

SCIENTIFIC EVIDENCE OF

CLEAN&SEAL

FOR SEVERE PERIODONTITIS,
MUCOSITIS, & PERIIMPLANTITIS

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Overview of Publications

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Shirakata et al 2024	Iorio-Siciliano et al 2021	Zhu et al 2024
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		Asparuhova et al. 2020
		Eliezer et al 2019
		Asparuhova et al 2019
		Eliezer et al 2018
		Pilloni et al 2018
		Fujioka-Kobayashi et al 2017
		Müller et al. 2016

Relevant Studies on **PERISOLV** and **hyaDENT BG**

Benyei, L., Friedmann, A., Ostermann, T. *et al.* [Non-surgical treatment of residual periodontal pockets using sodium hypochlorite/amino acid gel and cross-linked hyaluronic acid—a 9-month pilot randomized controlled clinical trial](https://doi.org/10.1007/s00784-024-05906-w). *Clin Oral Invest* **28**, 513 (2024).
<https://doi.org/10.1007/s00784-024-05906-w>

Objectives

This pilot randomized controlled clinical trial compares the clinical outcome obtained in persistent periodontal pockets during 9-month follow-up of supportive periodontal step 4 treatment performed by either combining subgingival instrumentation with adjunctively used sodium hypochlorite/amino acid gel and crosslinked hyaluronic acid (xHyA) or subgingival instrumentation alone.

Materials and methods

Study protocol is registered under NCT06438354 at Clinicaltrials.gov. Patients seeking further therapy after completed step 2 non-surgical periodontal treatment underwent either repeated subgingival instrumentation with adjunctive application of sodium hypochlorite/amino acid gel and crosslinked hyaluronic acid (group A) or repeated subgingival instrumentation alone (group B). One calibrated investigator performed the treatment sequence in both groups accordingly. Subgingival instrumentation of the residual pockets was carried out under local anaesthesia using hand- and ultrasonic instruments, as well as air polishing in both groups. Patients were instructed to continue oral hygiene without any restriction. At 3-month re-evaluation treatment was repeated accordingly at sites with persistent 5 mm probing depth and BoP + . Clinical attachment level (CAL), pocket probing depth (PPD), gingival recession (GR), and bleeding on probing (BoP) were recorded at baseline (T1), 3- (T2) and 9-month (T3) post-op, with CAL as a primary outcome measure.

Results

In total 52 patients (20 females and 32 males, mean age 58.4 ± 2.4 years) presenting with 1448 sites which required further periodontal treatment were enrolled. Both groups exhibited homogeneity in terms of age, gender, smoking habit, initial number of sites, and BOP. At 9-month evaluation, PD reduction and CAL gain showed significant differences between the test and control group, favouring the adjunctive treatment. GR tended to exhibit more recovery in the test group compared to the control group. Although BOP frequency effectively reduced in both groups, there was no statistically significant difference between the two groups.

Conclusion

Within the limits of the study, the present data indicates that, during subgingival instrumentation of persistent pockets, the adjunctive usage of sodium hypochlorite/amino acid gel and xHyA sufficiently improves the clinical outcomes. The continuous improvement of CAL in association with the GR scores observed in group A, indicates that sites subjected to adjunctive treatment may indicate a tendency for a regenerative response to treatment within the 9-month follow-up period.

Shirakata Y, Nakamura T, Setoguchi F, Imafuji T, Shinohara Y, Matsumura S, Iwata M, Noguchi K, Ramanauskaite E, Sculean A. [Histological evaluation of nonsurgical periodontal treatment with and without the use of sodium hypochlorite / amino acids and cross-linked hyaluronic acid gels in dogs](#). Clin Oral Investig. 2024 Apr 27;28(5):281. doi: 10.1007/s00784-024-05674-7. PMID: 38676852; PMCID: PMC11055767.

Objectives

To evaluate periodontal wound healing following scaling and root planing (SRP) in conjunction with the application of sodium hypochlorite/amino acids and cross-linked hyaluronic acid (xHyA) gels in dogs.

Materials and methods

In four beagle dogs, 2-wall intrabony defects were created and metal strips were placed around the teeth. Clinical parameters were measured 4 weeks after plaque accumulation. The experimental root surfaces were subjected to SRP with either the subgingival application of a sodium hypochlorite/amino acid gel and a xHyA gel (test group) or SRP alone (control group) using a split-mouth design. Clinical parameters were re-evaluated at 6 weeks. The animals were sacrificed at 8 weeks for histological analysis.

Results

The test group showed significant improvements in all clinical parameters compared to the control group. Histologically, the test group exhibited statistically significantly greater new bone formation [i.e., length of newly formed bone, new bone area] compared with the control group ($p < 0.05$). Furthermore, statistically significantly greater formation of new attachment [i.e., linear length of new cementum adjacently to newly formed bone with inserting collagen fibers] and new cementum was detected in the test group compared with the control group at 8 weeks ($p < 0.05$ and $p < 0.01$, respectively).

Conclusion

The adjunctive subgingival application of sodium hypochlorite/amino acid and xHyA gels to SRP offers an innovative novel approach to enhance periodontal wound healing/regeneration.

Clinical relevance

The present findings have for the first-time shown histologic evidence for periodontal regeneration in support of this novel treatment modality.

