

Computer Guided Implant placement through impacted Canine and immediate provisionalization

Nazario Russo^{1,3}, Giacomo Coppola^{1,3}, Davide Montisci^{1,3}, Leonardo Palazzo², Amedeo Lenzo^{1,3}, Andrea Mascolo³, Massimiliano Ciaravolo^{1,3}

¹ Department of Biomedical and Dental Sciences, University of Cagliari, Cagliari, 09121, Italy

² Department of Surgery and Biomedical Sciences, University of Perugia, Perugia, 06123, Italy

³ European Institute for Medical Studies (EIMS) - H.E.I., Graduate School, Malta

Abstract

Introduction : The aim of this study was to evaluate an unconventional protocol regarding implants insertion through impacted canines, as to avoid invasive surgical extraction.

Materials and Methods: This study was conducted on 1 patient, selected from the waiting list for dental implants at the University of Cagliari. To avoid invasive surgical removal of the impacted tooth, a dental implant (Ø 3.75 x 12 mm, Leone s.p.a., Firenze, Italy) was placed through the impacted tooth with a computer guided protocol and then immediate loaded.

Results: The implant was clinically stable; a 4-year follow up did not show any unusual feature at the root - implant interface.

Conclusions: This study suggests that implant insertion through an impacted canine does not interfere with implant integration and may represent an alternative solution to avoid surgery extraction; more studies are needed for this procedure to be considered suitable for a possible clinical option.

Keywords: *Oral Surgical Procedures; Osseointegration; Impacted tooth; Orthodontics; Dental implant; Single tooth; Tooth root; Tooth crown; Dental prosthesis.*

1. Introduction

The aim of this study was to to evaluate an unconventional protocol implants insertion through the impacted canine when this was found on the trajectory of a planned implant. Instead of extracting the impacted canine, treat the voluminous bone defect with regeneration techniques and wait for healing, an implant was placed through the impacted canine. Impaction is defined as failure in tooth eruption, which can be the result of obstruction in the eruption path or inappropriate tooth position [1]. After mandibular third molars, permanent maxillary canine are the second most frequently impacted teeth. The incidence of their

impaction is 1-2% in general population but the frequencies vary from country to country [2]. Factors affecting the prevalence of impaction include the age range of the target sample, radiographic features of tooth development and the timing of dental eruption [3], as regards frequency, there are many studies with different data, in the Italian population a prevalence of 2.4% is indicated [4]. The etiology of canine impaction may be related to general factors, such as inheritance, endocrine deficiencies, febrile diseases, and irradiation. Regarding local factors, the causes include tooth size-arch length discrepancy, prolonged retention, premature loss of primary canines, abnormal position of the tooth germ, presence of alveolar cleft, agenesis, ankylosis, supernumerary teeth, deleterious oral habits, trauma, disruption of the root structure, iatrogenic and idiopathic causes, and ectopic path of eruption [5]. Several radiographs are available for examination of impacted teeth. Panoramic radiographs, are often the first prescribed radiographs because they can provide information about all the teeth in upper and lower jaw and the surrounding structures. The panoramic radiograph is used as the basic method in epidemic research due to its economic and practical characteristics [6,7]. There are several known treatment options for impacted canines , surgical exposure and orthodontic traction is the preferred approach in compliant, motivated patients, with good dental health, where interceptive measures are inappropriate [8]. If orthodontic treatment are not feasible because of factors such as not good position of canine, severity of impaction and age of the patient, or when the patient is not willing to encounter conventional treatment options because of treatment duration, morbidity, and costs, single implant treatment should be considered,

[9,10,11]. The replacement of a single tooth with an implant in the anterior maxilla is a topic of interest for clinicians because of its esthetic implications. The first few cases with Implant placement through impacted Canine that have been treated with this unconventional implant protocol have been reaching now a follow-up of 5 years [12-16]. Invasive surgical extraction for the impacted tooth can be avoid with an unconventional protocol implants insertion through the impacted canine and immediate provisonalization, applying an immediate protocol means shortening of the treatment duration as only one surgical intervention is needed, so morbidity and costs of the treatment are reduced [17-18].

2. Materials and method

2.1 Inclusion patient's criteria and general requirements:

- The patient had to be able to maintain a good oral hygiene.
- Implant therapy was indicated.
- The impacted tooth had to be asymptomatic and free of surrounding pathologies.
- When treatment planning was discussed with the patient, it was explained that extraction might be complex and invasive and would necessitate additional augmentation procedures before implant placement.
- The patient had to request an alternative that was less invasive and promoted earlier delivery of the implant-supported dental prosthesis.
- After the protocol and its deviation from standard care were explained, the patient had to accept the risk of implant failure. In case of implant failure, traditional treatment with an augmentation procedure was warranted at no additional cost.
- An informed consent document had to be signed.

