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Reliability of orthodontic miniscrews: bending and maximum load of different Ti-6Al-4V titanium and stainless steel temporary anchorage devices.

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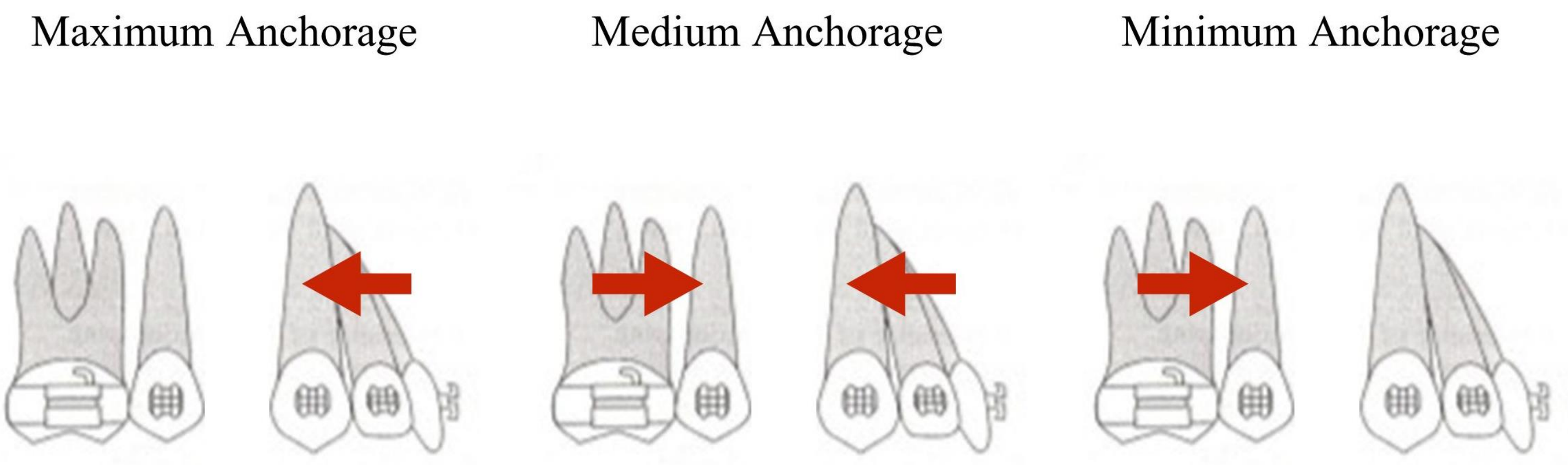
INTRODUCTION

- During orthodontic treatment excessive forces have been associated with undesirable reactions and side effects, including bone hyalinization, root resorption, patient discomfort, and anchorage loss.



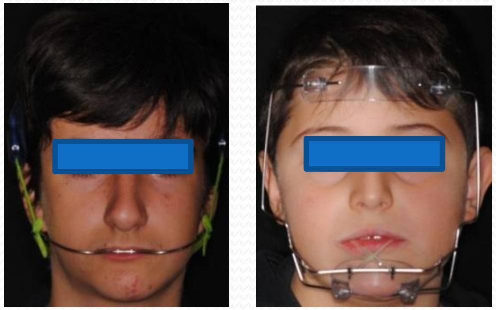
Nanda, Biomechanics in Orthodontics: Principles and Practise

Sfondrini G, Gandini P, Sfondrini MF, Cacciafesta V, Fraticelli D. Ortognatodonzia Terapia. Editor: Edizioni Martina 2008.
Ludwig B, Baumgaertel S, Bowman SJ. Mini-implants in orthodontics – Innovative Anchorage Concepts. Editor: Quintessence publishing Co Ltd 2008.

