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Comparative Evaluation Of Platelet Rich Plasma Coated Retrieved Orthodontic Mini Implant With New Orthodontic Mini Implant For Stability – An Experimental Clinical Study

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Abstract:
Background*: Orthodontic mini implants, also known as temporary anchorage device are used for absolute anchorage to treat variety of malocclusions. However, the rate of failure of these orthodontic mini implants are high therefore, there is an increase need for their reinsertion and methods are required to increase their stability upon reinsertion.*
Aim*: To evaluate and compare maximum insertion torque and implant stability quotient for new as received orthodontic mini implants and PRP coated retrieved orthodontic mini implants.*
Materials and Methods*: The experimental clinical study comprised of 22 participants those required the use of orthodontic mini implants for treatment. New as received orthodontic mini implants were inserted in 11 participants (Group A). 11 participants of Group -B were in which mini implant had failed, so, the orthodontic mini implants were retrieved, sterilized, observed under scanning electron microscope for blunting of tip, autoclaved and were coated with Platelet Rich Plasma before reinsertion. Implant Stability Quotient (ISQ) and Maximum insertion torque (MIT) values were recorded to check for primary stability. Clinical follow up was done for 6 months.*
Results*: MIT and ISQ for both Group A and Group B did not show statistical difference thus, retrieved PRP coated orthodontic mini implants can be considered for reinsertion. They have similar primary stability as newly placed orthodontic mini implants. MIT and ISQ values for successful orthodontic mini implants were higher than failed orthodontic mini implants but were not statistically significant. However, MIT in Group A between successful and failed implants was statistically significant. Thus, there can be a lot of other patient related factors which may lead to implant failure. MIT was positively correlated with ISQ values for both the groups.*
Conclusions*: If PRP is coated on retrieved orthodontic mini implants then they can be reinserted as they have similar primary stability as newly received orthodontic mini implants, keeping in mind the other factors responsible for implant failure.*
Keywords*: New orthodontic mini implant, Retrieved Orthodontic mini implant, Platelet Rich Plasma, Implant Stability Quotient, Maximum Insertion Torque, Primary Stability*

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I. Introduction

In orthodontics, anchorage refers to the resistance provided by anatomical structures to counteract unwanted tooth movement during orthodontic treatment. Absolute anchorage is when the anchorage units remain stationary and is very difficult to obtain it with conventional orthodontics due to anchorage loss. Anchorage loss refers to the reactive movement of the anchor unit, which can negatively impact the effectiveness of orthodontic therapy.[1]

In circumstances where absolute anchorage is necessitated, the forces exerted on the teeth are fully absorbed by the surrounding bone. This approach known as skeletal anchorage, can also be referred to as absolute anchorage due to its rigid stability.[1]

Orthodontic mini implants (skeletal anchorage) with little invasiveness can thus, help us achieve absolute anchorage. [2]

Mini-implants used for skeletal anchorage in orthodontics have a failure rate between 6% and 30%, depending on various clinical factors. The stability of mini implants depends upon a lot of factors right from bone quality to initial stability after placement. It also depends upon early and delay loading, proximity of implant to root and oral hygiene of patient. [3]

Initial stability depends upon bone quality and quantity and late stability is determine after 2-4 months after full turnover of surrounding peri implant tissues.[4] However, in orthodontics, Initial stability of mini implants that is their lack of mobility upon placement in bone is crucial for their success to carry out various tooth movement. [5]During the placement of mini implant into the bone, the amount of rotating force applied is known as Insertion torque. Since, insertion torque is not invasive, easy to use and associated with primary stability of implant, it is often used.[6] The maximum Insertion Torque(MIT) which is expressed in Newton centimetre is the highest torque value during placement of orthodontic mini implants. A positive degree of MIT is necessary to provide initial stability.

However, orthodontic mini implants are frequently reused after failure at one site to lower treatment expenses but the effect of its reuse on stability has not been fully understood. While some studies show no significant difference between new and used mini implants [7], others show the opposite and contradict its re usage. [8] When the orthodontic mini implants are used again, there are certain characteristic changes observed on the tip and surface of the implants along with changes in elemental composition which may [8] or may not [9] significantly affect stability of orthodontic mini implant. These changes can be observed with help of scanning electron microscope as it generates high resolution images of sample's surface. The image formed by scanning electron microscope is produced using electron beam rather than light which enables far higher magnification and resolution than conventional light microscope or stereomicroscope. [10,11.]

