

## Implant Supported Dental Prosthesis for the Early Management of Dentoalveolar Defect Associated with Maxillofacial Injuries

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### Abstract

**Aim:** Few clinical studies have reported the use of implant supported dental prosthesis for the management of post-traumatic dentoalveolar defects sustained during maxillofacial injuries. This is a presentation of our experience of such patients with the view of adding to the evidence on the subject matter.

**Materials and Methods:** This is retrospective study of patients seen at Cedarcrest Hospitals and QH Specialist Dental Clinics and Research Centre, in Abuja, over a period of nine years (2013 to 2022). Following standard maxillofacial fracture management, dentoalveolar defects were rehabilitated with implant supported prosthesis. Information extracted from the case files included demographics, case history, associated injuries, number of missing teeth and record of implant treatment done. Data obtained were analysed with SPSS version 20.

**Results:** There were 19 patients with 13 (68.4%) male and 6 (31.6%) female. Gunshot was the cause of injuries in 9 (47.4%) patients, Road Traffic Crashes in 8 (42.1%) and fall from a height in 2 (10.5%). Associated injuries sustained included soft tissue in 17 (90.0%) patients and fractures of the following bones: maxillary 11 (57.9%), mandibular 5(26.1%), orbital 3 (15.8%) and zygomatic bone in 1(5.3%) patient. Implant rehabilitation was done using 92 implants for a total of 119 missing teeth. Augmentative surgery achieved with autologous bone grafts in 4 (21.1%) patients and synthetic bone grafts in 13 (78.9%) patients. Rehabilitation was achieved with cemented crowns and bridges in most cases and ball retained removable denture in 2 (10.5%) patients. Implant survival rate of 98.9% and crown survival rate of 98.3% was recorded with a follow-up of 50.6 ± 26.8. months.

**Conclusion:** Early implant supported rehabilitation of post-traumatic dentoalveolar defects using osteointegrated implants and bone augmentation were successful with few complications, holistic planning at the onset of management is key.

**Clinical Significance:** This article is an experience of holistic implant management of patients that sustained dentoalveolar defects in addition to maxillofacial injuries. It highlights the peculiarities of immediate management as well as its advantages and challenges. It will therefore provide a knowledge base that many clinicians may learn from.

**Keywords:** Dentoalveolar Injuries; Post-Traumatic; Osteointegration; Implants

### Abbreviations

RTC: Road Traffic Crashes; DAI: Dentoalveolar Injuries

### Introduction

Dental implantology has become an acceptable method of replacement of lost teeth; it has been established to be a predictable solution with a record of 95-98% proportion of successful cases and seeks to avoid any kind of edentulous state including tooth loss due to trauma [1-3]. Unlike is obtainable in dental implant seeking

patients in which teeth were lost due to inflammatory causes or mild trauma, dentoalveolar defects associated with maxillofacial injuries are more severe and as such, the use of implant supported fixed dental prosthesis requires special consideration to restore orofacial form and function [4,5].

Several case reports and few clinical studies have reported the use of implant supported dental prosthesis as part of the management of maxillofacial injuries [4-9]. Gandhi., et al. [4] reported bi-

lateral Le Fort II and a right mandibular angle fracture with comminuted dentoalveolar fracture of lower anterior teeth. Patient was managed with immediate bone fixation and four years later, screw retained hybrid implant supported fixed dental prosthesis was used to restore dentoalveolar defect.

A 25 year old female that sustained significant injury to the maxilla following a road traffic crash (RTC) had fixation of fractured bone with miniplates and was referred to a maxillofacial surgery unit 2 months after the injury. Additional surgery of plate removal and bone augmentation with demineralized bone matrix was done and dentoalveolar defect restored with cemented implant supported fixed dental prosthesis [10]. The importance of early multidisciplinary approach for the management of dentoalveolar defects in maxillofacial surgery was emphasised in these cases [4,9,10]. Gunshot injuries could be severe with a debilitating consequence on the aesthetics and function of orofacial complex. Restoration therefore requires multiple surgeries and implant supported prosthesis [11].