INTRODUCTION

The resistance to undesirable tooth repositioning is defined as anchorage and can be obtained with:

- Extraoral devices



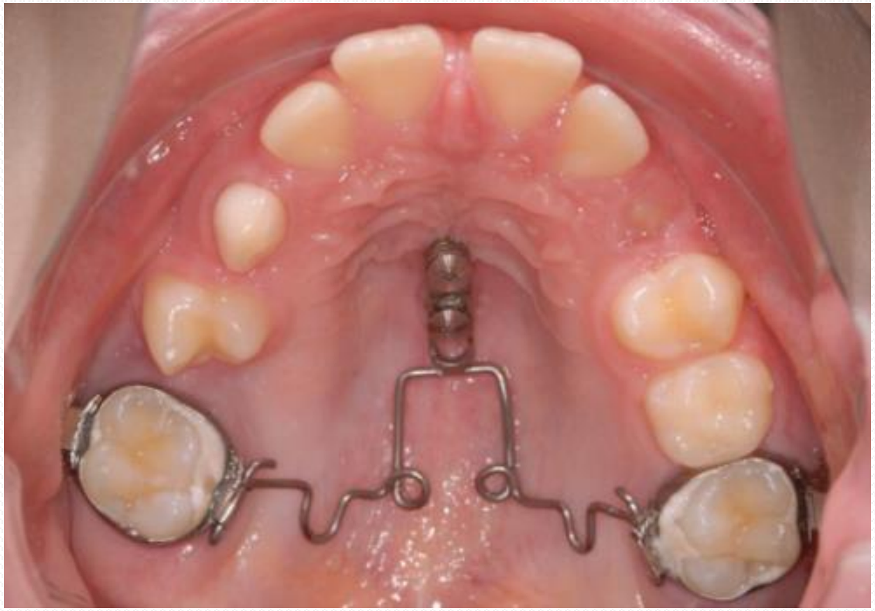
- Inraoral devices

- Intermaxillary forces

- Skeletal anchorage systems

INTRODUCTION

Orthodontic miniscrews have been introduced as a new system for anchorage control. These temporary anchorage devices (TADs) are mini implant inserted into either maxillary or mandibular jaws to help the clinician to move the correct teeth and avoid other teeth to slide toward a wrong direction [Mc Guire et al., 2006]



INTRODUCTION

The use of miniscrews gained popularity during last years for their simplicity of use. So TADs has been reported also for non-conventional purposes, as:

stabilization for facemask protraction [Kircelli et al., 2006],
fracture management [Pires et al., 2011],
palatal skeletal expanders [Suzuki et al., 2016],
and provisional miniscrew-supported pontics [Wilmes et al., 2014].

Higher tangential loads → Higher fracture risk

INTRODUCTION

Therefore, the purpose of the present investigation was to evaluate:

-Titanium miniscrews
-Stainless steel miniscrews

-1.5 mm diameter
-2.0 mm diameter

By measuring:

-forces to bend the miniscrews of 0.1 mm
-forces to bend the miniscrews of 0.2 mm
-forces to fracture the miniscrews

MATERIALS AND METHODS

Seven different miniscrews were tested (10 specimen each):

Name	Manufacturer	Diameter	Length	Material	n
Spider Screw	HDC	1.5 mm	10 mm	Titanium Ti-6Al-4V (Grade 5)	10
Mini Implants	Leone	1.5 mm	10 mm	Stainless Steel	10
Benefit	Orteam	1.5 mm	11 mm	Titanium Ti-6Al-4V (Grade 5)	10
Storm	Kristal	1.5 mm	10 mm	Titanium Ti-6Al-4V (Grade 5)	10
Mini Implants	Leone	2.0 mm	10 mm	Stainless Steel	10
Benefit	Orteam	2.0 mm	11 mm	Titanium Ti-6Al-4V (Grade 5)	10
Storm	Kristal	2.0 mm	10 mm	Titanium Ti-6Al-4V (Grade 5)	10

