

# Immediate Dentoalveolar Restoration Technique (IDR). Autograft characterization and a case report

➤ **W. MARTINS JUNIOR<sup>1</sup>, E. PRADO FERRAZ<sup>2</sup>, M. MATEUS BELOTI<sup>2</sup>, A. LUIZ ROSA<sup>2</sup>, J. CARLOS MARTINS DA ROSA<sup>3</sup>**

<sup>1</sup> Department of Periodontology, University of Ribeirao Preto, Ribeirão Preto, SP, Brazil

<sup>2</sup> Department of Oral and Maxillofacial Surgery and Periodontology, School of Dentistry of Ribeirao Preto, University of Sao Paulo, Ribeirao Preto, SP, Brazil

<sup>3</sup> Department of Implantology, São Leopoldo Mandic Dental Research Center, Campinas, SP, Brazil

## TO CITE THIS ARTICLE

Martins Junior W, Prado Ferraz E, Mateus Beloti M, Luiz Rosa, Carlos Martins da Rosa J. Immediate Dentoalveolar Restoration technique (IDR). Autograft characterization and a case Report. *J Osseointegr* 2017;9(3):305-9.

DOI 10.23805 /JO.2017.09.03.06

## ABSTRACT

**Case report** We present a case of implant rehabilitation using the immediate dentoalveolar restoration (IDR) technique where the bone walls are reconstructed by a bone graft harvested from the maxillary tuberosity. In addition, we performed cellular and molecular evaluations of osteoblastic cells harvested from maxillary tuberosity as: cell proliferation, alkaline phosphatase activity, extracellular matrix mineralization and gene expression of osteoblastic markers. Three maxillary tuberosities were reconstructed using microtomography and qualitative-quantitative analyses were performed. Clinical and tomographic evidences showed that IDR is a feasible technique that allows in only one session the full reconstruction of alveolar socket, placement of dental implant and provisionalization. Cell proliferation increased over time and cell displayed alkaline phosphatase (ALP) activity, extracellular mineralized matrix and gene expression of all evaluated bone markers (ALP, RUNX2, bone sialoprotein, osteopontin, osteocalcin and distal-less homeobox 5), ratifying the osteogenic potential of the tuberosity cells. Micro-CT analysis showed the maxillary tuberosity as a highly porous structure surrounded by a thin cortical that resembles a mechanical barrier. These cellular, molecular and tomographic features indicate that the maxillary tuberosity is a source of osteoblastic cells and acts as a natural scaffold, supporting the excellent functional and aesthetic results of IDR technique.

**KEYWORDS** Compromised sockets; Dental implants; Immediate dentoalveolar restoration; Maxillary tuberosity; Osteoblastic cell.

## INTRODUCTION

The final goal of implant therapy is to restore both dental aesthetics and function with a high level of predictability. The clinical success of oral implants is based on their osseointegration associated with delicate surgical technique that grants soft tissue stability around the implants and adjacent teeth but is strongly dependent of adequate bone volume (1-3). Currently, there is a tendency towards shorter healing delays and ultimately towards immediate loading protocols (4, 5). Immediate implant placement at the time of the dental extraction is usually associated to barrier membranes and demands some prerequisites: preservation of the bone margins to support the barrier membranes, primary stability of the implants and careful management of the soft tissues (6). Such procedure after the extraction of a compromised tooth is challenging due to the presence of bone defects, infection, and/or inflammation. The preservation or creation of harmonious soft tissue contours of the peri-implant mucosa and level of bone support are key factors for achieving favorable esthetic results after implant treatment in the esthetic zone (7, 8). Many clinical studies support the use of bone block grafting and other techniques for the reconstruction of the bone defects in compromised alveolar sockets during or after tooth removal involving several surgical stages (9-12). These cases could be successfully treated using the Immediate Dentoalveolar Restoration (IDR) technique, that allows to carry out dental extraction, implantation and provisionalization in the same procedure. It is a flapless bone reconstruction using cortico-cancellous bone graft harvested from the maxillary tuberosity resulting in an effective stability of soft and bone tissues with lower overall cost and treatment time (13-16). After implant placement, the graft is harvested and shaped to the defect size and inserted between the implant and the remaining soft tissue. Then, remaining bone from the graft is particulated and compacted until it completely fills the gaps between the cortico-cancellous graft and

the implant surface. The provisional restoration is made at the same time according to the correct anatomical contour of the emergence profile (13-15).