There is a need for complete implant rehabilitation of patients following post-traumatic dentoalveolar defect sustained during maxillofacial injuries but there are few clinical studies on this subject. The aim of this study is to document our experience of post-traumatic implant rehabilitation with the view of adding to the evidence on the subject.

## Materials and Methods

This is a retrospective study of patients seen in the past 9 years (2013 to 2022), that sustained traumatic injury to the face with associated teeth loss and were rehabilitated with osseointegrated dental implants supported prosthesis. Partially edentulous patients that was caused by trauma, seeking implant-retained prosthesis were included in the study while other edentulous patients due to pulpal or periodontal diseases were excluded.

All the patients were managed at Cedarcrest Hospitals and QH Specialist Dental Clinics and Research Centre, the two facilities located in Abuja, Nigeria. The standard protocol for trauma patients' management was followed. Maxillofacial and all other related surgeons were always invited within 2 hours of admission into the Accident and Emergency unit. All patients had CT Scan of the facial bones as baseline investigation in addition to the general management. Stable patients were admitted into the wards. Comprehensive planning was usually followed by theatre sessions. Early management usually included soft tissue reconstruction and open reduction and internal fixation of facial bone fractures. Gunshot injuries usually experience multiple surgeries including debridement, soft tissue management and bone augmentation with autogenous iliac

crest bone. Placements of osseointegrated implants, (ADIN Dental Implant Systems Ltd, Israel) with bone augmentation (Hammade Raw Material  $\beta$ -TCP, Ankara, Turkey), were done for some selected cases with the same surgery under General Anesthesia (GA), using standard techniques. Patients were usually discharged within 1 week of admission with follow-up visits in the dental clinic. Patients planned for implant placement under Local Anaesthesia were attended to 4 to 6 months in the dental clinic. All the patients had bone augmentation. Additional procedures became imperative for some patients during prosthetic phase and surgeries performed included Alveoloplasty, Sulcoplasty and Commisuroplasty.

The information obtained from case files included demographics, cause of injury, associated injuries, missing teeth and distribution in the arch, degree of bone loss, record of implant treatment and follow up. Data obtained were analyzed using statistical package (SPSS), version 20.

## Results

A total of 19 patients were included in the study, 13 (68.4%) male and 6 (31.6%) female. Gunshot was the cause of injury in 9 (47.4%) patients, Road Traffic Crashes in 8 (42.1%) and fall was the cause in 2 (10.5%).

Table 1 shows the dentoalveolar and associated maxillofacial injuries recorded among the patients. Apart from dentoalveolar injuries sustained in 2 patient caused by fall, extensive maxillofacial injuries were observed in the majority of patients including soft tissue 17 (90.0%), maxillary fractures 11 (57.9%), mandibular fractures 5(26.1%), orbital fractures 3 (15.8%) and zygomatic bone fractures in 1(5.3%). All the fractures were fixed with open reduction and internal fixation using miniplates osteosynthesis at the time of injury. Orbital floor repair was also carried out in the affected 3 patients with orbital mesh.

Two cases of gunshot injury with extensive mandibular defect was reconstructed, employing load bearing osteosynthesis with 2.4 reconstruction plate and autologous bone graft from iliac crest., in addition to debridement. Each of them were operated 3 times.

Dentoalveolar injuries (DI) were located in the upper arch in 5 (26.3%) patients, lower arch in 2 (10.5%) and both arches in 12 (63.2%) patients. DI was also observed to be located in the anterior region in 11 (57.9%) and both anterior and posterior regions in 8 (42.1%) patients. Implants were placed under general anaesthesia at the time of bone fixation in 4 (21.1%) patients while 13 (78.9%) patients had implant placed under local anaesthesia. Eight (42.1%) patients had the implants placed 3 to 5 months with mean SD  $4.2 \pm 0.8$  months, after bone fixation.