Recent advancements have introduced methods to assess mini-implant stability by adapting tools originally designed for dental implants, such as the Osstell Measurement System. This device operates using a handheld probe that emits magnetic pulses, inducing vibrations in a small magnetic peg (SmartPeg) attached to the implant. As the vibrational frequency increases, the implant reaches a resonant frequency, which is detected by the probe. The system quantifies this resonance as the Implant Stability Quotient (ISQ)—a numerical value indicating the degree of osseointegration. Higher ISQ scores correlate with greater implant stability, reflecting stronger bone-to-implant contact. [12]

There have been various measures taken over a period of time to increase stability of dental and orthodontic mini implants such as coating of implants with materials like hydroxyapatite, platelet rich plasma etc. [13]

Platelet-rich plasma (PRP) is a bioactive concentrate derived from a patient's own blood, containing elevated levels of platelets and growth factors compared to normal circulating levels which aids in additional new bone formation thus, securing the implant firmly in place and enhancing it's stability. Due to its autologous origin, there is no chance of immunological reaction or cross transmission of diseases.[14]However, some researches have observed beneficial effect of platelet-rich plasma on implant stability[14] whereas others have seen no significant difference between coated and non-coated implants. [15.]

Therefore, this study has been taken up to analyze whether plasma coated retrieved orthodontic mini implant's stability is comparable to new orthodontic mini implant.

II. Material And Methods

Study Design and Ethical Considerations: This investigation was designed as a experimental clinical trial conducted in the Department of Orthodontics at Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat. Ethical clearance was obtained from the Institutional Ethics committee Review Board. Informed consent was obtained from all participants, and a participant information sheet was provided before enrollment.

Sample Size: A sample size of 22 patients was calculated with 11 in each group

Participant Selection

Inclusion Criteria

- Patients aged 16–30 years requiring orthodontic mini-implants for anchorage reinforcement.
- Good systemic and periodontal health.
- Adequate interradicular bone available for placement in maxillary or mandibular buccal alveolus.
- Cooperative patients willing to comply with follow-up visits.

Exclusion Criteria

- Systemic diseases affecting bone metabolism (diabetes, osteoporosis).
- Smokers or patients with parafunctional habits (bruxism, clenching).
- Patients with poor oral hygiene or active periodontal disease.
- Pregnant or lactating women.
- History of bisphosphonate or corticosteroid therapy.

Group Allocation

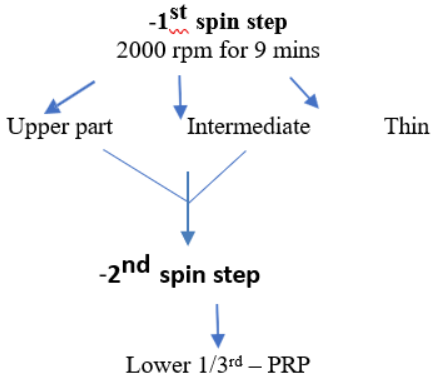
- **Group A (New mini-implants):** 11 patients received new, as-received orthodontic mini-implants (Titanium alloy; 1.6 mm × 8 mm).
- **Group B (Retrieved + PRP-coated mini-implants):** Eleven patients who had experienced failure of mini-implants during orthodontic treatment were included. The failed implants were retrieved, sterilized, coated with autologous Platelet-Rich Plasma (PRP), and reinserted at a new interradicular site.

Mini-Implant Retrieval and Preparation

Failed mini-implants were carefully removed using a manual driver without additional trauma to surrounding bone. Retrieved implants were:

1. Cleaned mechanically with an ultrasonic scaler to remove soft tissue remnants.
2. Sterilized using cold sterilisation & autoclaving at 121°C for 15 minutes.
3. Examined under Scanning Electron Microscope (SEM) to assess tip blunting.
4. PRP Coating: Autologous PRP was prepared using the double-spin method. and the PRP was applied onto the retrieved implants
5. PRP Preparation Protocol

Approximately 10 mL of blood was drawn from each patient's brachial vein into sterile tubes containing sodium citrate. The following steps were used:



