Mechanical Stability of Collagen Membranes: An In Vitro Study

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OBJECTIVE
Large horizontal or even minor vertical augmentations benefit from mechanically stable resorbable membranes that can be fixed with pins to immobilize the graft material. A prior investigation of native non-chemically cross-linked collagen membranes focusing on differences in degradation behavior and tissue integration already indicated good mechanical properties of a newly developed collagen membrane (CX). The aim of this study was (i) to compare the mechanical strength of commonly used native non-chemically cross-linked (NXL) and chemically cross-linked (XL) collagen membranes in vitro and (ii) to present an application of CX in a challenging clinical case of a so-called “knife-edge-ridge” needing vertical and horizontal bone augmentation prior to implant placement.

MATERIALS AND METHODS
• Prior to all assays, 6 mm x 30 mm membrane samples (n=6 for each membrane) were fully hydrated in phosphate-buffered saline at room temperature.
• Mechanical testing was performed using a Zwick/Roell 22.5 tensive tester (Zwick/ Roell, Ulm, Germany) with a load cell (maximum range of 500 N). Jaw separation was set at 10 mm. The strain rate was 12.5 mm/min for force and stress at break, and 50 mm/min for suture retention. For stress at break, the mean thickness of each membrane was used to calculate the cross-sectional area. For suture retention, a surgical suture (USP 5-0, Polyamide 6 Ethylon II Blue, Johnson & Johnson Int., Belgium) was placed 2 mm from the membrane border and tested as described previously.
• Statistical analysis was performed using a Wilcoxon test with Bonferroni corrections for multiple comparisons and significance was set at p<0.05. CX was the comparison group for all statistical tests.

RESULTS
IN VITRO STRENGTH ASSAYS (FIGURE 1)
• CX demonstrated the highest force at break wet (21.2 N; interquartile range [IQR]: 13.3–23.7).
• CX had the highest stress at break wet (14.2 N/mm2; IQR: 9.1–16.3).
• CX showed the highest suture retention wet (6.1 N; IQR: 5.9–6.5).

CLINICAL CASE
• A healthy 54 year old man had two long-time missing teeth at positions 46 and 47 (FDI).
• Prior to all assays, 5 mm x 30 mm membrane samples (n=6 for each membrane) were fully hydrated in phosphate-buffered saline at room temperature.
• Mechanical testing was performed using a Zwick/Roell 22.5 tensive tester (Zwick/ Roell, Ulm, Germany) with a load cell (maximum range of 500 N). Jaw separation was set at 10 mm. The strain rate was 12.5 mm/min for force and stress at break, and 50 mm/min for suture retention. For stress at break, the mean thickness of each membrane was used to calculate the cross-sectional area. For suture retention, a surgical suture (USP 5-0, Polyamide 6 Ethylon II Blue, Johnson & Johnson Int., Belgium) was placed 2 mm from the membrane border and tested as described previously.
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CONCLUSIONS
Wet creos™ xenoprotect membrane has a higher mechanical strength, resists higher stress and demonstrates a higher suture pull-out force than all other tested non-cross- linked and cross-linked collagen membranes. These mechanical characteristics suggest that creos™ xenoprotect can provide an important tool in extensive guided bone regeneration such as horizontal ridge augmentation.

REFERENCES

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