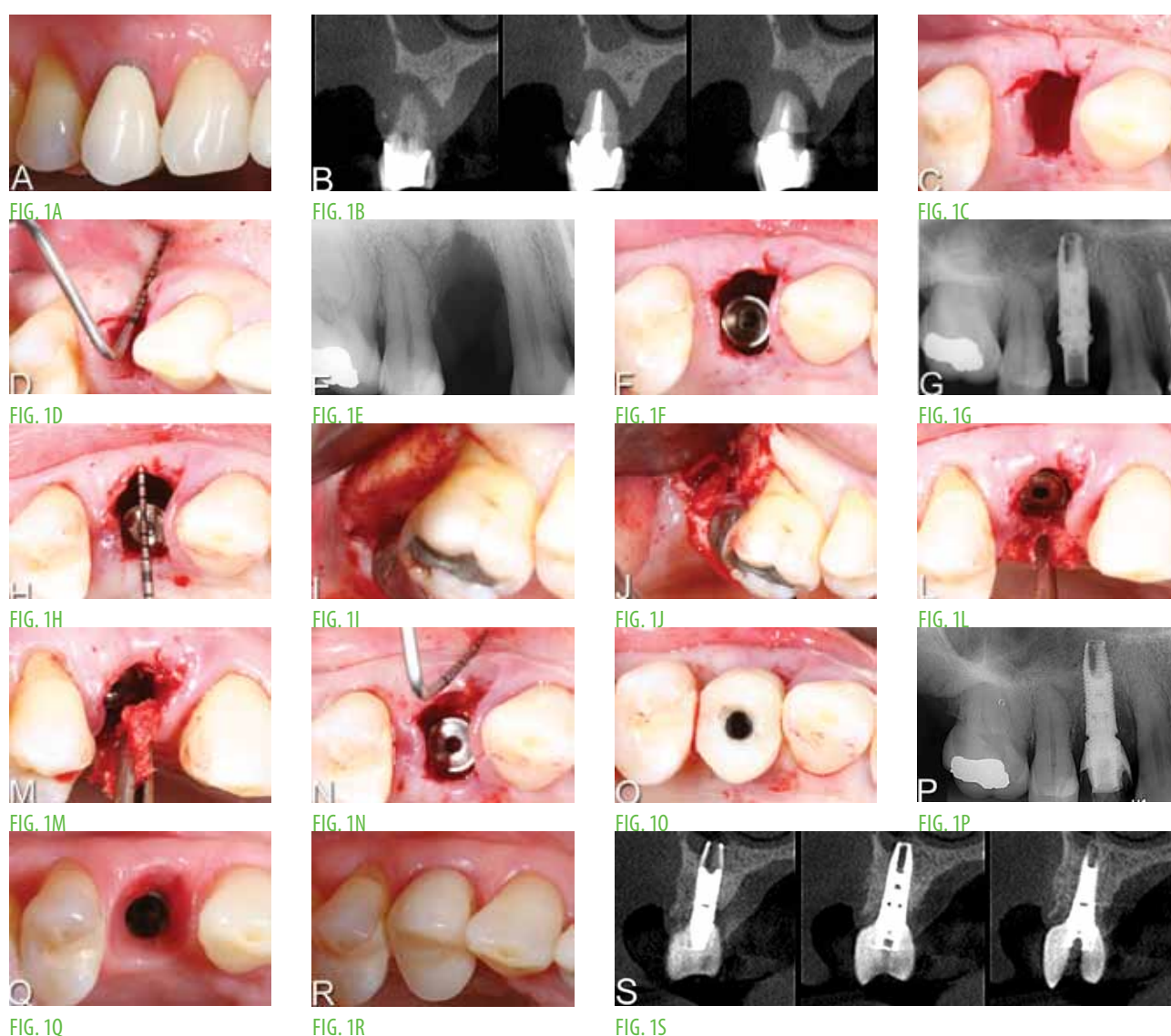
The advantages of IDR include: harvesting tuberosity is a relatively simple surgical procedure; the graft is easily shaped to fit the receptor region and acts as a biological membrane, thereby promoting effective bone and gingival healing. These could benefit of both the trabecular nature of the graft and its delivery of cells and growth factors to the receptor site. The purpose of this paper is to present a case of implant rehabilitation associated to IDR as well as tomographic and cellular evidences that support this