2.2 Case Presentation

A 52-year old woman (Fig. 1) consulted the Department of Implantology of the University of Cagliari (Cagliari, Italy), for dental restoration. On the left side, horizontally impacted canine was present in sites intended to host implants (Fig. 2). Guided implant surgery using implant simulation software can contribute to a better treatment planning and a more accurate implant placement. Implant

simulation software is based on DICOM (Digital Imaging and Communication in Medicine) data obtained by cone beam computer tomography (CBCT) image and provides a pre-operative view of the anatomical structures of the patient related to a scanning template representing the future prosthetics (Fig. 3).



Fig.1 Patient 1. Pretreatment photograph. Left side with impacted canine and deciduous canine with decay.



Figs.2 Pretreatment periapical radiographs.

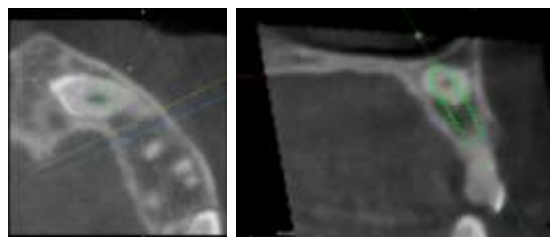


Fig.3 Guided implant surgery simulation. The CBCT image revealed an impacted right maxillary canine, situated on the palatal side. Leone virtual treatment plan : implant virtually placed in location.

Hereby, it becomes possible to virtually plan the ideal implant position according to anatomical and prosthetic information. The planned implant position should then be transferred to the patient with a high level of accuracy. This transfer can be obtained with drill guides processed by stereolithographic rapid prototyping (Fig. 4). Recently, computer-aided design and manufacturing (19-20) have made it possible to use data from computerised tomography to not only plan an implant rehabilitation, but also to transfer this information to the surgery. One of these techniques uses stereolithography, a laser-driven polymerisation process that fabricates an anatomic model and surgical templates (21-22). This novel approach not only allows the precise translation of the treatment plan directly to the surgical field, but it also offers many significant benefits over traditional procedures (Fig. 5).



Fig.4 In addition, the 3D image can be used for patient education to show and explain the patient's problem, so the image is now a patient education tool.



Fig.5 Implant placement planned on stereolithographic model.

The patient did not want to undergo orthodontic treatment, and autotransplantation was no treatment option. She asked for a fixed restoration without involvement of the adjacent teeth and chose for a single implant treatment. She was healthy and non-smoker. It was decided to extract the primary deciduous canine (Fig. 6) immediately followed by computer guided insertion of an implant according to an immediate loading protocol with immediate provisionalization in only 1 surgical stage.



Fig.6 Canine deciduous tooth extraction.

It was decided to use a computer-assisted surgical system (3Diagnostic System, Leone®, Firenze, Italia) to meet the patient's expectations. A surgical protocol was arranged: planning, study of the stereolithographic model, placement of implants, and creation of a surgical template according to 3-dimensional (3D) image data. The implant insertion was achieved with the use of 1 surgical templates: the template was necessary for the placement of the implant trough the impacted canine.



Fig.7 Surgical template fabricated from treatment plan.

Local anesthesia with mepivacain 3% and adrenaline 1:100 000 (Mepivacain, Monico S.p.a., Venezia, Italy) was administered, and disinfection with chlorhexidine (Corsodyl, Glaxosmithkline, Milano, Italy) was performed followed by the removal of the deciduous teeth. The first surgical template guide was positioned and stabilized by anchor with the residual teeth. The initial implant site was prepared followed by implant insertion.

Drilling through the crown of the impacted canine was performed with a 2.2-mm Ø squad drill (Fig. 7), followed by 2,8-mm Ø squad drills Zero1 (Fig. 8), following the traditional drilling sequence. The implant was then placed (Fig. 9). Primary stability was achieved through the apical portion which was not drilled and then the implant (Ø3,75 x 12mm, Leone®, Firenze, Italy) was placed.



Fig.8 Drilling through the crown of the impacted canine.

Fig.9 Primary stability was achieved through the apical portion which was not drilled and then the implant (Ø3,75 x 12mm, Leone®, Firenze, Italy) was placed.