MATERIALS AND METHODS

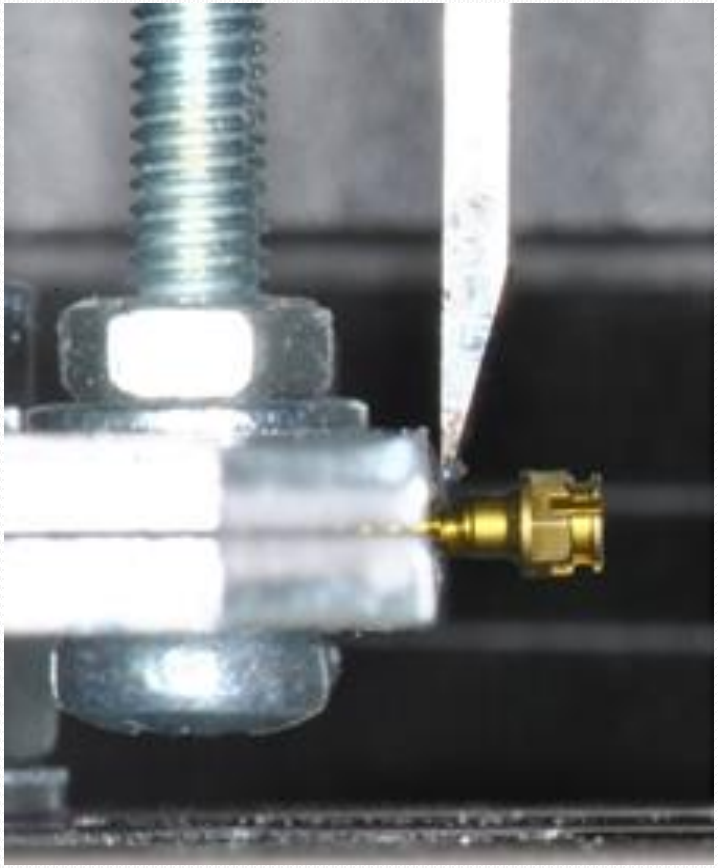
Specimens were tested with a Universal Testing Machine.

Each mini implant was blocked in the lower jaw of the machine. The head (between endo osseous thread and trans mucosal collar) was exposed to tangential load with a 1mm/min crosshead speed.

-Bending force at 0.1mm (Groups 1 to 7)

-Bending force at 0.2mm (Groups 8 to 14).

-Maximum load before screw fracture (Groups 15 to 21).



Load values were reported in newton.

Statistical analysis was performed (ANOVA + Tukey).

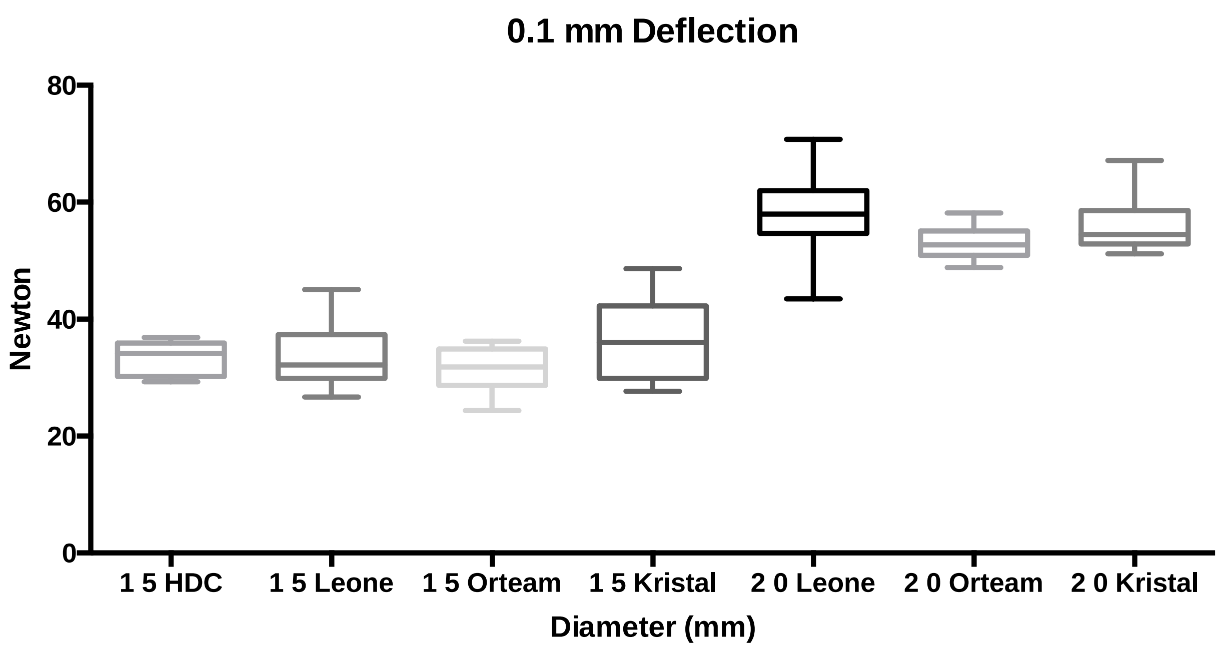
RESULTS

0.1mm deflection:

-No significant differences were detected among 1.5mm diameter miniscrews (P>0.05).