technique as a good alternative for reconstructing bone defects, allowing implant-supported rehabilitations.

## CASE REPORT

### Application of IDR technique

A 46-year-old female looked for an appointment complaining of spontaneous pain in the maxillary right first premolar. Intraoral examination revealed a very thin periodontal biotype with probing depth of approximately 12 mm on all sides (Fig. 1A) and mobility. Cone Beam



**FIG. 1** Clinical aspect of the compromised maxillary right first premolar (A). Computed tomography showing the amount of bone loss (B). Clinical aspect of the socket immediately after the premolar extraction (C) and the absence of the buccal cortical plate (D-E). Clinical (F) and radiographic (G) aspect of implant platform switching placed in the proper position. Gap of 3 mm from implant platform to gingival margin (H). Exposition of the donor bone graft area (I) and maxillary tuberosity harvesting (J). Cortico-cancellous bone fragments shaped to match the defect configuration and placed in position (K-M). Buccal, palatal, mesial and distal defects restored (N). Provisional crown with ideal emergence profile providing marginal sealing (O). Radiographic aspect (P) and clinical evidence of the maintenance of soft tissue (Q) after 3 months. Clinical (R) and tomographic (S) control after 3 years showing maintenance of soft tissue volume, gingival margin and papillae; buccal and palatine walls were entirely remodelled; interproximal crestal bone remodeled in the cervical, middle and apical thirds of the implant.

Computed Tomography (CT) images showed a total loss of buccal, palatine, mesial and distal bone walls (Fig. 1B). The bone height above the root apex was very small. Considering the esthetic and functional demands, the treatment plan included an atraumatic extraction of the tooth, curettage of the socket, an immediate implant placement in the correct 3-D position and a reconstruction of the alveolar bone using the IDR technique as described elsewhere (7, 13-16) using cortico-cancellous bone graft harvested from the maxillary tuberosity, in order to restore the lost socket walls. Briefly, after the tooth extraction, the implant was placed at the proper position achieving primary stability (Fig. 1C-H). The bone defects were restored with cortico-cancellous bone harvested from maxillary tuberosity and shaped to the defect maintaining the biological distance of 2-3 mm to gingival margin. The residual gap was filled with cancellous bone harvested from the same donor area, maintaining the reconstructed bone walls and the surrounding soft tissue (Fig. 1 I-N). The provisional crown was placed in a position immediately out of occlusion (Fig. 10) and the definitive restoration was accomplished after 6 months. Clinical evaluation after 3 years showed stability of the soft tissue volume regarding gingival margin and papillae (Fig. 1 Q-R) and CT images highlighted the gain in bone volume all around the implant (Fig. 1S).

### Cellular and morphological characterization of the maxillary tuberosity autograft

Maxillary tuberosity graft-like bone fragments were removed from three dry skulls and submitted to micro-computed tomography (micro-CT) for morphometric analysis using the SkyScan 1172 system (SkyScan, Belgium). The images were acquired at 60 kVp and 200 mA and reconstructed using the NRecon software (Bruker-Skyscan, Belgium) with smoothing, ring artifact

correction and beam hardening correction 20%. The micro-CT analysis was carried out using the 3D software (Bruker-Skyscan) to evaluate percentage and volume of total porosity. The reconstructed image (Fig. 2A) showed two different structures of bone corresponding respectively to a cancellous and a cortical region. As expected, the external surface looks very thin and cortical, while the internal region is essentially trabecular with a highly porous structure resembling a scaffold. The quantitative analysis of 3 graft-like fragments showed that the maxillary tuberosity presents around 70% of total porosity and 150 mm<sup>3</sup> of porous volume.

