serves to prevent fibroblasts and other soft connective-tissue cells from entering the bone defects and apparently allow slower-migrating cells with osteogenic potentials to repopulate the defect. The undesirable fibroblasts and soft connective tissues seem to inhibit or delay the osseointegration of the implant. Histologic analyses generally indicate that complete bone healing is always seen in defects augmented with GTR as compared to defects without GTR (3). In this study, we present the result of the use of single photon emission computerized tomography (SPECT) to demonstrate osteoblastic activity and osseointegration superiority in areas where immediate implant placement is augmented with bone grafting, and guided tissue regeneration (BG/GTR).

## SUBJECTS AND METHODS

A 6-month old female pig weighing 23 kg was chosen for the study. The pig was pre-anaesthetised with Azaperone (Stresnil) and Butophanol at the dose rates of 6 mg/kg and 0.2 mg/kg respectively, induced with 5% thiopentone at 10 mg/kg, intubated and maintained with isofluorane in oxygen. An Omicron Plus Multiparameter monitor was used to evaluate the vital parameters, including ECG, heart rate, pulse rate, invasive arterial blood pressure, respiratory rate, $Sp0_2$ and end tidal $CO_2$.

Endopore® implants of the same size (12 mm x 4.1 mm INT-Hex) were placed in the fresh extraction socket in the canine region of a pig's jaw. The implant on the right side had peri-implant bone grafting utilizing autogeneous bone together with cytoplast resorbable GTR membrane, whilst the implant on the left side of the jaw received no peri-implant bone grafting/GTR. The autogenous bone was obtained from a distal and remote area of the mandible relative to the implant site. A disposable bone glider was utilized for harvesting of the autogenous bone.

At 81 days (11 weeks and 4 days) post implantation, the pig was anaesthetized and given an intravenous injection (into the ear vein) of 740 $MB_q$ (20 mci) technetium 99 m methylene diphosphate. The pig was subsequently euthanized two and half hours after the injection and then the mandible was removed. Tomographic images of the mandible in the region of interest (ROI) were acquired within 30 minutes of removal, using a Semens Orbiter II rotating large field-of-view gamma camera equipped with a low energy high resolution collimater (Siemens Medical System Inc, Erlangan, Germany). A total of 64 projection images (205/ images) were acquired over 180 degrees in a 128 by 128 matrix with a dedicated nuclear medicine computer (Siemens ICON computer).

The projection data were corrected for flood field non-uniformity and centre of rotation. Transverse reconstruction was then performed with a Shepp-Loga Hanning Filter cut-off frequency of 0.4. By utilizing the transverse slices, the activity in the jaw at the site of immediate implant with BG/GTR and that of immediate implant without BG/GTR was observed and calculated and compared with a reference point within the jaw on each side. The average count (pixel)

for each area of interest (BG/GTR and non BG/GTR) was calculated and compared.

## RESULT

The SPECT images demonstrated increased osteoblastic activities on both sides of the jaw in the area of interest (AOI) as shown in Fig. 1. The osteoblastic activity in the side

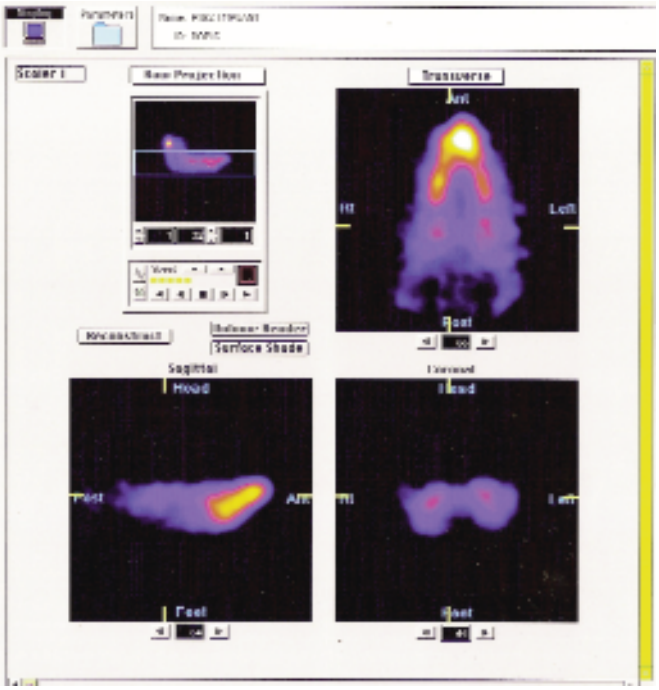

Fig. 1: The comparative osteoblastic activity displayed by the side (right side) with bone grafting and GTR relative to the side (left side) with no bone grafting.

which had immediate implant in conjunction with BG/GTR was more than the side in which no BG/GTR was done when immediate implant was placed (Fig. 2); the average count

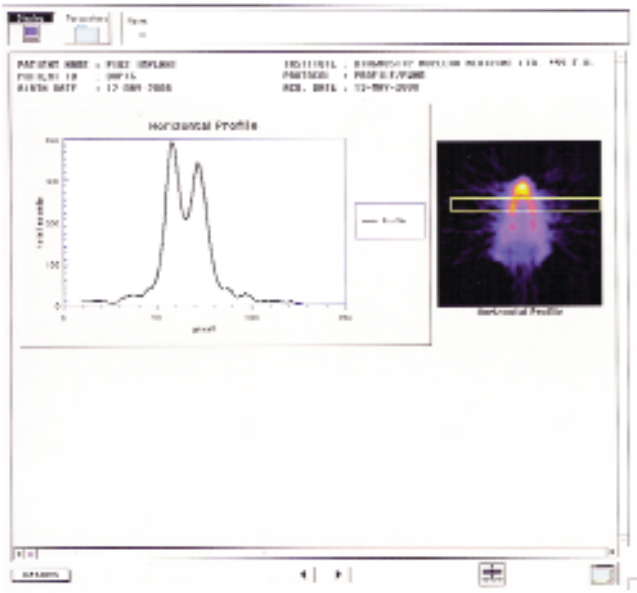

Fig. 2: The comparative osteoblastic activity curve/ratio between the two sides.

being 30.1 pixel and 27.6 pixels respectively (Fig 3) and a calculated relative activity ratio of 1:1.1.