Provisory pec abutment can be immediately placed on the provisional crown and then, the provisional prosthesis was placed and fixed immediately (Fig.10) therefore achieving immediate function. Eventually, the discrepancy between prosthesis and implants may be corrected through an acrylic resin (Paladur Heraeus Kulzer GmbH, Hanau, Germany) rebase procedure. The patient was included in a maintenance program to maintain optimal hard- and soft-tissue healing . The first 15-day remote control showed no clinical or radiographic

signs of any problem (Fig.11). After 4 months the definitive crown was placed (Fig.12,13).

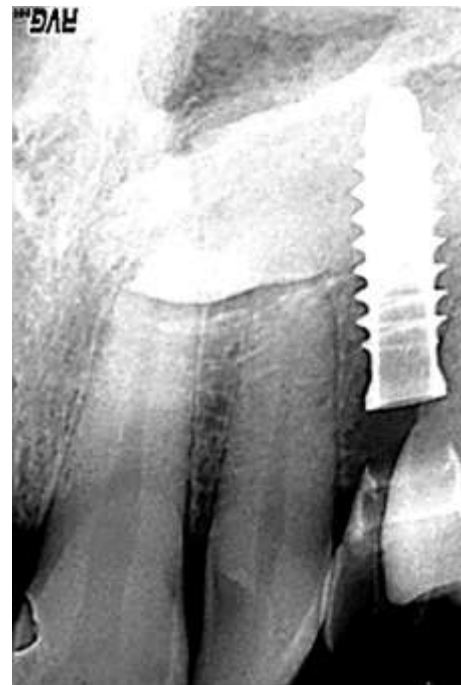


Fig.10 The provisional prosthesis was placed and fixed immediately.

Fig.11 No clinical or radiographic signs of any problem. Final periapical radiograph. The implant has been placed through the impacted canine.



Fig.12 Final ceramic restoration.

Fig.13 Final individual restorations. Stability of the gingival margin and the papillae has been maintained.

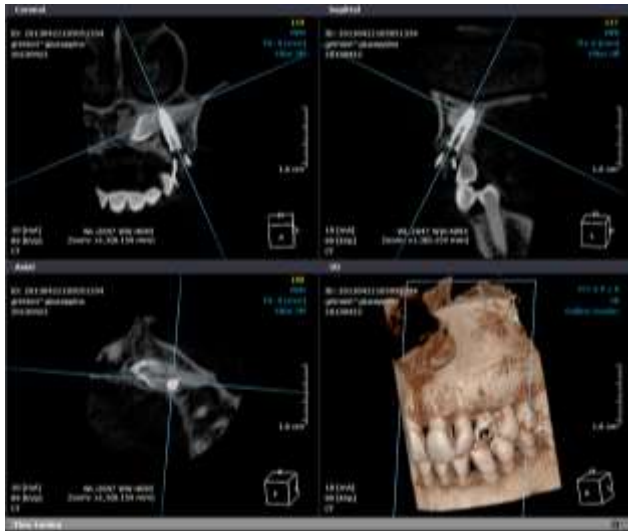


Fig.14 CBCT radiographic examination of the implants placed through the impacted tooth. The implant in canine site crossed over the root. No abnormal reaction was seen.

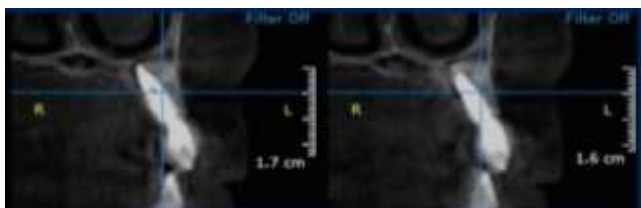
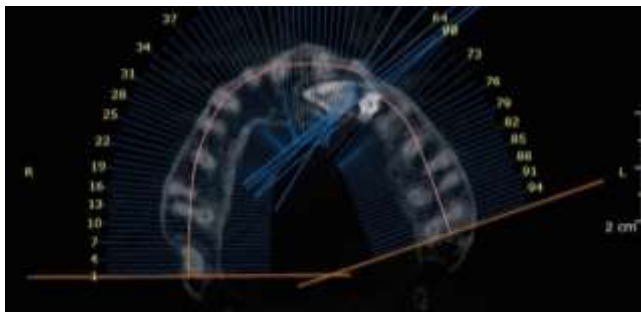


Fig.15 CBCT radiographic examination after 4-years follow-up. No abnormal reaction was seen.