In order to evaluate some characteristics of osteoblastic cells derived from the maxillary tuberosity, graft-like fragments from maxillary tuberosity sites discharged for four patients submitted to maxillary orthognatic surgery were processed as follow. The graf-like fragments were minced and osteoblastic cells harvested by enzymatic digestion and cultured as described elsewhere (17) up to 17 days. Cultures were assayed for cell proliferation at 3, 7 and 10 days using a MTT assay (18); alkaline phosphatase (ALP) activity at 10 and 14 days using a commercial kit (Labtest Diagnostica SA, Belo Horizonte, MG, Brazil); extracellular matrix mineralization at 17 days using Alizarin red staining protocols (19) and gene expression of key osteoblastic markers alkaline phosphatase (ALP), runt-related transcription factor 2 (Runx2), bone sialoprotein (BSP), osteopontin (OPN), osteocalcin (OC) and distal-less homeobox 5 (DLX5) at 10 and 14 days, using quantitative real-time PCR (qPCR).

These cells were capable of proliferating and increasing the cell number along the culture progression (Fig. 3A). The expression of osteoblastic phenotype was confirmed by ALP activity at days 10 and 14 (Fig. 3B) and formation of mineralized extracellular matrix (Fig. 3C). Likewise, these cells exhibited increased gene expression of all

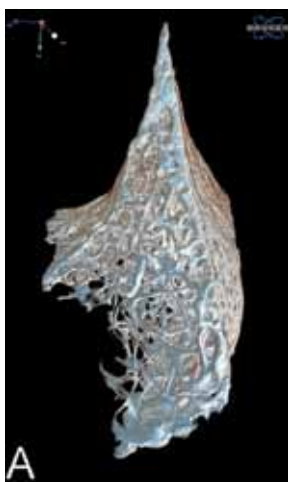


FIG. 2A

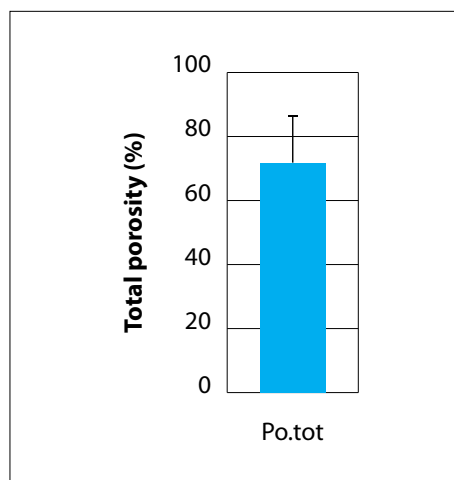


FIG. 2B

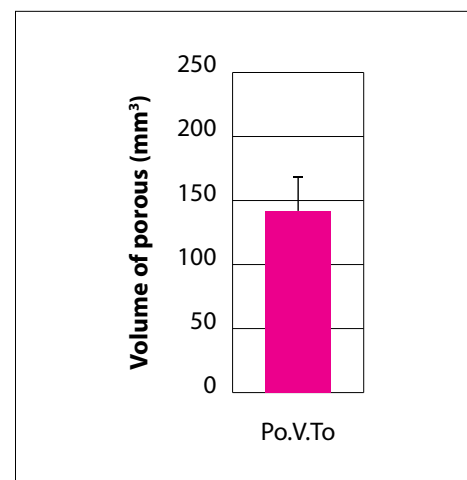


FIG. 2C

FIG. 2 Micro-CT analysis of graft-like maxillary tuberosity. 3-D reconstruction shows the internal three-dimensional structure, resembling a scaffold and the outer surface that contributes to mechanical strength of the graft (A). Morphometric parameters show the percentage of total porosity (B) and of porous volume (C).