Ramanauskaite E, Machiulskiene Visockiene V, Shirakata Y, Friedmann A, Pereckaite L, Balciunaite A, Dvyliene UM, Vitkauskiene A, Baseviciene N, Sculean A. [Microbiological Effects of Sodium Hypochlorite/-Amino Acids and Cross-linked Hyaluronic Acid Adjunctive to Non-surgical Periodontal Treatment](#). Oral Health Prev Dent. 2024 Apr 30;22:171-180. doi: 10.3290/j.ohpd.b5281925. PMID: 38687029.

Objective

To investigate the microbiological outcomes obtained with either subgingival debridement (SD) in conjunction with a gel containing sodium hypochlorite and amino acids followed by subsequent application of a cross-linked hyaluronic acid gel (xHyA) gel, or with SD alone.

Material and Methods

Forty-eight patients diagnosed with stages II-III (grades A/B) generalised periodontitis were randomly treated with either SD (control) or SD plus adjunctive sodium hypochlorite/amino acids and xHyA gel (test). Subgingival plaque samples were collected from the deepest site per quadrant in each patient at baseline and after 3 and 6 months. Pooled sample analysis was performed using a multiplex polymerase chain reaction (PCR)-based method for the identification of detection frequencies and changes in numbers of the following bacteria: *Aggregatibacter actinomycetemcomitans* (A.a), *Porphyromonas gingivalis* (P.g), *Tannerella forsythia* (T.f), *Treponema denticola* (T.d), and *Prevotella intermedia* (P.i).

Results

In terms of detection frequency, in the test group, statistically significant reductions were found for P.g, T.f, T.d and P.i ($p < 0.05$) after 6 months. In the control group, the detection frequencies of all investigated bacterial species at 6 months were comparable to the baseline values ($p > 0.05$). The comparison of the test and control groups revealed statistically significant differences in detection frequency for P.g ($p = 0.034$), T.d ($p < 0.01$) and P.i ($p = 0.02$) after 6 months, favouring the test group. Regarding reduction in detection frequency scores, at 6 months, statistically significant differences in favour of the test group were observed for all investigated bacterial species: A.a ($p = 0.028$), P.g ($p = 0.028$), T.f ($p = 0.004$), T.d ($p < 0.001$), and P.i ($p = 0.003$).

Conclusion

The present microbiological results, which are related to short-term outcomes up to 6 months post-treatment, support the adjunctive subgingival application of sodium hypochlorite/amino acids and xHyA to subgingival debridement in the treatment of periodontitis.

Ramanauskaite, Egle & Machiulskiene, Vita & Sakalauskaite, Urte & Eliezer, Meizi & Sculean, Anton. (2023). [Clinical Evaluation of a Novel Combination of Sodium Hypochlorite/Amino Acid and Cross-linked Hyaluronic Acid Adjunctive to Non-surgical Periodontal Treatment: A Case Series](#). 21. 279-284. 10.3290/j.ohpd.b4347453.

Objective

The adjunctive subgingival application of sodium hypochlorite/amino acid and a mixture of natural and cross-linked hyaluronic acid gels (high molecular weight) has been recently proposed as a novel modality to enhance the outcomes of non-surgical periodontal therapy. The aim of this prospective case series was to evaluate the clinical outcomes obtained following the subgingival application of a combination of sodium hypochlorite/amino acid and a mixture of natural and cross-linked hyaluronic acid (high molecular) gels in conjunction with non-surgical periodontal therapy.

Material and Methods

Twenty-one systemically healthy, non-smoking patients diagnosed with stage II-III, grade A/B periodontitis underwent full-mouth subgingival debridement (SD) performed with ultrasonic and hand instruments. All sites with probing depths (PD) ≥ 4 mm were treated with additional repeated (i.e., 2-3 times) instillation of sodium hypochlorite/amino acid gel in the periodontal pockets prior to and during SRP. Following mechanical debridement, a mixture of natural and cross-linked hyaluronic acid (high molecular) gel was applied in the pockets. The primary outcome variable was PD reduction; changes in clinical attachment level (CAL) and bleeding on probing (BOP) were the secondary outcomes. The clinical parameters were assessed at baseline, 3 and 6 months after therapy.

Results

Compared to baseline, a statistically significant mean reduction of PD values was obtained after 3 and 6 months, amounting to 2.6 ± 0.4 mm, and 2.9 ± 0.4 mm, respectively ($p < 0.001$). Mean CAL gain measured 2.3 ± 0.5 mm at 3 months and 2.6 ± 0.5 mm at 6 months in comparison to baseline ($p < 0.001$). Mean reduction of BOP values was 54.9 ± 16.9 % at 3 months and 65.6 ± 16.4 % at 6 months ($p < 0.001$). The number of moderate pockets (4-5 mm) decreased from 1808 at baseline to 274 at the 6-month evaluation, and the number of deep (≥ 6 mm) pockets dropped from 319 to 3, respectively.

Conclusion

The combination of sodium hypochlorite/amino acid and a mixture of natural and cross-linked hyaluronic acid (high molecular) adjunctive to subgingival debridement may represent a valuable approach to improve the outcomes of non-surgical periodontal treatment.