Type of Injury	Frequency	Percentage
Teeth+ Alveolus	2	10.5
Teeth +Alveolus+ Soft Tissue	2	10.5
Teeth+ Alveolus+ Soft Tissue+ Mandible	2	10.5
Teeth+ Alveolus+ Soft Tissue+ Maxilla	7	36.8
Teeth+ Alveolus+ Soft Tissue+ Mandible +Maxilla	3	15.8
Teeth +Alveolus+ Soft Tissue+ Zygoma, Maxilla, Orbital	1	5.3
Teeth +Alveolus +Soft Tissue +Orbital	2	10.5
Total	19	100.0

**Table 1:** Dentoalveolar and associated maxillofacial injuries recorded among the patients.

There were a total of 119 missing teeth which were rehabilitated with 92 osseintegrated dental implants (ADIN Dental Implant Systems Ltd, Israel). Table 2 shows the list of additional procedures during implant placement and prosthetic phase. Alveolar remodeling and bone grafting was carried out on all the patients due to the associated alveolar defect. The donor site for the autologous bone

grafts were the chin, retromolar region and iliac crest in 4 (21.1%) patients while in 11(57.9%) patients, bone grafting was done with synthetic bone grafts (Hammade Raw Material  $\beta$ -TCP, Ankara, Turkey). Sulcoplasty was carried out in 12 (63.2%) patients where it was discovered that the sulcus was limited and would impede function. Bilateral commissuroplasty was carried out in 2 patients (bilateral in 1 and unilateral in the second), to improve on the mouth

Additional Procedures	Frequency	Percentage
Alveoloplasty +Bone Grafting	5	26.3
Alveoloplasty +Bone Grafting + Sulcoplasty	12	63.2
Alveoloplasty +Bone Grafting + Sulcoplasty +commisuroplasty	2	10.5
Total	19	100.0

**Table 2:** List of additional procedures carried out during implant placement and prosthetic phase among the patients.

opening during the prosthetic phase of implantology’.

Time lapse between implant and crown placement ranged from 4 to 11 months with mean SD of  $5.5 \pm 2.1$  months. In 17 (89.5%) patients, cemented crowns were placed while a ball retained overdenture was used in the rehabilitation of 2 gunshot injury patients with extensive alveolar bone defect. Patients have been followed up for a range of 2 to 87 months with mean SD of  $50.6 \pm 26.8$  months.

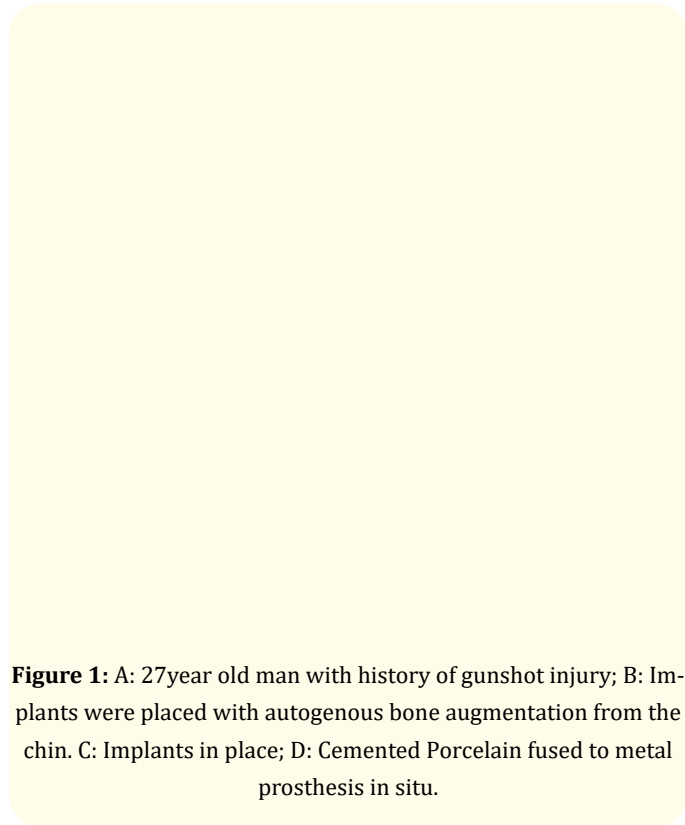
The complication recorded includes Crown loosening of 2 teeth (1.7%) and loss of 1 (1.1%) implant. It implies implant survival proportion of 98.9% and crown survival proportion of 98.3%.