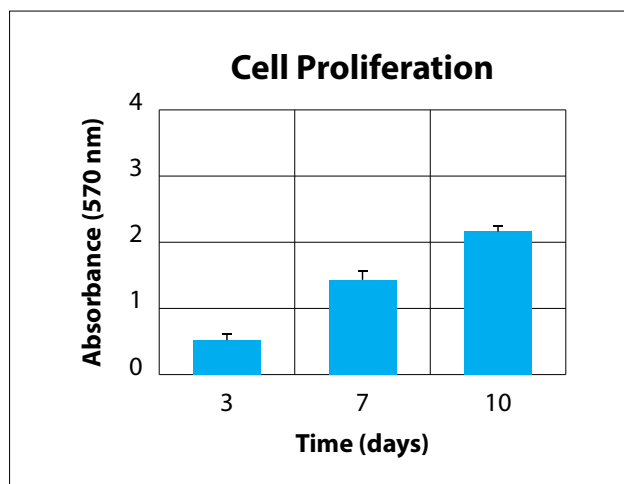


FIG. 3A

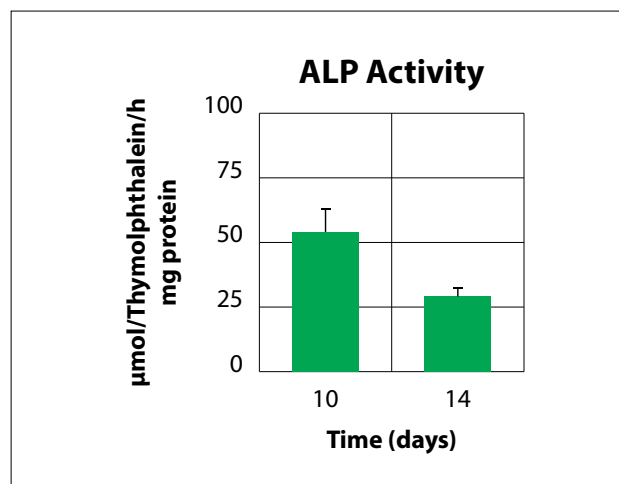


FIG. 3B

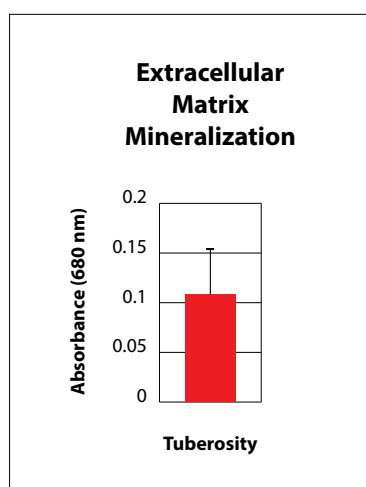


FIG. 3C

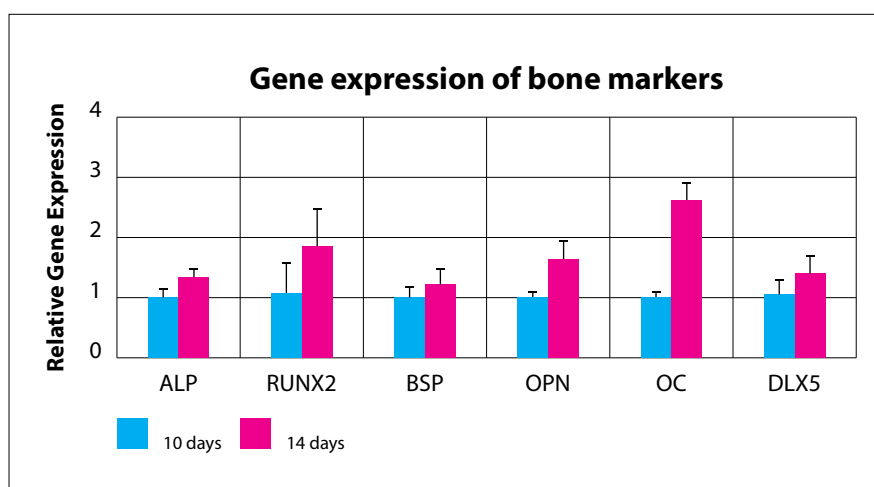


FIG. 3D

FIG. 3 Proliferation and osteoblastic characterization of cells harvested from graft-like maxillary tuberosity. Cell proliferation (A); ALP activity (B); extracellular matrix mineralization formation (C) and gene expression of bone markers (D).

evaluated bone markers from day 10 to 14, remarkably Runx2 and OC (Fig. 3D).