3. Discussion

During the 4-years follow-up, no failure was observed, resulting in a 100% survival rate, the implant placed through the canine show a perfect radiographic feature related to the dentine-implant interface (Fig.14,15). A computer-assisted surgical system allows for correct positioning and placement of dental implants, abutments, and provisional prostheses in a single stage [23]. The computer software offers numerous advantages in the implant-prosthetic rehabilitation for totally or partially edentulous patients. These advantages include visualization of anatomic structures, evaluation of implant position and angulation for evaluating accuracy of implant insertion, and realization of prefabricated prostheses [24]. This does not preclude the need to respect all guidelines of immediate loading, thereby avoiding the risk of osseointegration failure. This technique combines the advantages of immediate-load post-extractive implants and those of flapless surgery. Furthermore, this technique presents cost-effective advantages for the patient compared with multiple-step techniques because it reduces the number of surgical and prosthetic phases [23-28].

4. Conclusion

1. Treating a patient with dental implant insertion through an impacted canine might not interfere with implant integration.
2. Unconventional dental implant insertion may represent a clinical alternative solution to avoid surgery extraction.
3. More studies are needed before this unconventional procedure might be considered as a possible clinical option when, at an impacted tooth site, clinicians seek to avoid invasive surgery.
4. Prospective studies would confirm the clinical predictability and reproducibility of this technique.

References

- [1.]Raghoobar GM, Boering G, Vissink A, Stegenga B. Eruption disturbances of permanent molars: a review. J Oral Pathol Med. 1991;20(4):159-66.
- [2.]M. Abu-Hussein, N. Watted , E. Hussien , P. Proff , A. Watted ; Maxillary Impacted Canines; Clinical Review Journal Dental and Medical Sciences Research,2017, 1, 6,10-26
- [3.]Al-Zoubi H, Alharbi AA, Ferguson DJ, Zafar MS. Frequency of impacted teeth and categorization of impacted