Ramanauskaite, Egle & Machiulskiene, Vita & Shirakata, Y. & Dvyliene, Urte & Nedzelskiene, Irena & Sculean, Anton. (2023). [Clinical evaluation of sodium hypochlorite/amino acids and cross-linked hyaluronic acid adjunctive to non-surgical periodontal treatment: a randomized controlled clinical trial](#). Clinical Oral Investigations. 27. 3. 10.1007/s00784-023-05271-0.

Objectives: To compare the clinical outcomes obtained with either mechanical subgingival debridement in conjunction with a sodium hypochlorite and amino acids containing gel followed by subsequent application of a cross-linked hyaluronic acid gel (xHyA) gel, or with mechanical debridement alone.

Materials and Methods: Forty-eight patients diagnosed with stages II-III (Grades A/B) generalised periodontitis were randomly treated with either scaling and root planing (SRP) (control) or SRP plus adjunctive sodium hypochlorite/amino acid and xHyA gels (test). The primary outcome variable was reduction of probing depth (PD), while changes in clinical attachment level (CAL), bleeding on probing (BOP) and plaque index (PI) were secondary outcomes. The outcomes were assessed at baseline, at 3 and 6 months following therapy.

Results: All patients completed the 6 months evaluation. At 6 months, the test group showed statistically significantly better results in terms of mean PD reduction (2.9 ± 0.4 vs 1.8 ± 0.6 mm, $p < 0.001$). Similarly, mean CAL gain was statistically higher in the test group compared to the control one (test: 2.6 ± 0.5 vs control: 1.6 ± 0.6 mm, $p < 0.001$). Mean BOP decreased from $81.8 \pm 16.2\%$ to $48.9 \pm 14.5\%$ in control ($p < 0.001$) and from $83.2 \pm 15.5\%$ to $17.6 \pm 11.5\%$ in test ($p < 0.001$) groups with a statistically significant difference favouring the test group ($p < 0.001$). Mean PI scores were reduced statistically significantly in both groups (from $38.8 \pm 26\%$ to $26.5 \pm 20.5\%$ in control ($p = 0.039$) and from $60.6 \pm 10.9\%$ to $12.7 \pm 8.9\%$ in test group ($p < 0.001$)), with a statistically significant difference between the groups ($p < 0.001$). The number of moderate pockets (4–6 mm) were reduced from 1518 (41.2%) to 803 (22.6%) in the control and from 1803 (48.6%) to 234 (7.7%) in the test group with a statistically significant difference between the groups ($p < 0.001$), while the number of deep pockets (≥ 7 mm) changed from 277 (7.6%) to 35 (1.0%) in the control and from 298 (8.7%) to 4 (0.1%) in test group ($p = 0.003$).

Conclusion: Within their limits the present data indicate that: a) both treatments resulted in statistically significant improvements in all evaluated clinical parameters, and b) the adjunctive subgingival application of sodium hypochlorite/amino acid and xHyA to SRP yielded statistically significantly higher improvements compared to SRP alone.

Clinical relevance: The combination of sodium hypochlorite/amino acid and xHyA gels to subgingival mechanical debridement appears to represent a valuable approach to additionally improve the outcomes of non-surgical periodontal treatment.

Diehl, D.; Friedmann, A.; Liedloff, P.; Jung, R.M.; Sculean, A.; Bilhan, H. [Adjunctive Application of Hyaluronic Acid in Combination with a Sodium Hypochlorite Gel for Non-Surgical Treatment of Residual Pockets Reduces the Need for Periodontal Surgery—Retrospective Analysis of a Clinical Case Series](https://doi.org/10.3390/ma15196508). *Materials* 2022, 15, 6508. <https://doi.org/10.3390/ma15196508>

Abstract

The comprehensive treatment of periodontitis stage 2 to 4 aims at the resolution of periodontal inflammation and “pocket closure”, which implies a residual probing depth of ≤ 4 mm and a negative BoP. However, supportive periodontal therapy (SPT) regularly leaves behind persistent periodontal pockets with 5 or more mm in residual PPD and sites that often re-colonize and re-infect. Various adjunctive options for subgingival instrumentation have been proposed to enhance the antimicrobial effects to better control the re-infection of these residual sites. The locally applied adjuncts, based on their anti-inflammatory effect, are sodium hypochlorite antiseptic cleaning gel and cross-linked hyaluronic acid (xHyA). Both recently moved into the focus of clinical research on non-surgical and surgical therapy for periodontitis. The surgical use of xHyA indicates regenerative potential, supporting periodontal regeneration. This case series retrospectively analyzes the clinical benefits of the consecutive flapless application of sodium-hypochlorite-based cleaning gel and xHyA at the SPT to achieve pocket closure, thereby reducing the need for periodontal surgery. In 29 patients, 111 sites received the treatment sequence. At 6-month re-evaluation, an overall PPD reduction exceeding 2 mm was achieved, associated with a similar CAL gain (2.02 mm); the bleeding tendency (BoP) was reduced by >60%. Pocket closure occurred in almost 25% of all the sites. Within their limits, the present data suggest that the proposed combined adjunctive treatment of residual active periodontal sites yielded significant improvement in the clinical parameters. Further studies in RCT format are required to confirm these observations.

