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Quantitative Determination of Implant Stability Using Resonance Frequency Analysis (RFA) In an Indigenous Implant System – A Clinical Research Case Study

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ABSTRACT:

Osseointegration is the apparent direct attachment or connection of osseous tissue to an inert, alloplastic material without intervening fibrous connective tissue. Implant stability is a measure of the clinical immobility of an implant, which is a requisite characteristic of osseointegration. A 60-year-old female came with a chief complaint of missing mandibular molar. Patient opted to restore the edentulous site withan Implant supported fixed prosthesis. The stability of this implant was assessed during its placement and on subsequent weeks with the help of a resonance frequency analysis method (RFA),using Osstell ISQ™.RFA was developed byMeridith and co-workers and is considered a user friendly, non-invasive, reliable, and clinically applicable technique to measure implant stability .The mean Implant stability quotient (ISQ) values at 36 region were between 70-80. The survival of implants is highly predictable when the surgical and prosthetic phase are done meticulously along with measurement of ISQwhich is indicative of steady osseointegration.The aim of this clinical casestudy is to quantitatively determine the implant stability and check the prognostic value of an indigenous implant system (i- Fix)

KEY WORDS: Dental implants, implant prosthesis, Implant stability quotient (ISQ),Resonance Frequency Analysis (RFA)

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INTRODUCTION:

Osseointegration is the apparent direct attachment or connection of osseous tissue to an inert, alloplastic material without intervening fibrous connective tissue. Branemark et. al., demonstrated that direct contact between bone and titanium implant surface was possible. [1]

Implant stability is a requisite characteristic of osseointegration. [2,3] It is achieved at two levels: Primary and secondary. Primary stability is associated with bone density, height, width and drilling technique.Secondary stability depends on bone formation and remodeling at the implant bone interface.[4-5]

Implant stability may be assessed by various invasive and non- invasive techniques, however the reliability of these techniques are questionable.The need for a user friendly, non-invasive, reliable, and clinically applicable technique to measure implant stability lead to the development of resonance frequency analysis (RFA) by Meridith and co-workers in 1996[2]. The Osstell ISQ™works on vibration and structural principle.[6,7]It is a portable, hand-held device that uses the magnetic frequencies between the transducer (a magnetic peg) and the resonance frequency analyzer. RFA is expressed as implant stability quotient (ISQ) on a scale from 1 to 100 which represents a standardized unit of stability.[6]

A high value indicates greater stability, whereas a low value implies instability. A successful implant typically has an ISQ greater than 65. An ISQ <50 may indicate potential failure or increased risk of failure.[8]

The aim of the present case study was the quantitative determination of implant stability using Resonance Frequency Analysis in an indigenous Implant System (i- Fix).

CASE REPORT:

A 60 years old female patient reported to the Department of Prosthodontics and Crown & Bridge, with a chief complaint of missing tooth in the left mandibular region.(Figure 1)

On intra-oral examination, 36 was missing and it was diagnosed asACP Classification- Class I.[9]A definitive treatment plan was formulated with an implant supportedFP1 Screw retained prosthesis using i-Fix (Involution Private Limited,India) implant system.

This clinical study was designed as a prospective study to measure implant stability periodically with an RF analyzer at the time of implant placement, up to 12 weeks post placement and 6 months post loading.

A CBCT evaluation was done and bone quality was categorized as type D3.[10] (Figure 2). With the help of a diagnostic wax up,a surgical stent was fabricated.After obtaining informed consent, Surgical phase was carried out.Under local anesthesia (Lignox 2% A,IndoCo Remedies,India)sequential osteotomy was done using osteotomy drills and the implant (i-Fix ,5*11.5 mm, Involution Private Limited, India) placement was done. (Figure 3)

RFA was performed starting with an assessment immediately following implant placement. Following this assessment was conducted periodically for 12 weeks with a one week interval between each assessment. It was further continuedpost loading for a period of 6 months.The ISQ values obtained are shown in Table 1. The readings were taken using Osstell ISQ™ (Integration Diagnostics AB, Goteborg, Sweden) instrument (Figure 4) by inserting a standardized abutment (Smartpeg™, Integration Diagnostics AB, Goteborg, Sweden) onto the implant (Figure 5). The transducer probe was held so that the probe tip was aimed at the small magnet on top of the Smartpeg™ at a distance of 2-3 mm (Figure 6). The probe was held still during the pulsing time until the instrument beeped and displayed the ISQ value.(Figure 7)
The restorative phase was carried out 12 weekspost-surgery (Figure 8-9). An implant level impression was made usingclosed tray impression technique.An implant supported FP1 screw retained prosthesis was then delivered to the patient(Figure 10). Post loading,ISQ values were recorded at regular intervals up till 6 months to assess the implant stability.

