P6-7

Effect of implant placement depth on bone remodeling on implant- supported single zirconia abutment crown : A 3D finite element study

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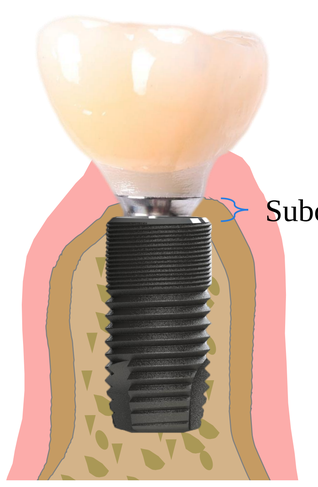
State of problem

Dental implant subcrestally placed below the crestal of cortical bone in various depths ranging from 0.5 to 3 mm.

Maintain peri-implant bone level



Subcrestal Implant

❑Reduce Micromotion

Szmukler-Moncler S et al. 1998

❑Prevent crestal bone resorption

Chou HY et al. 2010, Donovan R et al. 2010 and Baggi L et al. 2008

❑Induce greater bone remodeling

Fetner Met al. 2015, Oskarsson M et al. 2018 and Froum S et al. 2018

❑Recommend subcrestal placement 0.5 mm to compensate physiologic bone resorption.

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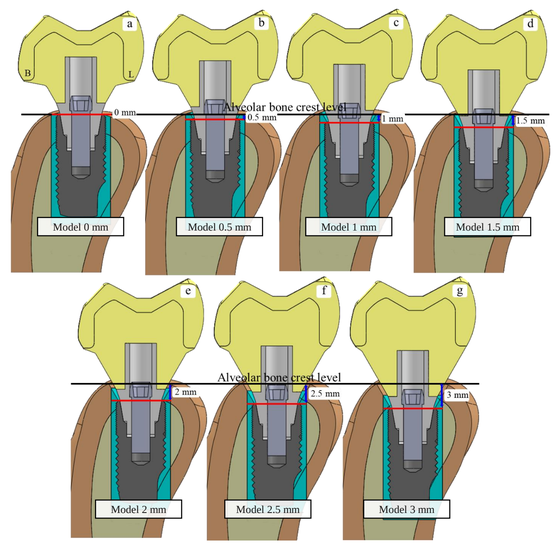
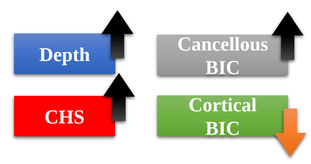
Purpose

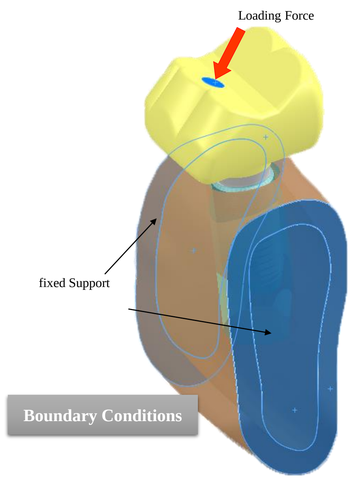
This study aims to evaluate the influence of subcrestal implant placement depth on bone remodeling using time-dependent finite element analysis (FEA) with a bone remodeling algorithm over 12 months

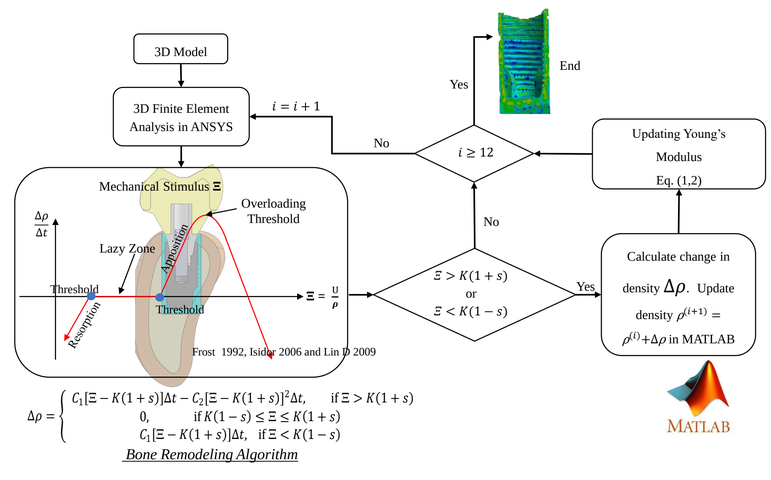
Methods



Model	Crown Height Space (CHS) (mm)	Bone Implant Contact (mm^2) (contact percentage)	
		Cortical bone	Cancellous Bone
0 mm	10	48.62 (19.55%)	200.04 (80.45%)
0.5 mm	0.5	37.37 (15.02%)	211.29 (84.98%)
1 mm	11	26.13 (10.50%)	222.53 (89.05%)
1.5 mm	11.5	14.46 (5.81%)	234.2 (94.18 %)
2 mm	12	5.06 (2.03%)	243.6 (97.97%)
2.5 mm	12.5	1.08 (0.43%)	247.58 (99.57%)
3 mm	13	0.00 (0 %)	248.66 (100%)