## DISCUSSION AND CONCLUSION

We reported here a case on the use of IDR technique for proper implant rehabilitation in fresh sockets with alveolar bone defects. In addition to the clinical and tomographic evidences of a successful rehabilitation, we also presented microtomographic and osteoblastic characterization of graft-like maxillary tuberosity fragments. All these evidences would help to explain the already reported success of the IDR based rehabilitation (15).

Surgical alternatives for bone augmentation have been described, however such techniques are less predictable, demand longer periods for rehabilitation, usually costly and associated to higher morbidity. As an alternative,

IDR technique using maxillary tuberosity graft presents significant gains in esthetic results and in treatment time, recovering of an alveolar bone defect in the same surgical implant installation and immediate provisionalization, without opening a flap and keeping intact the gingival architecture (15). As previously described, if the soft tissue and periosteum remains attached to buccal bone the blood supply would be maintained, allowing rapid graft revascularization (4, 20).

Bone density at the buccal, palatal and basal cortical maxillary tuberosity was the lowest compared to other maxillary and mandibular bones (21). Due to its thickness, maxillary tuberosity grafts are easily shaped and its cortical structure can act as a biological barrier stabilizing the soft tissue and the particulate bone graft around the implant (14).

The total porosity and porous volume indicate that the cancellous structure can act as a scaffold structure for cellular and vascular growth. In contrast with findings that



describe the maxillary tuberosities to consist mainly of marrow spaces, adipose tissue and a low vital bone profile (22), our cellular analysis showed that cells derived from tuberosity fragments displayed osteogenic features. Cells derived from maxillary tuberosity displayed osteoblast features as ALP activity, production of mineralized extracellular matrix and expression of a panel of bone markers genes. Therefore, maxillary tuberosity presents an ideal structure for bone regeneration, since it is a natural scaffold filled with osteoblastic cells and growth factors (23). Taken together, this case report, tomographic and cellular features strengthen clinical outcomes showing that the IDR technique using maxillary tuberosity when properly indicated and performed exhibits high rates of success.