DISCUSSION:

The development of clinical, non-invasive diagnostic instruments with high sensitivity and reproducibility to detect changes in implant stability during tissue integration of dental implants is desirable to determine the loading protocol to be followed. In this respect, RFA is a clinical method capable of quantitative evaluation of implant stability in order to identify implants with less stability and to take measures to improve it .[2,6]

ISQ Values At Different Time Points	**ISQ Reading (Buccolingual)**	**ISQ Reading (Mesiodistal)**
At Surgery	80	80
1st week	80	80
2nd week	78	78
3rd week	78	78
4th week	76	78
5th week	78	78
6th week	80	80
7th week	80	80
8th week	80	80
9th week	80	80
10th week	79	79
11th week	79	79

12th week	80	80
1 month post loading	79	79
3 months post loading	79	79
6 months post loading	79	79

Table 1 : ISQ Values immediately following implant placement, periodically at an interval of one week up till 12 weeks post operatively and post loading of implant.

In the present study the values were within a range of 70-80. An ISQ value below 50 should be regarded as a warning sign.[8]Primary stability is a purely mechanical phenomenon. During the first weeks of healing, bone modeling and remodeling take place around the implant surface. This phase with the formation of lamellar bone from woven bone may cause a decrease in primary bone contact.[11] Robertsextrapolated a wound healing process from a rabbit model, concluding that bone density undergoes significant changes during the early weeks following wound formation (0 to 6 weeks in humans) [12]. Similarly, the plateau effect in implant stability after 6 weeks was noted by Cochran, et. al,[11] and this phenomenon was correlated by the concept of enhanced bone formation around the implant surface. The findings of this study are also suggestive of the same.

Zix et. al, conducted a study in 35 patients and found mean implant stability quotient was 52.5 + 7.9. They concluded that single RFA measurement of an implant was insufficient to predict their clinical outcome. Repeated measurements over a longer period of time would thus be necessary [13]. Aparicio et. al also found primary stability is affected by bone type and single reading using RFA is of limited clinical significance.[14].Hence in this study RFA Analysis was conducted for a period of 12 weeks with one week interval between each assessment. Accordingto study byBaltayan et. al,he concluded that Implants with ISQ values more than or equal to 66 shows a higher survival rate.[8]The current study is in congruence for determining the quantitative value for implant stability in an idealistic scenario which shows us a mean value between 75- 80 consistently, indicative of a high ISQ value, which seems promising.

However,long term clinical trials are further required incases involving compromised situations such as inadequate bone and highly pneumatized maxillary sinusetc., in order to determine the prognostic value of this indigenous implant system.

CONCLUSION:

In the Indian clinical scenario, the credibility and applicability to meet the demands of patient desiring dental implant as the treatment modality, along with it being cost effective is the need of the hour. This case study of an indigenous implant system (i- Fix) has shown us promising results with respect to high ISQ along with it being a cost effective option for the common man. There is still scope for further research to determine its prognostic value in the near future. Continuous predictable time dependent and morbidity free results will aid us in providing optimal patient therapy, as the goal of modern implantology is healthcare for all!

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LIST OF ABBREVIATIONS:

Abbreviation	Definition
RFA -Resonance frequency analysis	RFA is a method used to determine stability (the level of osseointegration) in dental implants.RFA measurements are used to assess the stability of the implant immediately after placement, as well as to measure the stability during the healing time
ISQ -Implant stability quotient	The measurement unit for frequency is hertz, but when assessing implants, hertz are often converted into an implant stability quotient (ISQ). This value is mathematically derived from the frequency measurements, and ISQ was developed to create a scale of values, ranging from 1 to 100, that can be tracked and translated into micro-mobility and implant stability.