**Discussion**

Implant dentistry treatment is now globally accepted and seeks

to avoid any kind of edentulous state including tooth loss due to trauma [2,3]. Unlike what is obtainable in dental implant seeking patients seen daily in the dental clinics, there are several more urgent considerations in maxillofacial injury patients such as early resuscitation, bone fixation and soft tissue reconstruction. Functional restoration of dental rehabilitation with osseointegrated dental implants are usually considered a secondary procedure. It is important to include post traumatic restoration of dentoalveolar defect as part of the definitive and holistic management of a patient involved in maxillofacial injury. There has been several case reports but few clinical studies on the subject of post-traumatic implant rehabilitation of dentoalveolar defects following maxillofacial injury, thereby justifying this study.

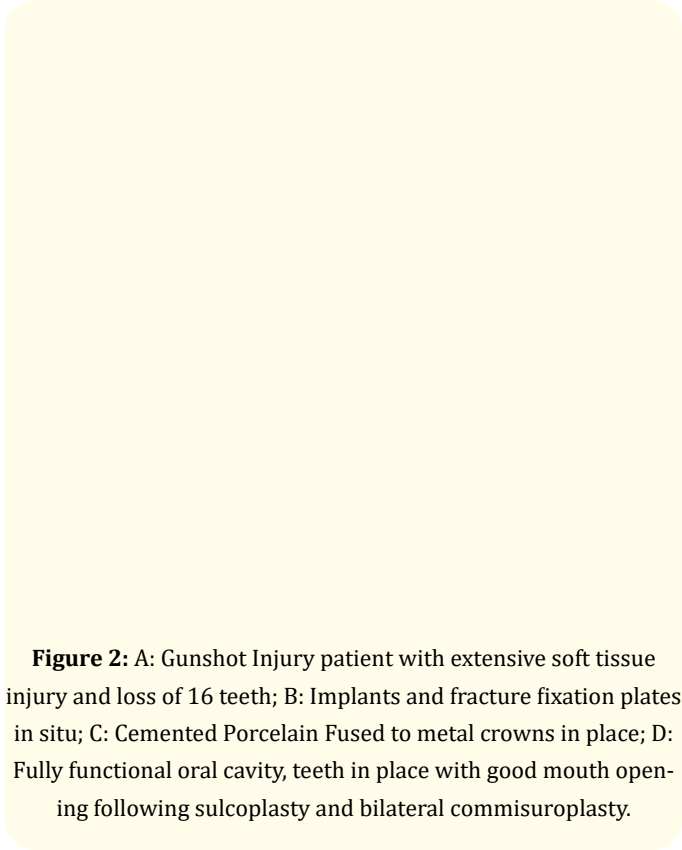
Gunshot and Road Traffic Crashes were the commonest cause of injury in this study, accounting for 89%. This is similar to several reports of dental implant rehabilitation of dentoalveolar defect following maxillofacial injuries. Gunshots injuries were reported by Balla., *et al.* [11], Sharma and Swamy [12], and Wang., *et al.* [9], while RTC were reported by Kamoi [13] as well as Robinson and Cunningham [14]. This could be a reflection of the severity of impact experienced with these mechanisms and extensive tissue damage including dentoalveolar defects (Figure 1 and 2). In a study of the aetiology of maxillofacial injury in the same city, Abuja, 2013 by Bello., *et al.* [15], RTC was the cause of injury in 84.4% while gunshot injury was 2.6%. The upsurge in gunshot injuries is a reflection of insurgency and banditry attacks that has pervaded the



**Figure 1:** A: 27year old man with history of gunshot injury; B: Implants were placed with autogenous bone augmentation from the chin. C: Implants in place; D: Cemented Porcelain fused to metal prosthesis in situ.

landscape of Nigeria in the past 10 years.