Relevant Studies on **PERISOLV**

Radulescu V, Boariu MI, Rusu D, Roman A, Surlin P, Voicu A, Didilescu AC, Jentsch H, Siciliano VI, Ramaglia L, Vela O, Kardaras G, Sculean A, Stratul SI. [Clinical and microbiological effects of a single application of sodium hypochlorite gel during subgingival re-instrumentation: a triple-blind randomized placebo-controlled clinical trial.](#) Clin Oral Investig. 2022 Nov;26(11):6639-6652. doi: 10.1007/s00784-022-04618-3. Epub 2022 Jul 12. PMID: 35829773.

Objectives

The aim of this study is to assess the clinical and microbiological effects of a single subgingival administration of sodium hypochlorite gel (NaOCl) and compare it with 1% chlorhexidine (CHX) gel and a placebo gel following mechanical re-instrumentation during supportive periodontal therapy (SPT).

Materials and method

Sixty-two patients who had been treated for stage III-IV periodontitis and enrolled in SPT were included in the study based on following criteria: (1) active periodontal therapy completed at least 6 months before enrollment in the study, (2) presence of at least 4 non-adjacent sites with probing pocket depths (PPDs) ≥ 4 mm with bleeding on probing (BOP), or presence of 5-8 mm PPDs with or without BOP. All sites presenting PPD ≥ 4 mm and BOP at baseline and 3-, 6-, and 9-month follow-up timepoints were subgingivally re-instrumented with ultrasounds. Selected patients were randomly assigned into three groups and treated additionally with a single subgingival administration of NaOCl gel (group A); 1% CHX gel (group B); and placebo gel (group C). Main outcome variable was pocket closure at 12 months. Secondary outcome variables were changes in mean PPD, BOP, and clinical attachment level (CAL) along with changes in the numbers of the following five keystone bacterial pathogens: *Aggregatibacter actinomycetemcomitans* (A.a.), *Porphyromonas gingivalis* (P.g.), *Prevotella intermedia* (P.i.), *Tannerella forsythia* (T.f.), and *Treponema denticola* (T.d.).

Results

At 12 months, pocket closure was obtained in 77.5% in the NaOCl treated sites. The reduction in PPD was higher with CHX than with NaOCl, although a statistically significant adjunctive effect for NaOCl ($P = 0.028$) was only observed in comparison with placebo only. Mean CAL improved in all groups and at all timepoints, compared to the baseline ($P < 0.05$). However, after 6 months, CAL gain was statistically significantly higher in the NaOCl treated group than following application of CHX ($P = 0.0026$).

Conclusion

In SPT patients, a single adjunctive use of a NaOCl gel may provide benefits in controlling inflammation and residual pockets.

Clinical relevance

A baseline single application of NaOCl gel in conjunction with mechanical debridement may achieve substantial pocket closure in patients enrolled in SPT; treatment time, cost, and applicability considerations should be taken into account when selecting this therapy.

Iorio-Siciliano V, Ramaglia L, Isola G, Blasi A, Salvi GE, Sculean A. [Changes in clinical parameters following adjunctive local sodium hypochlorite gel in minimally invasive nonsurgical therapy \(MINST\) of periodontal pockets: a 6-month randomized controlled clinical trial](#). Clin Oral Investig. 2021 Sep;25(9):5331-5340. doi: 10.1007/s00784-021-03841-8. Epub 2021 Mar 9. PMID: 33687555; PMCID: PMC8370947.

Background

The mechanical disruption and removal of the subgingival biofilm represent the most important step in the treatment of periodontitis. However, in deep periodontal pockets, mechanical removal of the subgingival biofilm is difficult and frequently incomplete. Preliminary findings indicate that the use of amino acid buffered sodium hypochlorite (NaOCl) gel may chemically destroy the bacterial biofilm and facilitate its mechanical removal.

Objectives

To clinically evaluate the efficacy of minimally invasive nonsurgical therapy (MINST) of periodontal pockets with or without local application of an amino acid buffered sodium hypochlorite (NaOCl) gel.

Materials and method

Forty untreated patients diagnosed with severe/advanced periodontitis (i.e. stage III/IV) with a slow/moderate rate of progression (i.e. grade A/B) were randomly allocated in two treatment groups. In the test group, the periodontal pockets were treated by means of MINST and NaOCl gel application, while in the control group, treatment consisted of MINST alone. Full-mouth plaque scores (FMPS), full-mouth bleeding scores (FMBS), probing depths (PD), clinical attachment levels (CAL) and gingival recessions (GR) were assessed at baseline and at 6 months following therapy. The primary outcome variable was PD reduction at sites with PD \geq 5 mm at baseline.

Results

At 6 months, statistically significant differences between the two groups were found ($p = 0.001$) in terms of PD and CAL change. No statistically significant differences were found in terms of GR ($p = 0.81$). The number of sites with PD \geq 5 mm and BOP (+) decreased statistically significantly ($p = 0.001$), i.e. from 85.3 to 2.2% in the test group and from 81.6 to 7.3% in the control group, respectively. Statistically significant differences between test and control groups were recorded at 6 months ($p = 0.001$). MINST + NaOCl compared to MINST alone decreased statistically significantly ($p = 0.001$) the probability of residual PDs \geq 5 mm with BOP- (14.5% vs 18.3%) and BOP+ (2.2% vs. 7.2%).

Conclusion

Within their limits, the present results indicate that (a) the use of MINST may represent a clinically valuable approach for nonsurgical therapy and (b) the application of NaOCl gel in conjunction with MINST may additionally improve the clinical outcomes compared to the use of MINST alone.