CONFLICT OFINTEREST : Nil

FIGURES 10

Figure 1 : Missing 36

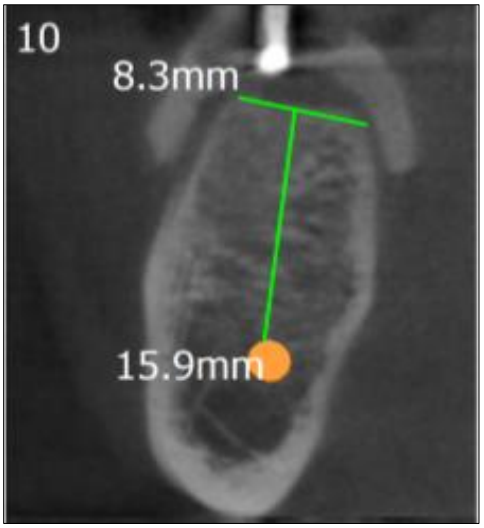

Figure 2 : CBCT slice showing edentulous site of 36

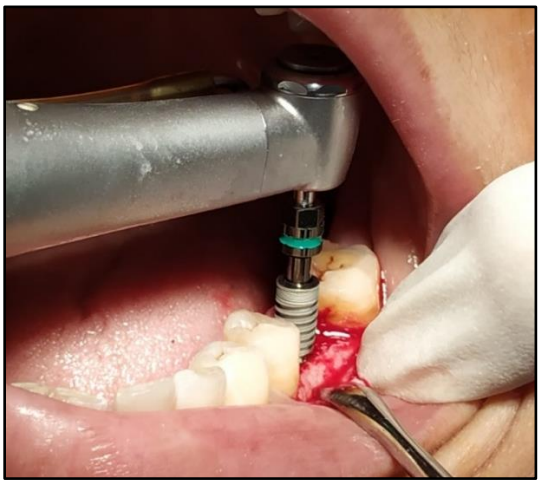

Figure 3 : Implant Placement (i-Fix System ,5 *11.5 mm) in the region of 36

Figure 4 :An Osstell ISQ™ Instrument with probe

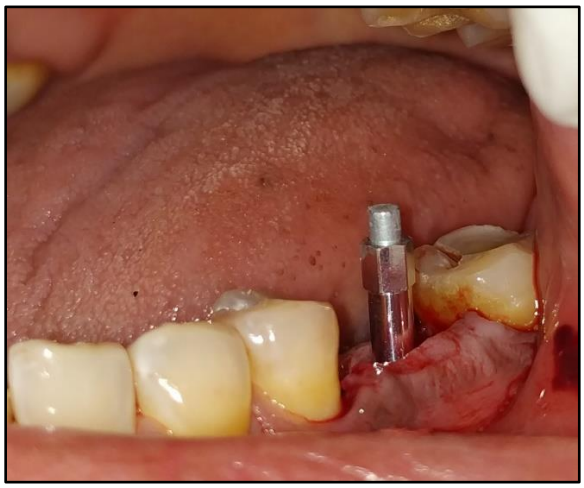

Figure 5 :Smartpeg™ attached to implant fixture .

Figure 6 :Recording ISQ value using Osstell ISQTM immediately following implant placement.

Figure 7 : ISQ Value being displayed on screen, following implant placement.

Figure 8 : Post -Operative Orthopantomograph

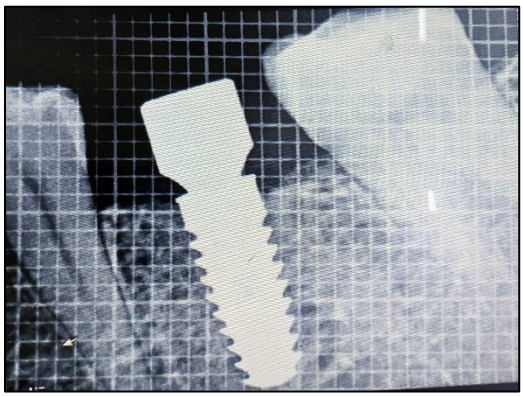

Figure 9 : Post -Operative IOPA with grid

Figure 10 : FP1 full veneer PFM crown replacing 36