Surgical Procedure

All implants were placed by a single experienced operator to eliminate inter-operator variability. After administration of topical and infiltrative local anesthesia (2% lignocaine with epinephrine 1:100,000), implants were placed

Clinical Evaluation of Stability

Two parameters were used to evaluate primary stability:

1. Maximum Insertion Torque (MIT): Measured using Lutron TQ® -8800 Digital Torque meter during implant placement, recorded in Newton-centimeters (Ncm).
2. Implant Stability Quotient (ISQ): Assessed using Resonance Frequency Analysis (Osstell ISQ device, Integration Diagnostics, Sweden).
3. Follow-Up Protocol

- Clinical assessments were made at every appointment upto 6 months.
- Success criteria included absence of mobility, no peri-implant inflammation, and ability to withstand orthodontic loading.
- Failure was defined as clinical mobility, pain, infection, or loss of anchorage.

Outcome Measures

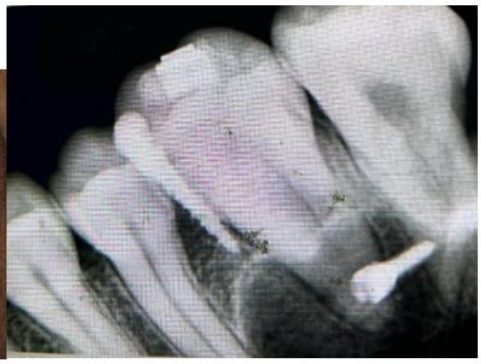
- **Primary Outcome:** Comparison of MIT and ISQ between Group A and Group B at baseline.
- **Secondary Outcomes:** Survival rate of implants at 6 months, correlation between MIT and ISQ, and comparison between successful and failed implants within each group. Blinding was done at the level of data analyst in the study.

Statistical Analysis: Data was entered and organised using Microsoft Excel(version 2017) and statistical analysis was performed using Statistical Package for social Sciences(SPSS), version 26.0(IBM Corp.). Demographic details of all the patients were analysed and mean age was calculated. Unpaired student t test was used to analyse the intergroup difference in successful and failed orthodontic mini implants in both new orthodontic mini implant group (Group A) and PRP coated retrieved orthodontic mini implant groups(Group B). P value <0.05 was considered statistically significant. Pearson correlation coefficient was used to analyse the relation between MIT and ISQ for successful and failed implants in both the groups.

Infiltrating site of implant placement with Local Anesthesia

Marking puncture point with probe

Insertion of orthodontic mini implant

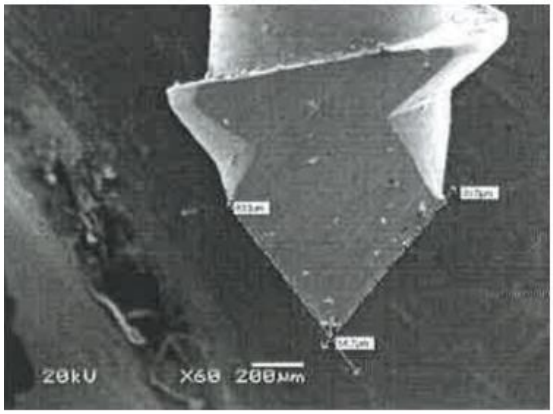


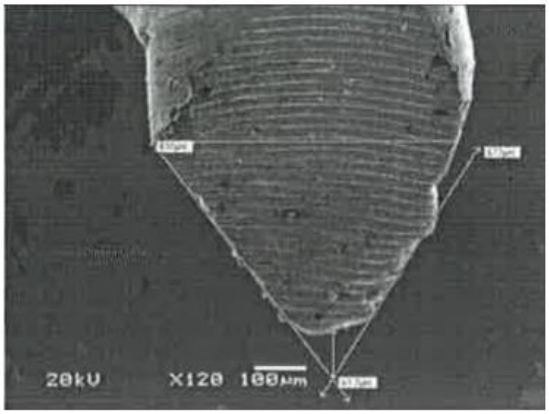
IOPA to check proximity of orthodontic mini implant with root