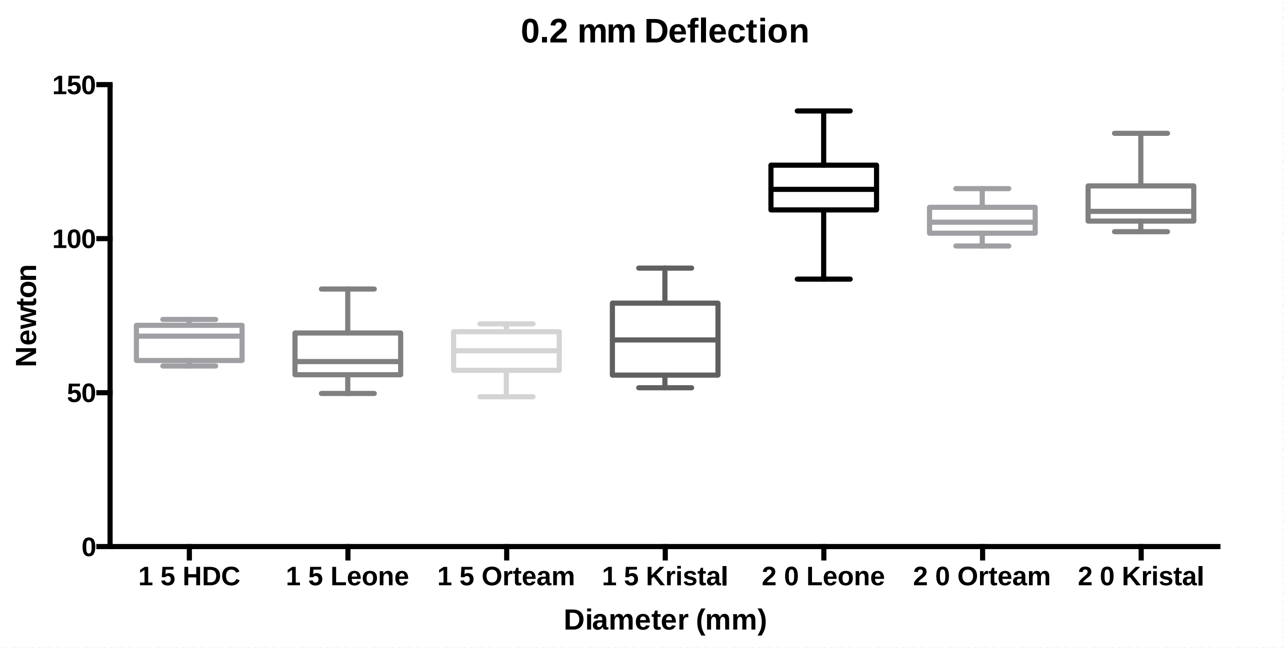
-Significantly higher forces (P<0.05) were reported for 2.0 mm diameter TADs, that showed no significant differences among them (P>0.05).

-No significant differences were found between SS and Ti mini implants (P>0.05).