Clinical relevance

In patients with untreated periodontitis, treatment of deep pockets by means of MINST in conjunction with a NaOCl gel may represent a valuable approach to additionally improve the clinical outcomes obtained with MINST alone.

Mayer Y, Ginesin O, Horwitz J. [A nonsurgical treatment of peri-implantitis using mechanic, antiseptic and anti-inflammatory treatment: 1 year follow-up](#). Clin Exp Dent Res. 2020 Aug;6(4):478-485. doi: 10.1002/cre2.286. Epub 2020 Mar 17. PMID: 32185910; PMCID: PMC7453777.

Objectives

The study's aim was to assess the clinical outcome 6 and 12 months after a nonsurgical treatment of peri-implantitis per se or in conjunction with a combination of local antiseptic and anti-inflammatory treatment.

Materials and method

Included were 69 patients with periodontitis, with 106 implants, diagnosed with peri-implantitis. Peri-implantitis was defined as radiographic bone loss ≥ 3 mm, probing depth (PD) ≥ 6 mm, with bleeding on probing. Group M peri-implantitis was treated with ultrasonic debridement and soft tissue curettage. Group P had additional implant surface treatment with rotatory hand piece composed of chitosan bristle, soft tissue curettage combined with application of 0.95% hypochlorite and 1 mg minocycline HCl.

Results

After 6 months, both groups demonstrated significant reduction of mean plaque index, PD, and clinical attachment level (0.71 ± 0.57 , 0.81 ± 0.55 ; 4.77 ± 0.73 mm, 4.42 ± 0.5 mm; 5.03 ± 0.86 mm, 5.13 ± 0.73 mm; respectively) and bleeding on probing. After 6 and 12 months, group P showed significantly better PD results compared to group M. The bleeding was significantly less in group P after 12 months ($15.3\% \pm 6.2$, $25.1\% \pm 8.2$, respectively).

Conclusion

Adjunctive treatment with local antiseptic and anti-inflammatories during mechanical phase was positively associated with inflammation reduction and connective tissue reattachment.

Schmidlin PR, Fujioka-Kobayashi M, Mueller HD, Sculean A, Lussi A, Miron RJ. [Effects of air polishing and an amino acid buffered hypochlorite solution to dentin surfaces and periodontal ligament cell survival, attachment, and spreading.](#) Clin Oral Investig. 2017 Jun;21(5):1589-1598. doi: 10.1007/s00784-016-1950-9. Epub 2016 Sep 5. PMID: 27596604.

Objectives

The aim of this study is to examine morphological changes of dentin surfaces following air polishing or amino acid buffered hypochlorite solution application and to assess their influence on periodontal ligament (PDL) cell survival, attachment, and spreading to dentin discs in vitro.

Materials and method

Bovine dentin discs were treated with either (i) Classic, (ii) Plus, or (iii) Perio powder (EMS). Furthermore, Perisolv® a hypochlorite solution buffered with various amino acids was investigated. Untreated dentin discs served as controls. Morphological changes to dentin discs were assessed using scanning electron microscopy (SEM). Human PDL cells were seeded onto the respectively treated discs, and samples were then investigated for PDL cell survival, attachment, and spreading using a live/dead assay, adhesion assay, and SEM imaging, respectively.

Results

Both control and Perisolv®-rinsed dentin discs demonstrated smooth surfaces at low and high magnifications. The Classic powders demonstrated the thickest coating followed by the Powder Plus. The Perio powder demonstrated marked alterations of dentin discs by revealing the potential to open dentinal tubules even before rinsing. Seeding of PDL cells demonstrated an almost 100 % survival rate on all samples demonstrating very high biocompatibility for all materials. Significantly higher PDL cell numbers were observed on samples treated with the Perio powder and the Perisolv® solution (approximately 40 % more cells; $p < 0.05$). SEM imaging revealed the potential for PDL cells to attach and spread on all surfaces.

Conclusion

The results from the present study demonstrate that cell survival and spreading of PDL cells on root surfaces is possible following either air polishing or application with Perisolv®. Future in vitro and animal testing is necessary to further characterize the beneficial effects of either system in a clinical setting.

Jurczyk K, Nietzsche S, Ender C, Sculean A, Eick S. [In-vitro activity of sodium-hypochlorite gel on bacteria associated with periodontitis](#). Clin Oral Investig. 2016 Nov;20(8):2165-2173. doi: 10.1007/s00784-016-1711-9. Epub 2016 Jan 12. PMID: 26759339.

Objectives

Sodium hypochlorite formulation (NaOCl gel), its components sodium hypochlorite (NaOCl), and the activating vehicle were compared with 0.1 % chlorhexidine digluconate (CHX) solution. The antimicrobial activity was proven by determination of minimal inhibitory concentrations (MIC), minimal bactericidal concentrations, and killing assays. Furthermore, the influence on formation as well as on a 4-day-old 6-species biofilm was tested.

Results

Except for one strain (*Parvimonas micra* ATCC 33270 in case of NaOCl gel), the MICs both of the CHX solution and NaOCl gel did not exceed 10 % of the formulations' concentration. In general, MICs of the NaOCl gel were equal as of the CHX solution against Gram-negatives but higher against Gram-positive bacteria. CHX but not NaOCl gel clearly inhibited biofilm formation; however, the activity of NaOCl gel was more remarkable on a 4-day-old biofilm. NaOCl killed bacteria in the biofilm and interfered with the matrix.