Osstell Device for measuring implant stability quotient

Lutron TQ® -8800 Digital Torque meter for evaluating maximum insertion torque

Smart Peg attachment for measuring ISQ

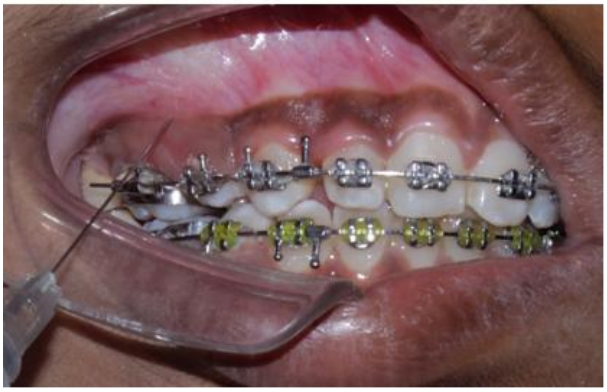




Scanning Electron Microscope to evaluate the tip of retrieved orthodontic mini implant for reinsertion

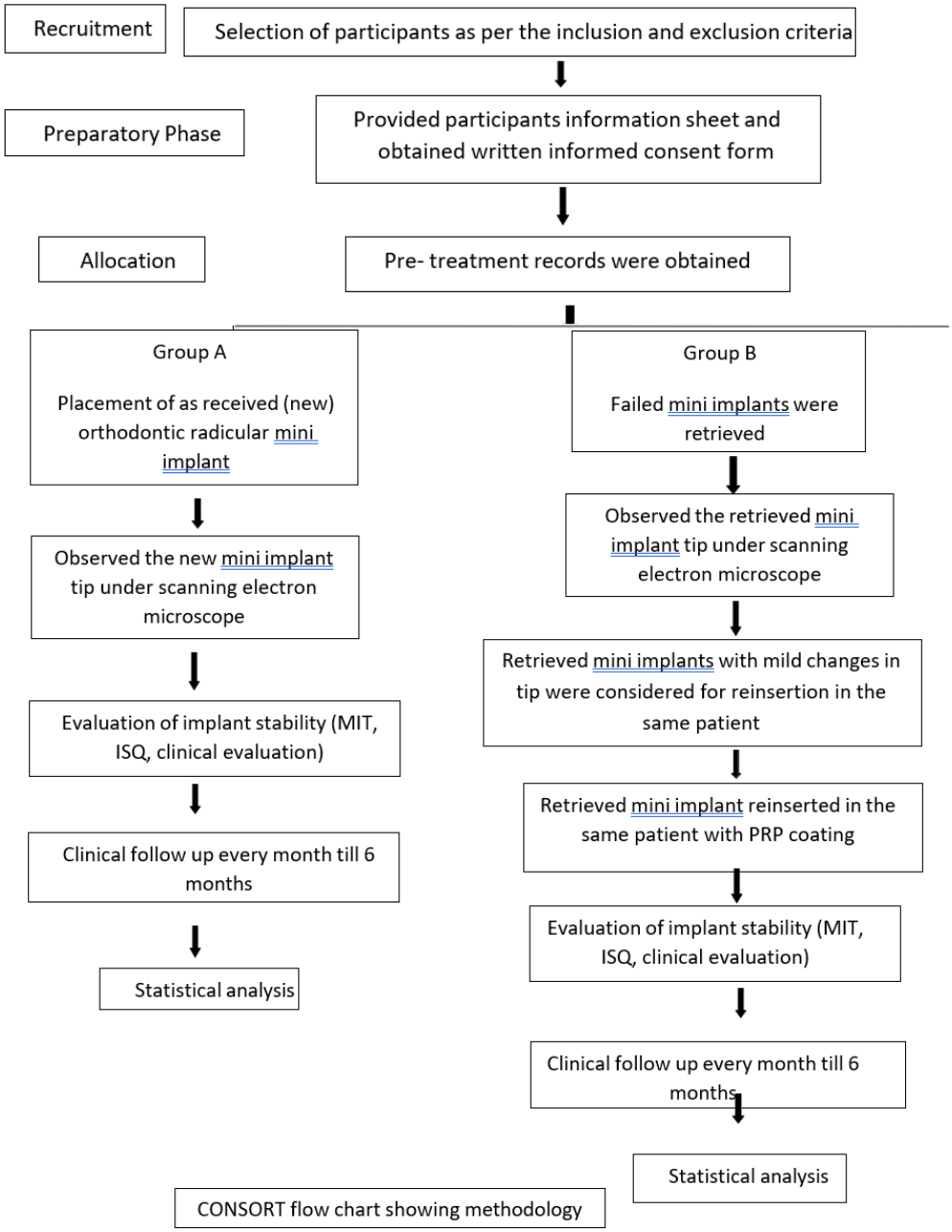
Blood drawn for preparation of PRP

Post centrifugation, Formation of PRP to coat retrieved orthodontic mini implant



Infiltrating site of implant placement with Local Anesthesia

Making puncture point with probe



CONSORT flow chart showing methodology

III. Result

Table 1: Pretreatment Demographic Details

Demographic Data of Participants in Group A		
Sr. No.	**Sex**	**Age (in years)**
Group A	4Males, 7 Females	21.8 ± 2.3
Group B	5Males, 6 Females	22.1 ± 3.0

Table2: ISQ and MIT for Group A & Group B implants

Sr. No.	MIT	ISQ
Group A	8.99±0.72	32±3.91
Group B	9.28±0.73	32.81±1.83

Table3 : ISQ and MIT for successful and failed implants for both group A and Group B

Sr. NO.	MIT			ISQ		
	Successful	**Failed**	**P value between successful and failed in individual group**	**Successful**	**Failed**	**P value between successful and failed in individual group**
Group A	9.26±0.67	8.29±0.13	0.004	33.75±1.66	27.66±5.13	0.172
Group B	9.43±0.71	8.59±0.43	0.136	33±1.73	32±2.8	0.705
P value between group A and B	0.611	0.501		0.378	0.312	

Table 4: Correlation between MIT and ISQ for successful and failed implants in both groups

Sr. No.	Successful	Failed
Group A	0.393	0.367
Group B	0.381	1

The study included 22 participants, 4 males and 7 females in Group A with mean age of 22 ± 2.69 years. Group B comprised of 5 males and 6 females with mean age of 22.1± 3.0 years

The mean and standard deviation of MIT and ISQ for Group A is 8.99±0.72Ncm and 32±3.91 respectively

The mean and standard deviation of MIT & ISQ for successful mini implants for Group A is 9.26±0.67Ncm and 33.75±1.66 respectively, The mean and standard deviation of MIT & ISQ for failed mini implants for Group A is 8.29±0.13Ncm and 27.66±5.13