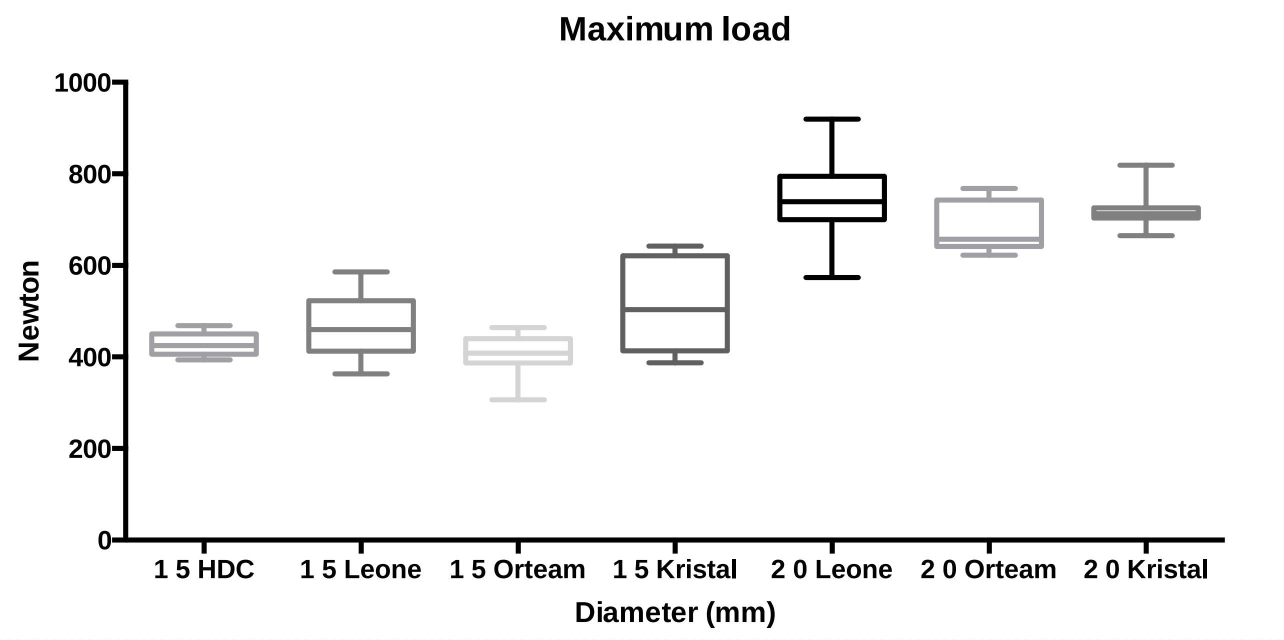
RESULTS

Similar behavior was reported at 0.2 mm deflection with significantly higher values.



RESULTS

Similar behavior was reported at maximum load before fracture with significantly higher values.