Conclusion

The NaOCl gel acts antimicrobial in particular against Gram-negative species associated with periodontitis. Moreover, its component NaOCl hypochlorite is able to alter biofilm matrices.

Clinical relevance

The NaOCl gel may represent a potential alternative for adjunctive topical antimicrobial treatment in periodontitis.

Guarnelli ME, Vecchiadini R, Farina R. ['Professional local administration of chloramine-based treatment in conjunction with ultrasonic mechanical instrumentation: clinical outcomes in patients with deep periodontal pockets persisting following active non-surgical therapy'](#)
Minerva Stomatologia, 2015; 64 suppl.1(2): 158-159

Background

Recently, a chemical agent (Perisolv®) has been proposed as an adjuvant to non-surgical therapy. The rationale for its use is based on the bactericidal effect of chloramines and a softening effect on debris that must be mechanically removed from the root surface.

Objective

To evaluate the clinical outcomes of ultrasonic mechanical instrumentation (UMI) when performed in conjunction with local application of Perisolv® at deep periodontal pockets persisting following active, non-surgical therapy (NST).

Methodology

Three periodontitis patients showing residual sites positive to bleeding upon probing (BoP) with pocket probing depth (PPD) > 5 mm following NST were included. At randomly selected, BoP-positive sites with PPD > 5 mm, the activated agent was applied and left in place for 30 seconds before proceeding with full-mouth UMI. After 20-25 minutes from agent activation, the sequence (Perisolv® application + UMI) was repeated.

Results

Mean PPD was 5.7 ± 1.0 mm at the conclusion of NST, and decreased to 3.4 ± 0.5 mm at 4-6 weeks following the administration of UMI+ Perisolv®. All sites treated with UMI+ Perisolv® showed PPD ≤ 4 mm and were BoP-negative following treatment.

Conclusion

The professional, local administration of a chloramine-based treatment (Perisolv®) in conjunction with UMI resulted in a substantial improvement of the periodontal conditions of patients with deep periodontal pockets persisting following NST.

Relevant Studies on xHyA

Iorio-Siciliano V, Blasi A, Mauriello L, Salvi GE, Ramaglia L, Sculean A. [Non-Surgical Treatment of Moderate Periodontal Intrabony Defects With Adjunctive Cross-Linked Hyaluronic Acid: A Single-Blinded Randomized Controlled Clinical Trial](#). J Clin Periodontol. 2025 Feb;52(2):310-322. doi: 10.1111/jcpe.14078. Epub 2024 Oct 14. PMID: 39402910; PMCID: PMC11743238.

Aim

To evaluate the clinical outcomes of moderate intrabony defects treated with minimally invasive non-surgical technique (MINST) with or without adjunctive delivery of cross-linked hyaluronic acid (xHyA) gel.

Materials and Methods

Forty-two patients with 42 interdental intrabony defects were randomly assigned to test (MINST + xHyA) or control procedures (MINST alone). Probing depth (PD), clinical attachment level (CAL), gingival recession (GR) and bleeding on probing (BOP) at the treated sites were assessed at baseline and at 3 and 6 months. Full-mouth plaque score (FMPS) and full-mouth bleeding score (FMBS) were recorded at baseline and after 6 months. Radiographic evaluation was performed at baseline and after 6 months, assessing the defect fill (DF) and radiographic defect angle (RDA). The primary outcome variable was PD change.

Results

Thirty-eight patients completed the trial without any adverse events. At 6 months, a statistically significant improvement ($p < 0.05$) was measured in all clinical parameters except GR ($p > 0.05$). However, no statistically significant differences were found between the experimental and control procedures ($p > 0.05$). Statistically significant differences between the test and control sites were observed at 3 months for PD and CAL changes ($p < 0.05$). The DF change was statistically significant when comparing experimental and control procedures at 6 months ($p < 0.05$). Both procedures failed to show statistically significant differences in terms of RDA changes at 6 months ($p > 0.05$).

Conclusion

Within their limitations, the present results indicate that (a) treatment of intrabony defects with MINST, with or without application of xHyA gel, resulted in statistically significant improvements in the investigated clinical parameters at 3 and 6 months after therapy, and (b) although the adjunctive use of xHyA gel to MINST improved the clinical outcomes compared with MINST alone up to 3 months, statistically significant differences were not observed at 6 months. The study protocol was registered in ClinicalTrials.gov (NCT05188898).

Zhu X, Sculean A, Eick S. [In-vitro effects of different hyaluronic acids on periodontal biofilm-immune cell interaction](#). Front Cell Infect Microbiol. 2024 Jun 13;14:1414861. doi: 10.3389/fcimb.2024.1414861. PMID: 38938883; PMCID: PMC11208323.

Background/objectives: Recent studies have demonstrated a positive role of hyaluronic acid (HA) on periodontal clinical outcomes. This in-vitro study aimed to investigate the impact of four different HAs on interactions between periodontal biofilm and immune cells.

