



EVALUATION OF FULLY SINTERED YTTRIUM-NIOBIUM-TETRAGONAL ZIRCONIA POLYCRYSTAL ((Y, Nb)-TZP) FOR PROSTHODONTIC RESTORATIONS AND DENTAL IMPLANTS

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Introduction

Fully sintered zirconia ceramics are necessary to realize single-visit restoration. However, achieving adequate machinability in fully sintered zirconia remains a challenge. The addition of yttria (Y_2O_3) and niobia (Nb_2O_5) to tetragonal zirconia polycrystal (TZP) improves both machinability and fracture toughness, despite reducing the strength and hardness of TZP. Enhanced fracture toughness helps decrease the fracture rates of zirconia crowns during function and zirconia implants during installation. This study aimed to evaluate the clinical survival rates of single zirconia crowns and the in vivo histomorphometry of zirconia implants made of (Y, Nb)-TZP.

Methods

Fifteen participants received a total of 15 monolithic single restorations made from fully sintered (Y, Nb)-TZP blocks. The restorations were clinically evaluated for survival rate 2.5 years after crown delivery. (Y, Nb)-TZP dental implants, measuring 3.4 mm in diameter and 7 mm in length, were inserted into rabbit tibiae and compared to sandblasted, large-grit, acid-etched (SLA) titanium implants made from grade 4 commercially pure titanium. Four weeks after implant surgery, the experimental animals were euthanized, and undecalcified specimens were prepared for light microscopy. The primary outcome measure was bone-to-implant contact (BIC). Wilcoxon's signed-rank test was used to compare means at a significance level of 0.05.



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1. The clinical study: an observational prospective cohort