$$\Delta\rho = \begin{cases} C_1[\Xi - K(1+s)]\Delta t - C_2[\Xi - K(1+s)]^2\Delta t, & \text{if } \Xi > K(1+s) \\ 0, & \text{if } K(1-s) \le \Xi \le K(1+s) \\ C_1[\Xi - K(1+s)]\Delta t, & \text{if } \Xi < K(1-s) \end{cases}$$

Bone Remodeling Algorithm

Results & Discussion

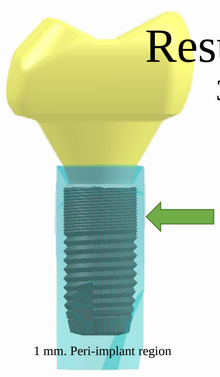
Result Interpretations

3 Parameters

1. Volume averages of density at the peri-implant region

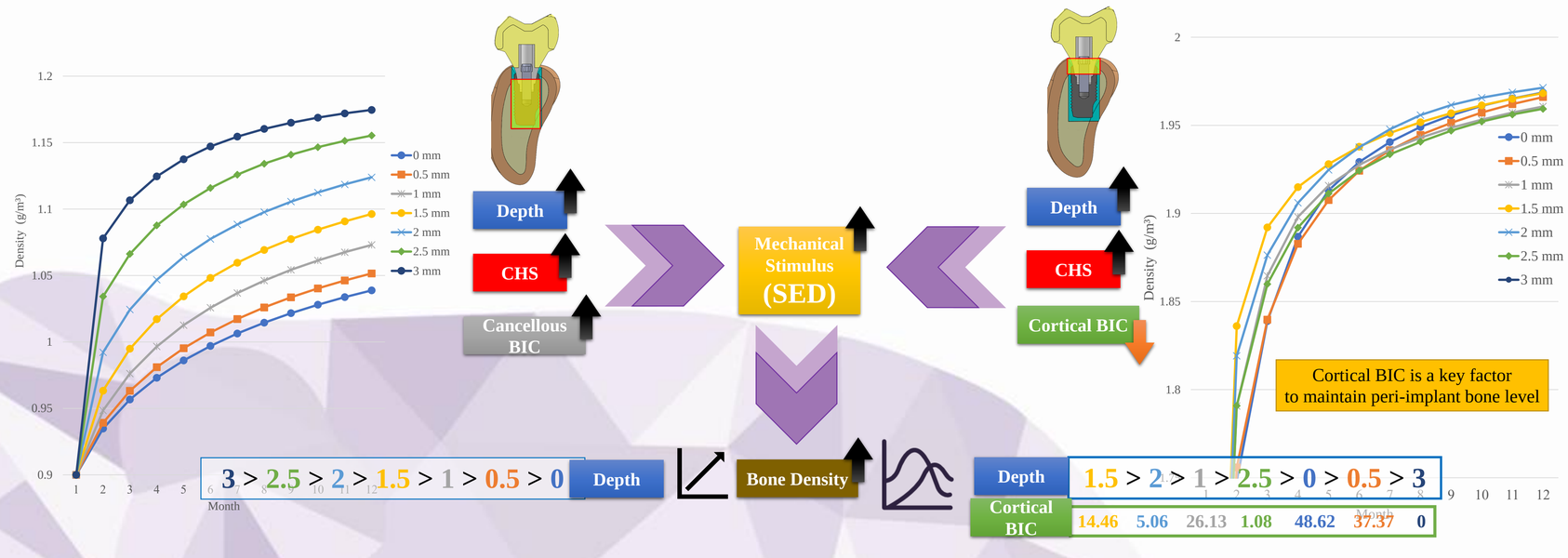
$$\bar{\rho} = \frac{1}{V}\int_V \rho dV \approx \frac{1}{\sum_{e=1}^{n} V_e}\sum_{e=1}^{n} \rho_e V_e$$

