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学位論文名	The in vitro study of anatomical and prosthetic factors related to force transfer around implant restoration with resrbed bone in posterior edentulous region （臼歯部インプラント補綴の安定性に関する実験的検討－不利な骨量ならびに骨質における応用を想定－）
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論 文 内 容 の 要 旨

Purpose

In clincal there are many patients present with severe alveolar bone resorption in the posterior edentulous regions. The implant treatment in these areas is restricted by anatomical factors such as unfavorable bone quantity and quality with irrelevant crown-implant (CI) ratios in implant restoration. Besides with the recent development in implantology, prosthetic factors such as different width of implant diameter, internal geometric abutment-implant connection implant system or splinted implant restoration become more available for implant treatment. But the mutual influence between the anatomical factors and prosthetic factors related to implant treatment in the severe bone resorption posterior edentulous regions is still unknown very well.

The purpose of this in vitro study was to use test models with strain gauge method to evaluate both the biomechanical influences of anatomical and prosthetic factors on strain occurrence around implant restorations under loading in the posterior edentulous region with severe bone resorption.

Materials and methods

In this series studies anatomical factor [Study 1] and prosthetic factor [Study 2] related to implant therapy were evaluated. All the produces of loading condition and test frequency and statistical methods ($p<0.01$: considered statistically significant) were carried out in a similar manner.

[Study 1]: Effect of the different quantity and quality of the supporting bone

5 x 12mm implants (GC) fixed with 13mm height abutments (GC) were arranged into the PMMA resin (Heraeus Kulzer) and super-hard stone (Kerr) blocks which were simulated as the low and high density bone according to elastic modulus range of alveolar bone. Four strain gauges (Kyowa) were attached on the each implant surface at 7.2, 9.5, 11.5 mm height form the tip and collar of the abutment to measure the strain under 50N of 30 degree lateral loading. The supporting levels around implants were increased by adding PMMA resin and super-hard stone to 7.2mm height (CI ratio: 2.05), 9.5mm height (CI ratio: 1.31) and 11.5mm height (CI ratio: 0.91) and the lateral strain was measured under each condition.

[Study 2-1]: Effect of the external and internal abutment-implant connection implant

External (EX) and internal (IN) abutment-implant connection system implants (5 x 12mm, GC) were arranged in a low bone density bone model (PMMA resin block). Four strain gauges (Kyowa) were attached on EX and IN implant surfaces at 4, 8, 12mm height from the tip and collar of the abutments. The supporting bone levels were then increased to 4mm (CI ratio: 4.5), 8mm(CI ratio: 1.75) and 12mm height (CI ratio: 0.83) by adding PMMA resin and the lateral strain was measured under each condition.

[Study 2-2]: Effect of the implant diameter

Implants (diameter: 3.8, 4.4, 5.0mm; length: 7mm, GC) fixed with abutments (height: 13mm, GC) were arranged in the low bone density model. Strain gauge (Kyowa) was attached to the place 1mm below the abutment-implant connection on each implant. According to the loading points on abutments, CI ratios were simulated as 1.85, 1.5, 1 in each implant restoration and the lateral strain was measured under each condition.

[Study 2-3]: Effect of splinted implant restoration

Two of the same diameter 7mm in length short implants (diameter: 3.8, 4.4, 5.0mm, GC) were splinted in the same test model which was used in [Study 2-2] and the lateral loading process was the same as [Study 2-2, CI ratio: 1.85]. In addition, each of these 3.8, 4.4, 5.0mm diameters short implant were splinted further to a 4.4 x 12mm long implant (GC) to evaluate and compare the effect of different types splinted implant restorations under loading.

Results

[Study 1]: Effect of the different quantity and quality of the supporting bone

An inclined movement occurred when implant was under loading and the strain always concentrated in the area where the support level ended in all the test conditions.

In comparing with the greatest strain, there were no significant differences between the low and high density bone models in 0.91 and 1.31 CI ratios. But when CI ratio was increased to 2.05, the strain values became significant larger, especially in the low density bone model. The strain concentration on the implant restoration was found to be less affected by a change of CI ratios in instances of good quality high density bone in this study.

[Study 2-1]: Effect of the external and internal abutment-implant connection implant

As the supporting bone levels decreased with increase in CI ratios, the greater strain was found both in EX and IN implants. There was a smaller strain value with a more equitable strain distribution on IN implant than on EX implant under three different CI ratios loading conditions. And the strain concentration on IN implant was found to be less affected by a change of CI ratios.

[Study 2-2]: Effect of the implant diameter

The greatest significant strain values were found in the 1.85 CI ratio loading condition and became smaller progressively as CI ratios were changed to 1.5 and 1, with the highest values in 3.8mm diameter implant and the lowest values in 5.0mm diameter implant restorations in all the test conditions. The least strain variation was found in 5.0mm diameter implant restoration related to change of CI ratios.

[Study 2-3]: Effect of splinted implant restoration

Evaluation of the splinted implant restoration supported by two short implants(length: 7mm), the strain became progressively lower significantly when the splinting conditions were changed form 5.0 to 5.0mm, 4.4 to 4.4mm to 3.8 to 3.8mm diameter implants. In comparing with the results form non-splinted diameter 5.0, 4.4, 3.8mm implant restoration recorded from [Study 2-2, CI ratio: 1.85] respectively, the strain values got significant lower obviously. In addition, the lateral strain was almost identical in comparing with the different splinting conditions of restorations supported by two of 5.0, 4.4, 3.8mm diameters short implant pairs to 5.0, 4.4, 3.8mm diameters short implants splinted with 4.4mm diameter 12mm length long implant.

Discussion and conclusion

According to the results of this series study, anatomical factors such as loss of bone quantity with increase in CI ratios of implant restoration and worse of bone quality, the strain around implant would increase under loading and increase the biomechanical risk for implant treatment as well. But some prosthetic factors such wider diameter implant, internal abutment-implant connection or splinted implant restoration, the clinicians might consider when treating patient to reduce the localized strain concentration and increase the long term clinical stability.

論文審査の結果の要旨

本研究は、不利な骨量、骨質を伴う臼歯部欠損でのインプラント補綴に影響を与える解剖学的、補綴学的因子について、生体力学的な観点から、荷重時にインプラント周囲骨で生じるひずみを指標として実験的に検討したものである。

その結果、解剖学的因子については骨量の喪失、骨質の脆弱化に伴いインプラント周囲骨に生じるひずみは増加した。補綴学的因子については内部結合様式アバットメントの使用、より直径の大きなインプラントの使用、上部構造の連結によりひずみの集中を軽減できることが明らかになった。

これらのことは、インプラント補綴の治療計画に貴重な示唆を与えるものであり博士（歯学）の学位の授与に値するものと認める。