> Summary of this prospective study

- Inclusion/exclusion criteria
- Clinical protocol
- Informed consent



Provisional restoration



Impression
jaw-relation check

Fully sintered
(Y, Nb)-TZP blocks

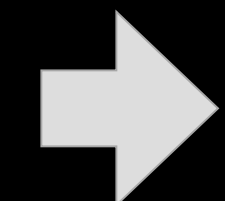


- Definitive (Y, Nb)-TZP single crowns

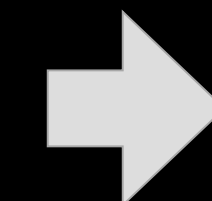


Delivery

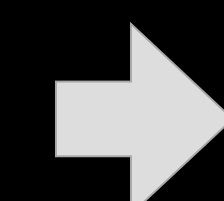
Screening



2nd visit



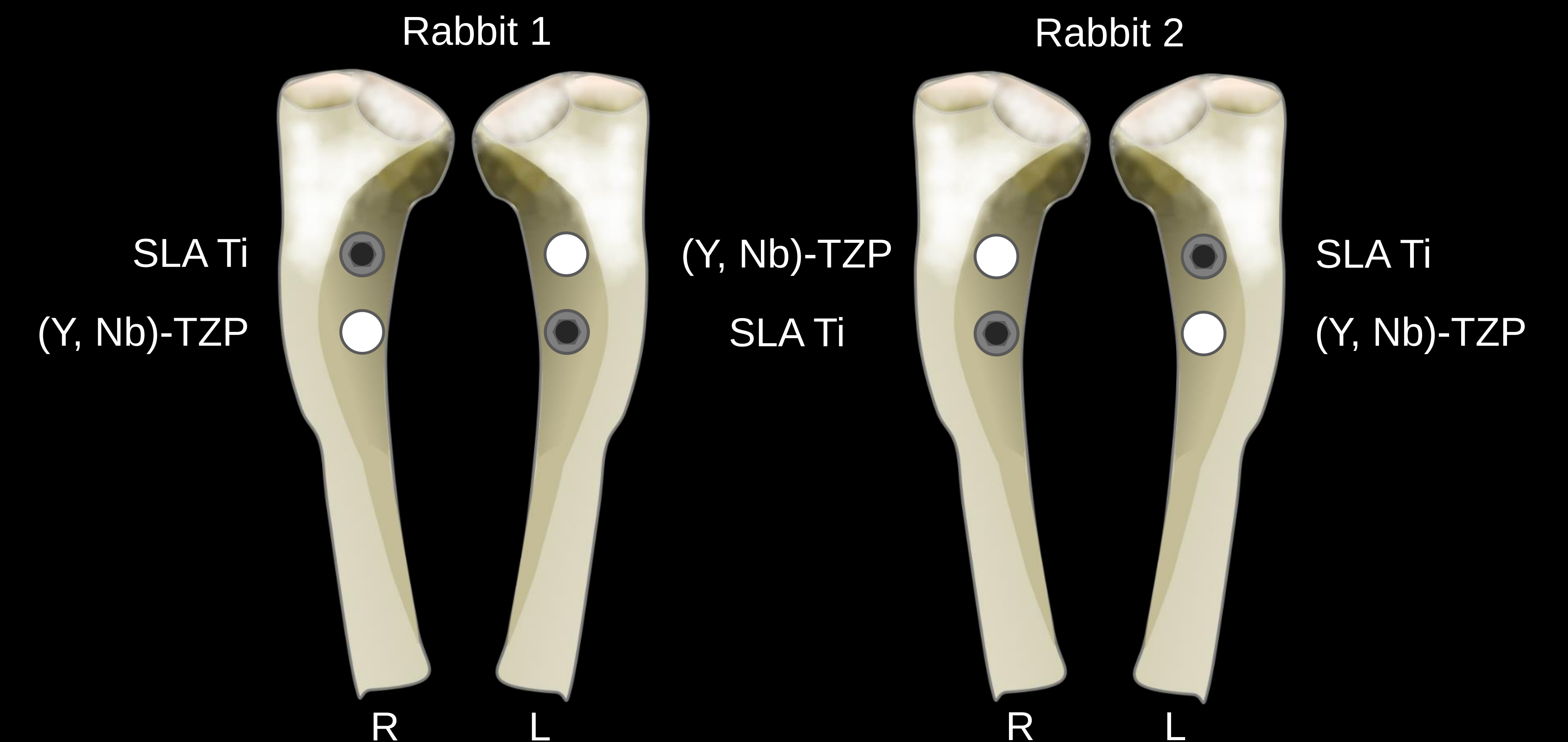
Lab work



3rd visit

2. The in vivo study: a rabbit tibia model

- > Specimen: Screw-shaped, 3.4 mm in diameter, 7 mm in length
- Control: SLA implants made of grade 4 Ti
- Sample arrangement: 2 × 2 Latin square
- Sample size per group: n = 4
- Euthanasia: 4 weeks after implant insertion
- Histomorphometry: bone-to-implant contact (BIC)
- Statistics: Wilcoxon's signed rank test





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Results

The survival rate of the (Y, Nb)-TZP single crowns was 100% after 2.5 years of clinical service. The median values (interquartile range) of bone-to-implant contact (BIC) were 44.4% (10.8%) for the (Y, Nb)-TZP implants and 67.7% (6.9%) for the SLA titanium implants. However, no significant difference was found in BIC between the two implant types ($P = 0.25$).

1. The clinical study: an observational prospective cohort

Distribution of the (Y, Nb)-TZP single restorations.

Tooth	Maxilla	Mandible
Cental incisor	1	0
Lateral incisor	0	0
Canine	2	0
First premolar	4	0
Second premolar	0	0
First molar	1	3
Second molar	0	4
Total	8	7

Survival rate of
the (Y, Nb)-TZP single crowns:
100% for 2.5-year clinical service