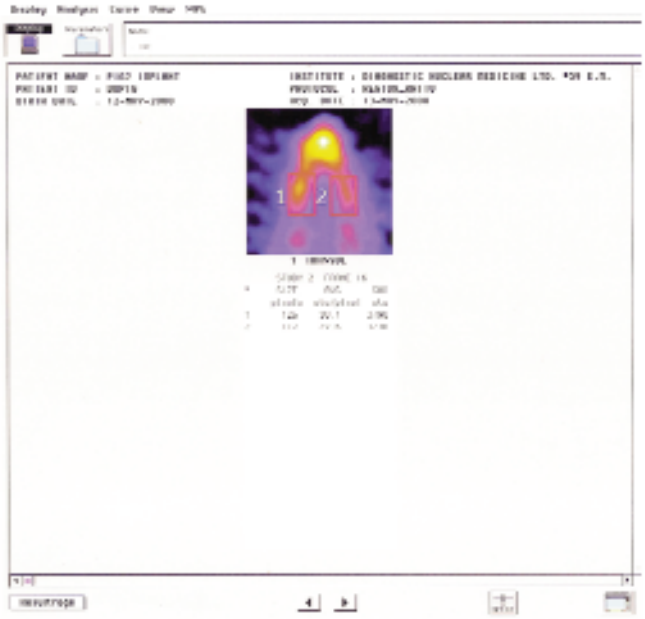

Fig. 3: The comparative osteoblastic activity average count between the two sides.

## DISCUSSION

Various challenges are seen confronting immediate tooth replacement with or without immediate loading (2). The first challenge is to be able to achieve sufficient bone-to-implant contact which is a pre-requisite for osseointegration (2). The second challenge is to be able to achieve peri-implant mucosal integration (2). Thirdly, an aesthetically pleasing outcome must be achieved with regards to the bone healing and peri-implant mucosal healing (2). All these challenges can be removed with proper technique of bone grafting with GTR when immediate implant is considered in the oral cavity. It is necessary to validate that GTR practice would enhance osteoblastic activity and osseointegration so that such practice of BG/GTR would be made a standard practice for immediate dental implantation.

Also resorption of cortical bone is a consequence of surgical trauma and is an inevitable result of implant surgery (4). It has been mentioned that the placement of an endosseous implant is accompanied by localized osteolysis which leads to reduced interfacial stiffness during the initial phase of healing (2).

The question to be asked is that with immediate implant, will the practice of routine BG/GTR counteract this localized osteolysis which leads to reduced interfacial stiffness during the initial healing phase? If the answer is in the affirmative, will peri-implant BG/GTR following GTR always lead to increased osteoblastic activity and better osseointegration?

Remodelling of the alveolus occurs following tooth extraction; measurements suggest that up to 50% of the buccolingual width of the alveolus is lost following tooth extraction (2, 5). Further, Araujo *et al* (6, 7) examined this phenomenon in the dog model and concluded that resorption favouring the buccal aspect of the extraction socket was due to preferential bundle bone resorption following tooth extraction and the more pronounced effect of surface resorption on the thin buccal plate of bone (6). Furthermore, they concluded that placement of an implant at the time of tooth extraction did not alter this resorptive phenomenon (7). More questions to be asked include: will BG/GTR in immediate implants compensate for this mandatory resorptive phenomenon? Can increased osteoblastic activity on bone scintigraphy validate this compensation?

The result of this current comparative study using SPECT shows that increased osteoblastic activity was present on both sides of the jaw in the AI but with more osteoblastic activity on the side which had immediate implant placed in conjunction with BG/GTR. This can lead to a statement of fact that after 11 weeks, better bone forming activities and osseointegration will occur when BG/GTR is done in conjunction with immediate implant. This in itself will compensate for the mandatory resorptive phenomenon mentioned above. In other words, this mandatory resorptive phenomenon is compensated for or counteracted even before it becomes evident.

In this experiment, SPECT has provided an excellent model applicable for the objective appraisal of the BG/GTR used in conjunction with immediate implant and also to allow comparison with an area which had no BG/GTR done in conjunction with immediate implant. Additionally, this SPECT study has also allowed a quantitative assessment of osteoblastic index.

Our experience is not limited to utilizing SPECT for quantitative assessment of osteoblastic activity/index as the centre at the School of Dentistry, The University of the West Indies, in St Augustine, Trinidad and Tobago was the first to utilize this experimental modality to objectively and quantitatively assess the osteoblastic activity of a new bone grafting technique (8, 9).

## CONCLUSION

Bone grafting with guided tissue regeneration, done in conjunction with immediate dental implant, will give better osteoblastic activity/index, better osseointegration, and will compensate for or counteract the mandatory resorptive phenomenon following immediate implant in comparison to a situation where immediate implant was done without any BG/GTR.

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