## REFERENCES

- Albrektsson T, Branemark PI, Hansson HA, Lindstrom J. Osseointegrated titanium implants. Requirements for ensuring a long-lasting, direct bone-to-implant anchorage in man. *Acta Orthop Scand* 1981; 52:155-170.
- Porter JA, Von Fraunhofer JA. Success or failure of dental implants? A literature review with treatment considerations. *Gen Dent* 2005;53:423-432.
- Belser UC, Grütter L, Vailati F, Bornstein MM, Weber HP, Buser D. Outcome evaluation of early placed maxillary anterior single-tooth implants using objective esthetic criteria: a cross-sectional, retrospective study in 45 patients with a 2- to 4-year follow-up using pink and white esthetic scores. *J Periodontol* 2009;80:140-151.
- Chiapasco M, Abati S, Romeo E, Vogel G. Implant-retained mandibular overdentures with Brånemark System MKII implants: a prospective comparative study between delayed and immediate loading. *Int J Oral Maxillofac Implants* 2001;16:537-546.
- Sanz-Sánchez I, Sanz-Martín I, Figuero E, Sanz M. Clinical efficacy of immediate implant loading protocols compared to conventional loading depending on the type of the restoration: a systematic review. *Clin Oral Implants Res* 2015;26:964-982.
- Cochran DL, Morton D, Weber HP. Consensus statements and recommended clinical procedures regarding loading protocols for endosseous dental implants. *Int J Oral Maxillofac Implants* 2004;19:109-113.
- Rosa JCM, Rosa DM, Zardo CM, Rosa ACPO, Canullo L. Reconstruction of damaged fresh sockets by connective-bone sliver graft from the maxillary tuberosity, to enable immediate dentoalveolar restoration (IDR) – a clinical case. *Int Magazine Oral Implantol* 2009;10:12-17.
- Huynh-Ba G, Pjetursson BE, Sanz M, Cecchinato D, Ferrus J, Lindhe J, Lang NP. Analysis of the socket bone wall dimensions in the upper maxilla in relation to immediate implant placement. *Clin Oral Implants Res* 2010;21:37-42.
- Schneider D, Grunder U, Ender A, Hämmerle CH, Jung RE. Volume gain and stability of peri-implant tissue following bone and soft tissue augmentation: 1-year results from a prospective cohort study. *Clin Oral Implants Res* 2011;22:28-37.
- Cosyn J, Eghbali A, De Bruyn H, Collys K, Cleymaet R, De Rouck, T. Immediate single-tooth implants in the anterior maxilla: 3-year results of a case series on hard and soft tissue response and aesthetics. *J Clin Periodontol* 2011;38:746-753.
- Buser D, Chappuis V, Bornstein MM, Wittneben JG, Frei M, Belser UC. Long-term stability of contour augmentation with early implant placement following single tooth extraction in the esthetic zone a prospective, cross-sectional study in 41 patients with a 5- to 9-year follow-up. *J Periodontol* 2013;84:1517-1527.
- Pieri F, Aldini NN, Marchetti C, Corinaldesi G. Esthetic outcome and tissue stability of maxillary anterior single-tooth implants following reconstruction with mandibular block grafts: A 5-year prospective study. *Int J Oral Maxillofac Implants* 2013;28:270-280.
- Rosa JCM, Rosa DM, Zardo CM, Rosa ACPO, Adolphi D. Immediate Dentoalveolar Restoration – Immediate loading of implant in damaged fresh extraction socket with gingival architecture involvement, using bone sliver graft from maxillary tuberosity: a clinical case. *TeamWork* 2010;3:22-41
- Rosa JC, Rosa AC, Rosa DM, Zardo CM. Immediate Dentoalveolar Restoration of compromised sockets: A novel technique. *Eur J Esthet Dent* 2013;8:432-443.
- Rosa JC, Rosa AC, Francischone CE, Sotto-Maior BS. Esthetic outcomes and tissue stability of implant placement in compromised sockets following immediate dentoalveolar restoration: results of a prospective case series at 58 months follow-up. *Int J Periodontics Restorative Dent* 2014; 34:199-208.
- Rosa JCM, Rosa ACPO, Francischone CE, Cardoso MA, Alonso AC, Capelozza L. Post-traumatic treatment of the upper incisors by Immediate Dentoalveolar Restoration with long-term follow-up. *Compend Contin Educ Dent* 2015;36:46-51.
- Beloti MM, de Oliveira PT, de Carvalho PSP, Rosa AL. Seeding osteoblastic cells into a macroporous biodegradable CaP/PLGA scaffold by a centrifugal force. *J Biomater Appl* 2009;23:481-495.
- Mosmann T. Rapid colorimetric assay for cellular growth and survival: application to proliferation and cytotoxicity assays. *J Immunol Methods* 1983;16:55-63.
- Gregory CA, Gunn WG, Peister A, Prockop DJ. An Alizarin red-based assay of mineralization by adherent cells in culture: comparison with cetylpyridinium chloride extraction. *Analytical Biochem* 2004;329: 77-84.
- Mounir M, Beheiri G, El-Beialy W. Assessment of marginal bone loss using full thickness versus partial thickness flaps for alveolar ridge splitting and immediate implant placement in the anterior maxilla. *Int J Oral Maxillofac Surg* 2014; 43:1373-1380.
- Park HS, Lee YJ, Jeong SH, Kwon TG. Density of the alveolar and basal bones of the maxilla and the mandible. *Am J Orthod Dentofacial Orthop* 2008; 133:30-37.
- Gapski R, Satheesh K, Cobb CM. Histomorphometric analysis of bone density in the maxillary tuberosity of cadavers: a pilot study. *J Periodontol* 2006;77:1085-1090.
- Ciconetti A, Sacchetti B, Bartoli A, Michienzi S, Corsi A, Funari A, Robey PG, Bianco P, Riminucci M. Human maxillary tuberosity and jaw periosteum as sources of osteoprogenitor cells for tissue engineering. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2007;104:618.e1-12.