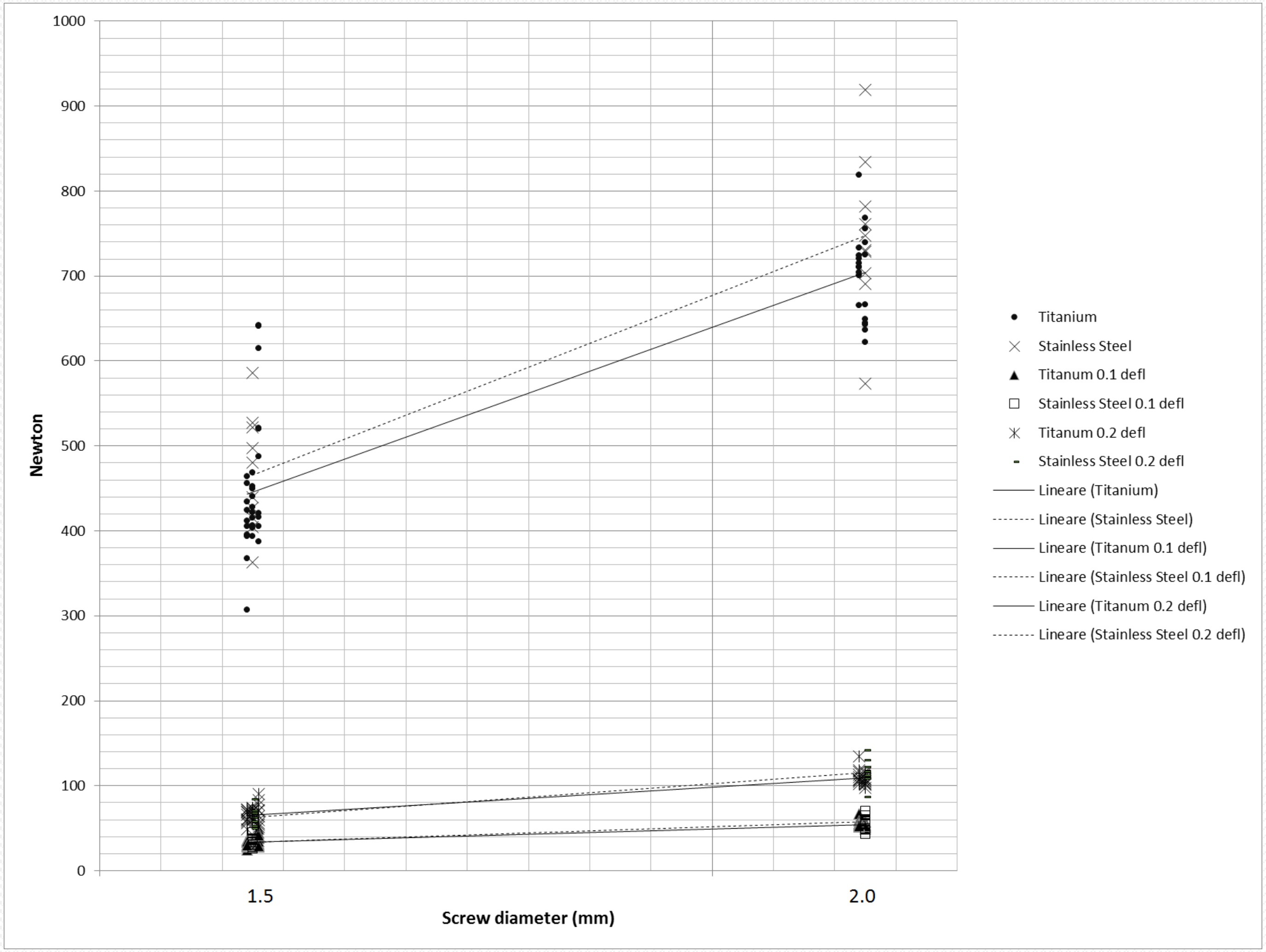


RESULTS

Linear regressions confirmed the trends:

Significant Miniscrew Diameter effect (P<0.05)

Not significant Miniscrew Material effect (P>0.05)



DISCUSSION

Previous Authors showed that, if miniscrew failure is the most frequent drawback, the screw fracture is the most unwanted complication during TAD employment [Kuroda and Tanaka, 2014].

In fact, a broken miniscrew has to be removed from bone, with an intervention that is not easy nor always successful. [Kuroda and Tanaka, 2014].

When miniscrews are used for orthodontic anchorage, the fracture risk is relatively low (about 1%) [Jing et al., 2016].

However, when mini implants are used for non-conventional orthopaedic applications, fracture risk could increase [Pires et al., 2011].

DISCUSSION

The use of temporary anchorage devices (TADs) has been reported, for non-conventional orthopaedic purposes, as:

- stabilization for facemask protraction [Kircelli et al., 2006],
- fracture management [Pires et al., 2011],
- palatal skeletal expanders [Suzuki et al., 2016], and
- provisional miniscrew-supported pontics [Wilmes et al., 2014].

In all these cases, the mini implants are subjected to higher tangential forces if compared with conventional orthodontic anchorage uses.

DISCUSSION

However, no studies evaluated in air bending and fracture loads, therefore the results of the present investigation are not directly comparable with existing Literature.

On the other hand, many Authors studied insertion and removal torque loads, showing a significant effect of screw diameter. In fact, lowest forces were recorded with small-diameter miniscrews, whereas higher values were found with higher diameter mini implants [Wilmes et al., 2011].

This is in agreement with the present report, both when evaluating bending and fracture loads after shear strength application.

DISCUSSION

Orthodontic mini implants are marketed both made with titanium or stainless steel.

There are no studies that compared mechanical behavior of miniscrews of different materials.

In our study, both titanium and stainless steel miniscrews were considered. No significant differences were recorded in bending and fracture loads between titanium and stainless steel TADs for both diameters tested (1.5 mm and 2.0 mm).

CONCLUSIONS

The knowledge of initial bending and maximum load of different mini implants reported in the present investigation could help clinicians during the choice of screw material and diameter.

Further studies are needed to test other variables related to miniscrews

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Thank you for kind attention