Unpaired t test was used to evaluate ISQ & MIT for successful and failed implants (p value<0.05). p value obtained is 0.172 & 0.004 hence, there was no statistical difference in ISQ of successful and failed mini implants whereas there is a statistical difference in MIT of successful and failed mini implants.

Pearsons correlation in Group A and Group B for successful & failed mini implants in Group A and Group B is 0.393 & 0.367; 0.381 and 1

The mean and standard deviation of MIT and ISQ for Group B is 9.28±0.73Ncm and 32.81±1.83 respectively

For failed mini implants in Group B, the mean and standard deviation of MIT is 8.59±0.43Ncm and ISQ is 32±2.8. For successful mini implants, the mean and standard deviation of MIT for Group B is 9.43±0.71Ncm and ISQ for successful mini implants is 33±1.73.

Unpaired t test was used to evaluate ISQ and MIT for successful and failed implants is 0.705 and 0.136(> 0.05) hence, there was no statistical difference in ISQ and MIT of successful and failed mini implants

MIT for successful and failed implants in group A and Group B and p value obtained was 0.611 and 0.501 (> 0.05) hence, there was no statistical difference in MIT for successful and failed mini implants in group A and Group B

ISQ for successful and failed implants in group A and Group B and p value obtained is 0.378 and 0.312 (> 0.05) hence, there was no statistical difference in ISQ of successful and failed mini implants in group A and Group B

IV. Discussion

Creekmore and Eklund[16] introduced mini implants in the field of orthodontics in 1983. The vitalium bone screw implant reportedly remained stationary throughout the treatment. The stability of the screw proved to be

crucial for the success of orthodontic treatment, several authors such as Kanomi[19], Melsen and costa [20] have since then experimented with various mini-implants to increase anchorage during retraction and intrusion.