Extensive maxillofacial injuries were observed in association with dentoalveolar injuries (DAI) including soft tissue injury, maxillary, mandibular, orbital and zygomatic bone fractures (Figure 2). Details of maxillofacial injuries are lacking in most scientific



**Figure 2:** A: Gunshot Injury patient with extensive soft tissue injury and loss of 16 teeth; B: Implants and fracture fixation plates in situ; C: Cemented Porcelain Fused to metal crowns in place; D: Fully functional oral cavity, teeth in place with good mouth opening following sulcoplasty and bilateral commisuroplasty.

reports but Pae., *et al.* [8], described a panfacial fracture case who was managed with a mandibular implant-supported fixed-removable and a maxillary partial removable prosthesis. Seymour., *et al.* [16], mentioned the need of team approach in the rehabilitation of severe trauma cases and emphasised the importance of communication among specialists in the implant management. Optimal result at minimal cost with reduced hospital stay is possible with adequate and holistic planning of these patients with DAI and associated maxillofacial injuries. Following proper investigation and planning, 21% of the patients had implant placed under general anaesthesia in conjunction with open reduction and internal fixation of the bone fractures while 42% had implant placed under local anaesthesia 4.2 months after bone fixation and discharge from the hospital admission. An important factor is adequate investigation and preparation. The position of the plates must be properly noted and there must be adequate preparation for the atraumatic extraction of the retained roots, especially during general anaesthesia. Effective management with successful outcome have been

recorded with this approach but case selection is key.

Funding is a challenge in the management of patients especially comprehensive treatment of a multiply injured ones. In the absence of an effective insurance system as in the third world countries like Nigeria, the funding is undertaken by family members or weak insurance companies who are usually sympathetic when the injury is fresh. If a comprehensive planning is not done at this stage, dental implant restoration of dentoalveolar defects is relegated to the back stage as soon as the patient is discharged from the hospital admission and may not be opportune to assess treatment again.

Post traumatic dentoalveolar defect has a pattern. It involves both lower and upper arches in 63% of cases and also involves both anterior and posterior teeth almost equally (Figure 2 and 3). Traumatic dental injury (TDI) is a popular terminology and it affects upper anterior teeth in majority of cases. Zerman and Cavalleri [17] examined 178 children with TDI and observed that 80% were maxillary central incisors and aetiology was mainly falls and RTCs. Nissan., *et al.* [5] in their study, placed implants following bone grafting in 20 consecutive patients with post-traumatic anterior maxillary defects. Extensive injury associated with maxillofacial injury may be a reflection of high impact mechanism of RTC and gunshots as opposed to majority of lesser impact fall recorded in children and young adults.

Most of the patients in this study had alveoloplasty and bone grafting in association with implant placement. Alveolar bone takes its blood supply from periodontal branches of apical blood supplies to the teeth [18]. It implies dentoalveolar injury will most likely compromise blood supply to the alveolus and this is particularly important in the aesthetic zone of anterior maxilla. Nissan., *et al.* [5] posited that soft tissue scarring combined with vascular compromise adds to the complexity of restoration in the aesthetic zone of the anterior maxillary teeth. According to Schwartz-Arad., *et al.* [19], traumatic dental injury that occur in early childhood poses a problem to future implant restoration especially in the aesthetic zone. The compromise of the blood supply result in disuse atrophy leading to reduction of bone volume. Therefore many authors are of the opinion that preimplant augmentative surgery is a prerequisite in many cases in the post-traumatic anterior maxilla [20-22]. Though there are many methods of augmenting the bone but Lundgren., *et al.* [22], while discussing the reconstruction of anterior maxilla maintained that autogenous bone is still the gold standard but it is associated with donor site morbidity. All the patients in

this study are above 25years and had completed their bone formation. The defect associated with the defects necessitated the use of bone grafts for augmentation. Both autogenous and synthetic bone grafts resulted in good functional outcome with above 5 years of follow up (Figure 1). Early implant placement could also be an advantage and contributed to the success because early restoration prevents disuse atrophy that causes further loss of bone volume with associated aesthetic compromise.