Complications

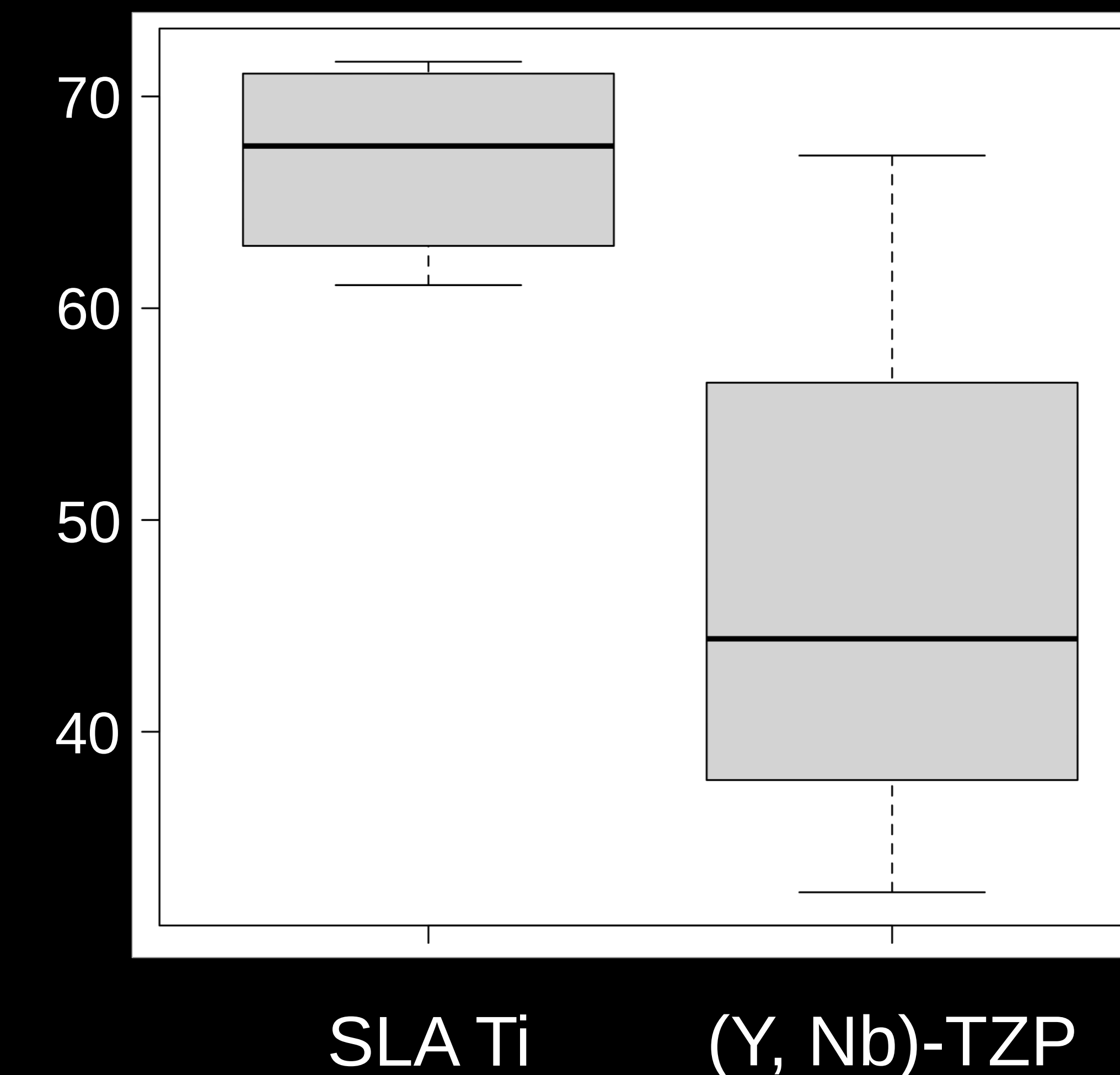
Surface staining: 1 case

Color stability and translucency: 1 case

Other mechanical and biological complications: 0 case

2. The in vivo study: a rabbit tibia model

BIC data from the in vivo experiment

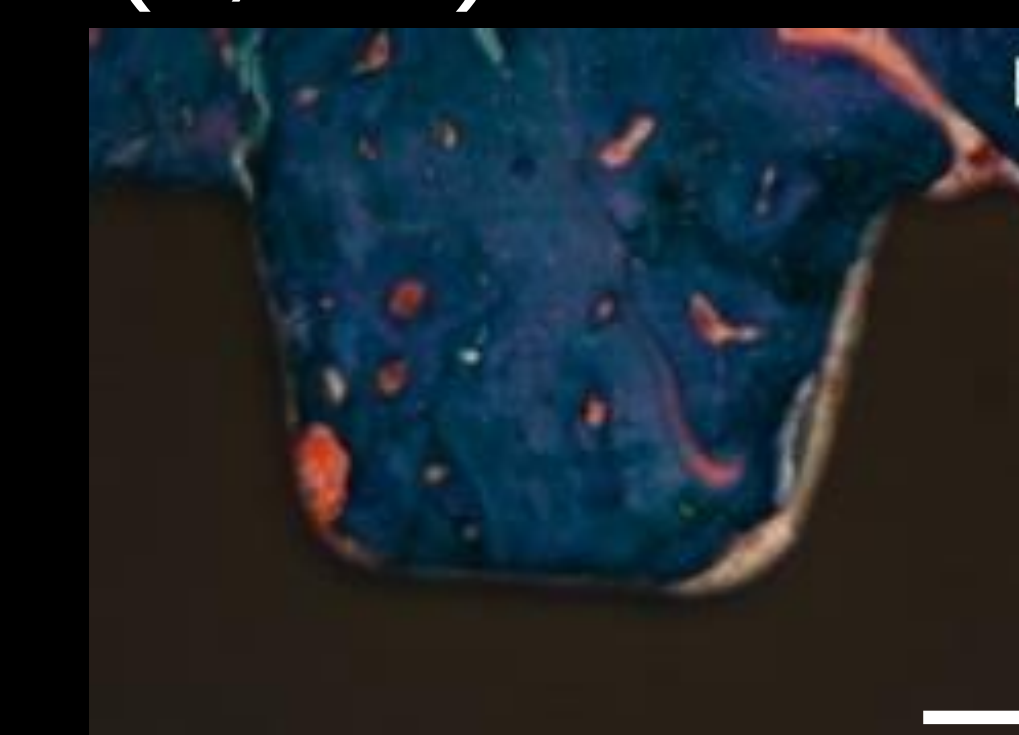


SLA Ti



Median: 67.7%
IQR: 6.9%

(Y, Nb)-TZP



Median: 44.4%
IQR: 10.8%

Wilcoxon's signed rank test found no significant difference in BIC between the SLA Ti and (Y, Nb)-TZP dental implants ($P = 0.25$).



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Conclusion

The fully sintered (Y, Nb)-TZP single-unit restorations demonstrated successful clinical performance over 2.5 years. Dental implants made of (Y, Nb)-TZP showed biocompatibility in bone response, based on the results of this in vivo experiment. However, considering the median BIC values and interquartile ranges of these zirconia and SLA titanium implants, topographical modification of the zirconia surface may be necessary.

References

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