2. Maximum von Mises Stress
3. Overloading elements

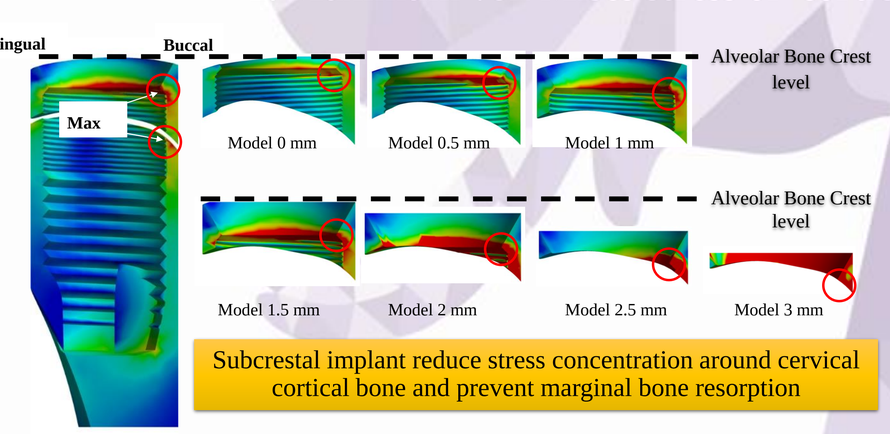


1 mm. Peri-implant region

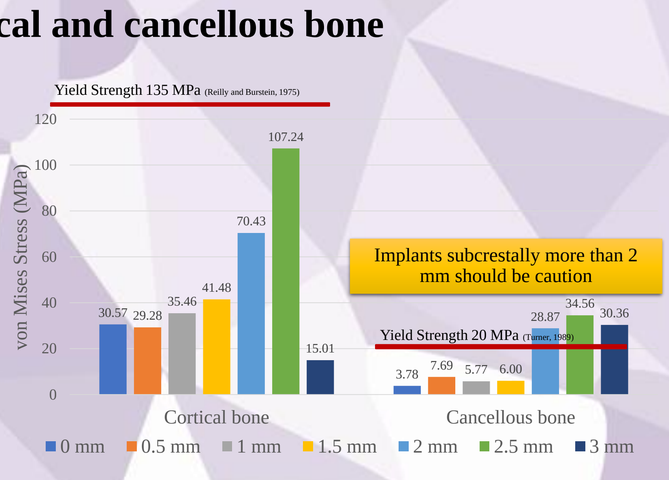
1. Volume averages of density at the peri-implant region over 12 months.



2. Maximum von Mises stress of cortical and cancellous bone

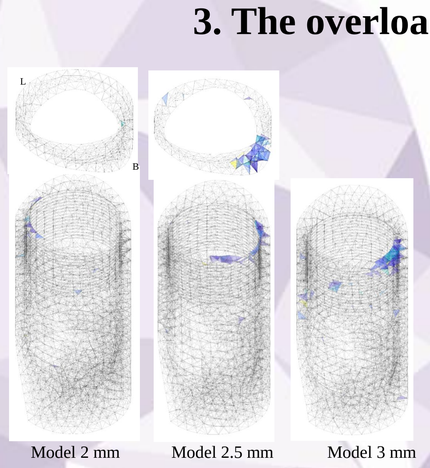


Subcrestal implant reduce stress concentration around cervical cortical bone and prevent marginal bone resorption



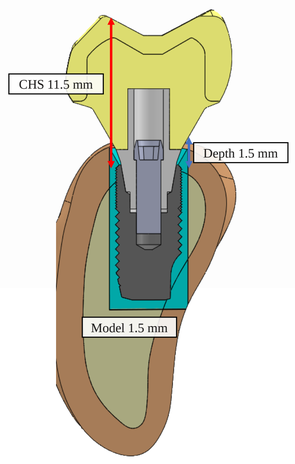
Implants subcrestally more than 2 mm should be caution

3. The overloading elements



This overloading could not be discovered through von Mises' stress failure criteria

This finding may help explain the occurrence of osseointegration failure of an integrated implant or progressive bone loss.



According to the findings

- ❑ Implant placements greater than 2 mm subcrestally induced bone resorption
- ❑ Implant positioned 1.5 mm subcrestally demonstrates rapid rise in cortical density without risk of bone overload.
- ❑ In clinical situation the CHS greater than 12 mm should be treated with caution and monitored on a frequent basis.
- ❑ However, further research should be undertaken through optimization research to identify the optimal depth.

Conclusion

Within the limitations of the study, it may be inferred that

- ❑ The implant placement depth has a direct effect on peri-implant bone remodeling, particularly in cancellous bone.
- ❑ The more implants placed apically, the greater the increase in bone density. However, implant placements depth than 2 mm. should be aware bone loss caused by overloading resorption.