Additional procedures during prosthetic phase of implantology is an important component for consideration in the early implant rehabilitation of post-traumatic dentoalveolar defect. In this study, final prosthesis was delivered approximately five and a half month after implant placement with a range of 4 to 11 months. The slightly elongated time is caused by the series of procedures needed to ensure functional restoration. Soft tissue healing following major maxillofacial surgery is very unpredictable such that additional procedures became imperative. Sulcoplasty was carried out in 63% of the patients and commisuroplasty in 10%. Sulcoplasty became necessary where the sulcus became very shallow in the course of healing thereby compromising the oral function while commisuroplasty became necessary to ensure adequate mouth opening (Figure 2).

Cemented versus Screw Retained prosthetics is a known controversy. Analysis of evolution of screw retained implant supported fixed prosthesis revealed that implants placed during the development era had high failure rates necessitating easy and frequent removal of the prostheses. Therefore screw retention became popular because it allows easy retrievability despite the compromise of occlusion [23-25]. With advances in biological properties and implant techniques, implant survival rate was being reported to increase from 50% to 100%, thereby reducing retrievability as a major consideration. Hebel BSC., *et al.* [25] in their comparative study concluded that screw retained prosthesis are not superior because it compromises occlusion and semirigid cement allows retrieval if necessary. Review of literatures recommends the two techniques for different clinical scenario. Screw retained implant supported fixed prosthesis is recommended in patients that is expected to lose more teeth and hence further modification; [25] patient with minimal interocclusal distance; [26] cantilever prosthesis [27,28]; and long span prosthesis [29]. Cement Retained implant supported prosthesis on the other hand were recommended in: aesthetic zone where screws may be visible; restoring malaligned implants [30];

short-span and single-unit implant restorations [29]; cases involving narrow diameter crowns in which the screw access may compromise the crown's integrity and posterior teeth where access is compromised [25]. In this study, most of the cases were restored with cement retained prosthesis (Figure 2 and 3) while 2 cases of gunshot injuries with significant dentoalveolar defect were restored with ball retained removable denture (Figure 3). Most of our cases were cement retained which was less technical and easier to manage in line with the observation of HebelBSC., *et al.* [25] that cemented restorations have been in contemporary dental practice for over 100 years. However our results has been very impressive

alveolar defects and holistic planning is important. Implants could be placed under general anaesthesia in conjunction with bone fixation, or 4 months after hospital admission under local anaesthesia. This approach prevents a situation where dental implant treatment is discountenanced as a priority in a resource limited settings. Bone augmentation which could be autogenous or synthetic, used to fill post-traumatic defects during implant placement has resulted in a good result with a record of 98% implant survival Proportion. Early post-traumatic implant management is associated with additional procedures during prosthetic phase to restore function. These could include alveoplasty, sulcoplasty and commisuroplasty. Fixed implant supported prosthesis could be screwed or cemented retained but cemented prosthesis have been used in this study with impressive result. However gunshot injuries with significant dentoalveolar defect could be restored with ball retained removable denture.

### Clinical Significance.

Maxillofacial injuries are being managed daily all over the world and post-traumatic dentoalveolar defects are possible injuries that could accompany such injuries. The field of implant-supported prosthesis is also growing daily and seeks to manage all edentulous spaces including those caused by trauma. This article is an experience of holistic implant management of patients that sustained dentoalveolar defects in addition to maxillofacial injuries. It highlights the peculiarities of immediate management as well as its advantages and challenges. It will therefore provide a knowledge base that many clinicians may learn from.

### Conflict of Interest

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**Figure 3:** A: Immediate Reconstruction following gunshot injury followed by autogenous bone grafting and implant placement; B: Ball abutment in place; C: Removable Denture; D: Fully restored implant supported removable partial denture.

with less than 5% complication at 5 years follow up.

### Conclusion

Osseointegrated dental implant management of post traumatic dentoalveolar defects sustained in a maxillofacial injury requires holistic planning. Gunshot and RTC are the commonest cause of dentoalveolar defect in these patients due to high impact mechanism involved. Soft tissue injury as well as maxillary, mandibular, orbital and zygomatic bone fractures could accompany the dento-

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