Materials and methods: The four HAs included: high-molecular-weight HA (HHA, non-cross-linked), low-molecular-weight HA (LHA), oligomers HA (OHA), and cross-linked high-molecular-weight HA (xHyA). Serial experiments were conducted to verify the influence of HAs on: (i) 12-species periodontal biofilm (formation and pre-existing); (ii) expression of inflammatory cytokines and HA receptors in monocytic (MONO-MAC-6) cells and periodontal ligament fibroblasts (PDLF) with or without exposure to periodontal biofilms; (iii) generation of reactive oxygen species (ROS) in MONO-MAC-6 cells and PDLF with presence of biofilm and HA.

Results: The results indicated that HHA and xHyA reduced the bacterial counts in a newly formed (4-h) biofilm and in a pre-existing five-day-old biofilm. Without biofilm challenge, OHA triggered inflammatory reaction by increasing IL-1 β and IL-10 levels in MONO-MAC cells and IL-8 in PDLF in a time-dependent manner, whereas xHyA suppressed this response by inhibiting the expression of IL-10 in MONO-MAC cells and IL-8 in PDLF. Under biofilm challenge, HA decreased the expression of IL-1 β (most decreasing HHA) and increased IL-10 levels in MONO-MAC-6 cells in a molecular weight dependent manner (most increasing xHyA). The interaction between HA and both cells may occur via ICAM-1 receptor. Biofilm stimulus increased ROS levels in MONO-MAC-6 cells and PDLF, but only HHA slightly suppressed the high generation of ROS induced by biofilm stimulation in both cells.

Conclusions: Overall, these results indicate that OHA induces inflammation, while HHA and xHyA exhibit anti-biofilm, primarily anti-inflammatory, and antioxidant properties in the periodontal environment.

Hakki SS, Bozkurt SB, Sculean A, Božić D. [Hyaluronic acid enhances cell migration, viability, and mineralized tissue-specific genes in cementoblasts](#). J Periodontal Res. 2023 Dec 9. doi: 10.1111/jre.13201. Epub ahead of print. PMID: 38069670.

Background/objectives: It has been repeatedly demonstrated that cementum formation is a crucial step in periodontal regeneration. Hyaluronic acid (HA) is an important component of the extracellular matrix which regulates cells functions and cell-cell communication. Hyaluronic acid/derivatives have been used in regenerative periodontal therapy, but the cellular effects of HA are still unknown. To investigate the effects of HA on cementoblast functions, cell viability, migration, mineralization, differentiation, and mineralized tissue-associated genes and cementoblast-specific markers of the cementoblasts were tested.

Materials and methods: Cementoblasts (OCCM-30) were treated with various dilutions (0, 1:2, 1:4, 1:8, 1:16, 1:32, 1:64, 1:128) of HA and examined for cell viability, migration, mineralization, and gene expressions. The mRNA expressions of osteocalcin (OCN), runt-related transcription factor 2 (Runx2), bone sialoprotein (BSP), collagen type I (COL-I), alkaline phosphatase (ALP), cementum protein-1 (CEMP-1), cementum attachment protein (CAP), and small mothers against decapentaplegic (Smad) -1, 2, 3, 6, 7, β -catenin (Ctnnb1) were performed with real-time polymerase chain reaction (RT-PCR). Total RNA was isolated on days 3 and 8, and cell viability was determined using MTT assay on days 1 and 3. The cell mineralization was evaluated by von Kossa staining on day 8. Cell migration was assessed 2, 4, 6, and 24 hours following exposure to HA dilutions using an in vitro wound healing assay (0, 1:2, 1:4, 1:8).

Results: At dilution of 1:2 to 1:128, HA importantly increased cell viability ($p < .01$). HA at a dilution of 1/2 increased wound healing rates after 4 h compared to the other dilutions and the untreated control group. Increased numbers of mineralized nodules were determined at dilutions of 1:2, 1:4, and 1:8 compared with control group. mRNA expressions of mineralized tissue marker including COL-I, BSP, RunX2, ALP, and OCN significantly improved by HA treatments compared with control group both on 3 days and on 8 days ($p < .01$). Smad 2, Smad 3, Smad 7, and β -catenin (Ctnnb1) mRNAs were up-regulated, while Smad1 and Smad 6 were not affected by HA administration. Additionally, HA at dilutions of 1:2, 1:4, and 1:8 remarkably enhanced CEMP-1 and CAP expressions in a dilution- and time-dependent manner ($p < .01$).

Conclusions: The present results have demonstrated that HA affected the expression of both mineralized tissue markers and cementoblast-specific genes. Positive effects of HA on the cementoblast functions demonstrated that HA application may play a key role in cementum regeneration.

Zhu X, von Werdt L, Zappalà G, Sculean A, Eick S, Stähli A. [In vitro activity of hyaluronic acid and human serum on periodontal biofilm and periodontal ligament fibroblasts](#). Clin Oral Investig. 2023 Jun 28. doi: 10.1007/s00784-023-05121-z. Epub ahead of print. PMID: 37380794.

Objectives

A beneficial effect of cross-linked hyaluronic acid (xHyA) on periodontal wound healing and regeneration has recently been demonstrated. The present in vitro study was designed to obtain deeper knowledge on the effect of xHyA when applied in the gingival sulcus (serum-rich environment) during non-surgical periodontal therapy.

Materials and methods

The influence of xHyA, human serum (HS), and xHyA/HS on (i) a 12-species biofilm formation, (ii) the adhesion of periodontal ligament fibroblasts (PDLF) to dentine surface, (iii) the expression and secretion of interleukin-8, and (iv) the expression of receptors of HyA in PDLF and gingival fibroblasts (GF) were evaluated.