The study included 22 participants, 4 males and 7 females in Group A with mean age of 22 ± 2.69 years. Group B comprised of 5 males and 6 females with mean age of

22.1± 3.0 years.The higher proportion of females aligns with previous study by Pabari et al[21] indicating that females seek orthodontic treatment more frequently than males due to aesthetic concerns. Miyawaki et al[17] observed that the age group (18–27 years) is typical for orthodontic patients requiring temporary anchorage devices (TADs), as skeletal maturity is a key factor in implant stability.

In group A that is newly placed orthodontic mini implants, out of 11 implants,8 were successful and 3 had failed (success rate of 72.7%) whereas in Group B that is plasma coated retrieved orthodontic mini implants, 9 were successful and 2 had failed (success rate of 81.8%). [22]

According to Dirk Weichmann[23] and P Sharma [24]et al, the average rate of orthodontic mini implant success is 70.2-90.7% and there can be a number of reasons for its failure, it can be due to patient related, implant related or treatment related factors.

One crucial predictor for orthodontic mini implant success is primary stability, which is the stability right after implant insertion. The contact between the implant and bone mostly determines it. Since the orthodontic mini implants need not to be osseo integrated, primary stability values required for their stability is less in comparison to dental implants.[18]

To measure the insertion torque we have used digital torque meter in our study and is the most widely used method for assessing mini-implant's primary stability.[25, 26]

Another readily applicable technique for assessing quantitative stability that may be applied frequently in both intraoperative and postoperative contexts is non-invasive resonance frequency analysis (RFA). In order to provide values that can be compared regardless of the implant system being utilized, the resulting Hertz waves are transformed into a numerical number known as the implant stability quotient (ISQ).[27, 28]

Our study evaluated the primary stability of orthodontic mini implants in two groups (Group A and Group B) by analysing Maximum Insertion Torque (MIT) and Implant Stability Quotient (ISQ) values.

The values suggest that higher insertion torque correlates with better primary stability, which is similar to study by Motoyoshi et al.[18] indicating that higher MIT values are associated with successful use of implants

Marquezan et al[29] as similar to our study also observed that the lower values for MIT and ISQ in failed mini implants may indicate poor primary stability in comparison to successful mini implants, thus, may be a predictor for mini implant failure

Sennerby & Meredith[30]observed that though ISQ is a useful measure of stability, its predictive value for failure can be influenced by bone density variations

ISQ for successful orthodontic mini implants is greater than failed orthodontic mini implants but did not significantly differ between successful and failed implants as there are many factors responsible for implant failure other than primary stability such as patient's oral hygiene status, bone density etc. as mentioned by Atsumi et al[31]

Similar to study by Javed et al.[32], this confirms that MIT is a critical factor in implant success, as higher torque values reduce micromotion and enhance osseointegration.

The lack of significance difference in MIT of successful and failed mini implants for Group B may be due to the small sample size of failures (n=2).

It was seen that there's positive correlation between ISQ and MIT. Thus, both are capable of indicating primary stability.[33,34]

Both groups had similar torque requirements for success, suggesting consistent biomechanical behaviour.

Platelet rich plasma, it increases the amount of bone formed around mini implant and also increases bone density thus, helping to improve overall implant stability. [35] Therefore, platelet rich plasma coated retrieved orthodontic mini implants have similar ISQ and MIT as newly received orthodontic mini implants and thus, can be considered for re insertion upon failure of orthodontic mini implant

The limitations of the study are small sample size, thus, limiting statistical power. Bone density variations were not evaluated due to lack of CBCT data to correlate MIT/ISQ with bone quality.

V. Conclusion

When Platelet Rich plasma is coated on retrieved orthodontic mini implants then they can be considered for reinsertion as they have similar primary stability (ISQ and MIT) as newly received orthodontic mini implants. MIT and ISQ values for successful orthodontic mini implants were higher than failed orthodontic mini implants but were not statistically significant except for MIT in Group A between successful and failed implants which was statistically significant. Thus, there can be a lot of other patient and treatment related factors such as oral hygiene, early or delayed loading, bone density and bone quality etc. which may be responsible for implant failure. MIT was positively correlated with ISQ values for both successful and failed implants thus, proving as an effective

tool for assessing primary stability for orthodontic mini implants. Future studies should explore additional factors such as bone density and cortical bone thickness to refine predictive models for implant failure.

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