- canines: A retrospective radiographic study using orthopantomograms. *Eur J Dent.* 2017 Jan-Mar;11(1):117-121.
- [4.] Sacerdoti R, Baccetti T. Dentoskeletal features associated with unilateral or bilateral palatal displacement of maxillary canines. *Angle Orthod* 2004;74:725-32.
- [5.] A. Watted, O. Awadi, M. Garah, M. Watad. A review of the diagnosis and management of impacted maxillary canines. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS).* 2018, 17, 86-92.
- [6.] Gisakis IG, Palamidakis FD, Farmakis ET, Kamberos G, Kamberos S. Prevalence of impacted teeth in a Greek population. *J Invest Clin Dent.* 2011;2:102-109.
- [7.] Haney E, Gansky SA, Lee JS, Johnson E, Maki K, Miller AJ, et al. Comparative analysis of traditional radiographs and cone-beam computed tomography volumetric images in the diagnosis and treatment planning of maxillary impacted canines. *Am J Orthod Dentofacial Orthop.* 2010;137:590-597.
- [8.] Becker, A. The orthodontic treatment of impacted teeth. 2nd ed. London, UK: Martin Dunitz Publishers; 2007:19-140.
- [9.] Spiechowicz E, Piekarczyk J, Gawor E, Stendera P, Ciechowicz B, Mierzwinska- Nastalska E. Reimplantation, bone augmentation, and implantation procedures for impacted maxillary canines: a clinical report. *J Prosthet Dent.* 2004;91:223-7.
- [10.] Garcia B, Boronat A, Larrazabal C, Penarrocha M, Penarrocha M. Immediate implants after the removal of maxillary impacted canines: a clinical series of nine patients. *Int J Oral Maxillofac Implants.* 2009;24:348-52.
- [11.] Alqerban A. Radiographic predictors for maxillary canine impaction. *Am J Orthod Dentofacial Orthop.* 2015;147:345-54.
- [12.] Davarpanah M, Szmukler-Moncler S, Davarpanah K, Rajzbaum P, de Corbiere S, Capelle-Ouadah N, Demurashvili G. Unconventional transradicular implant placement to avoid invasive surgeries: toward a potential paradigm shift. *Rev Stomatol Chir Maxillofac.* 2012;113(4):335-49.
- [13.] Davarpahah M, Szmukler-Moncler S. Unconventional implant placement. 2: placement of implants through impacted teeth. Three case reports. *Int J Periodontics Restorative Dent.* 2009 Aug;29(4):405-13.
- [14.] Davarpanah M, Szmukler-Moncler S. Unconventional implant treatment: I. Implant placement in contact with ankylosed root fragments. A series of five case reports. *Clin Oral Implants Res.* 2009 Aug;20(8):851-6. doi: 10.1111/j.1600-0501.2008.01653.x.
- [15.] Davarpanah M, Szmukler-Moncler S, Davarpanah K et al. [Unconventional transradicular implant placement to avoid invasive surgeries: toward a potential paradigm shift]. *Rev Stomatol Chir Maxillofac.* 2012 Sep;113(4):335-49. doi: 10.1016/j.stomax.2012.05.012
- [16.] Szmukler-Moncler S, Davarpanah M. Reliability of the rootimplant interface in unconventionally placed implants: an up to 6-year follow-up of 23 implants covering 3 distinct clinical applications. *Clin Oral Implants Res* 2009;20:814 (abstract).
- [17.] Slagter KW, den Hartog L, Bakker NA, Vissink A, Meijer HJ, Raghoebar GM. Immediate placement of dental implants in the esthetic zone: a systematic review and pooled analysis. *J Periodontol.* 2014;85:e241-50.
- [18.] den Hartog L, Slater JJ, Vissink A, Meijer HJ, Raghoebar GM. Treatment outcome of immediate, early and conventional single-tooth implants in the aesthetic zone: a systematic review to survival, bone level, soft-tissue, aesthetics and patient satisfaction. *J Clin Periodontol.* 2008;35:1073-86.
- [19.] D'souza KM, Aras MA. Applications of computer-aided design/computer-assisted manufacturing technology in dental implant planning. *J Dent Implant.* 2012;2:37-41.
- [20.] Sohmura T, Kusumoto N, Otani T, Yamada S, Wakabayashi K, Yatani H. CAD/CAM fabrication and clinical application of surgical template and bone model in oral implant surgery. *Clin Oral Implants Res.* 2009;20:87-93.
- [21.] Valente, Sbrenna AF, Buoni BA, C C. CAD CAM Drilling Guides for Transferring CT-based Digital Planning to Flapless Placement of Oral Implants in Complex Cases. *International Journal of Computer Assisted Radiology and Surgery.* 2006;1:413-14.
- [22.] Rosenfeld AL, Mandelaris GA, Tardieu PB. Prosthetically directed implant placement using computer software to ensure precise placement and predictable prosthetic out-comes. Part 2: rapid-prototype medical modeling and stereolithographic drilling guides requiring bone exposure. *Int J Periodontics Restorative Dent.* 2006;26:347-53. [PubMed]
- [23.] Lal K, White GS, Morea DN, Wright RF. Use of stereolithographic templates for surgical and prosthodontic implant planning and placement. Part I. The concept. *J Prosthodont.* 2006;15:51-58. [PubMed]
- [24.] Sarment DP, Al-Shammari K, Kazor CE. Stereolithographic surgical templates for placement of dental implants in complex cases. *Int J Periodontics Restorative Dent.* 2003;23:287-95. [PubMed]
- [25.] Malo, P., M. de Araujo Nobre, and A. Lopes. The use of computer-guided flapless implant surgery and four implants placed in immediate function to support a fixed denture: preliminary results after a mean follow-up period of thirteen months. *J Prosthetic Dent* 2007. 97:S26-S34.
- [26.] Johansson, B., B. Friberg, and H. Nilson. Digitally planned, immediately loaded dental implants with prefabricated prostheses in the reconstruction of edentulous maxillae: a 1-year prospective, multicenter study. *Clin Implant Dent Relat Res* 2008. 9:194-200.
- [27.] Daniele De Santis, Luciano Claudio Canton, Alessandro Cucchi, Guglielmo Zanotti, Enrico Pistoia, and Pier Francesco Nocini. Computer-Assisted Surgery in the Lower Jaw: Double Surgical Guide for Immediately Loaded Implants in Postextractive Sites—Technical Notes and a Case Report *Journal of Oral Implantology* 2010 36:1, 61-68.
- [28.] Immediate load small diameter implant: could represent a simplified fixed solution in lateral incisor agenesis? Russo N, Coppola G, Montisci D, Ciaravolo M, Mascolo A *EC Dental Science* 2019;18(2):221-225.;

First Author: Prof. Nazario Russo, graduated in Medicine and Surgery, Specialized in Orthodontics. He is currently Adjunct Professor at the University of Cagliari (Department of Biomedical and Dental Sciences), Head of the Implantology Unit of the University Polyclinic of Cagliari (AOU) and Director, Specialization School in Implantology, in EIMS-HEI (Malta).

Second Author: Dr. Massimiliano Ciaravolo, graduated in 2010 with honors in dentistry and dental prosthesis at the Second University of Naples (Italy). Specialized in 2016 with honors in Orthodontics at the University of Cagliari (Italy). He is currently Adjunct Professor at the University of Cagliari (Department of Biomedical and Dental Sciences).