Results

At 4 h of biofilm formation, xHyA and HS in combination (xHyA/HS) slightly decreased the colony-forming unit counts in biofilm whereas the metabolic activity of biofilm was reduced in all test groups (xHyA, HS, xHyA/HS) vs. control. At 24 h, the quantity of biofilm was reduced in all test groups vs. untreated control. The test substances did not affect adhesion of PDLF to dentin. HS increased the expression of IL-8 by PDLF and GF which was partially downregulated by xHyA. HS and/or xHyA promoted the expression of the HyA receptor RHAMM in GF but not in PDLF.

Conclusions

In summary, the present data indicate that serum neither negatively affect the activity of xHyA against periodontal biofilm nor had any unwanted influence on the activity of PDLF.

Clinical relevance

These findings lend additional support for the positive effects of xHyA on cells involved in periodontal wound healing, thus pointing to its potential use in non-surgical periodontal therapy.

Shirakata Y, Imafuji T, Nakamura T, Shinohara Y, Iwata M, Setoguchi F, Noguchi K, Sculean A. [Cross-linked hyaluronic acid gel with or without a collagen matrix in the treatment of class III furcation defects: A histologic and histomorphometric study in dogs.](#) J Clin Periodontol. 2022 Oct;49(10):1079-1089. doi: 10.1111/jcpe.13694. Epub 2022 Jul 21. PMID: 35817414; PMCID: PMC9796036.

Objectives

To histologically evaluate the effects of cross-linked hyaluronic acid (xHyA) with or without a collagen matrix (CM) on periodontal wound healing/regeneration in class III furcation defects in dogs.

Material and methods

Class III furcation defects were surgically created in the mandibular premolars in six beagle dogs. The defects were randomly treated as follows: open flap debridement (OFD) + CM (CM), OFD + xHyA (xHyA), OFD + xHyA + CM (xHyA/CM) and OFD alone (OFD). At 10 weeks, the animals were euthanized for histological evaluation.

Results

The newly formed bone areas in the xHyA ($4.04 \pm 1.51 \text{ mm}^2$) and xHyA/CM ($4.32 \pm 1.14 \text{ mm}^2$) groups were larger than those in the OFD ($3.25 \pm 0.81 \text{ mm}^2$) and CM ($3.31 \pm 2.26 \text{ mm}^2$) groups. The xHyA ($6.25 \pm 1.45 \text{ mm}$) and xHyA/CM ($6.40 \pm 1.35 \text{ mm}$) groups yielded statistically significantly ($p < .05$) greater formation of new connective tissue attachment (i.e., new cementum, with inserting connective tissue fibres) compared with the OFD ($1.47 \pm 0.85 \text{ mm}$) group. No significant differences were observed in any of the histomorphometric parameters between the xHyA and xHyA/CM groups. Complete furcation closure was not observed in any of the four treatment modalities.

Conclusion

Within their limits, the present results suggest that the use of xHyA with or without CM positively influences periodontal wound healing in surgically created, acute-type class III furcation defects.

Shirakata Y, Nakamura T, Kawakami Y, et al. [Healing of buccal gingival recessions following treatment with coronally advanced flap alone or combined with a cross-linked hyaluronic acid-gel. An experimental study in dogs. Journal of Clinical Periodontology.](#) 2021 Jan. DOI: 10.1111/jcpe.13433.

Objectives

To clinically and histologically evaluate in dogs the healing of gingival recessions treated with coronally advanced flap (CAF) with or without cross-linked hyaluronic acid (HA).

Material and methods

Gingival recession defects were surgically created on the vestibular side of both maxillary canines in 8 dogs. After 8 weeks of plaque accumulation, the 16 chronic defects were randomly treated with either CAF alone or CAF and HA-gel (CAF/HA). Clinical and histological outcomes were evaluated at 10 weeks post surgically.

Results

Compared to baseline, the clinical measurements at 10 weeks revealed a statistically significant decrease in gingival recession for both CAF ($p < 0.01$) and CAF/HA ($p < 0.001$) groups. Statistically significant differences were found in clinical attachment level ($p < 0.05$) and width of gingival recession ($p < 0.01$) favoring the CAF/HA group. Bone formation was statistically significantly greater in the CAF/HA group than in the CAF group ($1.84 \pm 1.16\text{mm}$ vs., $0.72 \pm 0.62\text{mm}$ respectively, $P < 0.05$). Formation of cementum and connective tissue attachment were statistically significantly higher in the CAF/HA group compared with the CAF group (i.e. $4.31 \pm 1.78\text{mm}$ versus $2.40 \pm 1.35\text{mm}$ and $1.69 \pm 0.98\text{mm}$ versus $0.74 \pm 0.68\text{mm}$, respectively ($P < 0.05$)).

Conclusion

The present data have for the first time provided histologic evidence for periodontal regeneration of gingival recession defects following treatment with CAF and HA.

Shirakata Y, Imafuji T, Nakamura T, Kawakami Y, Shinohara Y, Noguchi K, Pilloni A, Sculean A. [Periodontal wound healing/regeneration of two-wall intrabony defects following reconstructive surgery with cross-linked hyaluronic acid-gel with or without a collagen matrix: a preclinical study in dogs](#). Quintessence Int. 2021;0(0):308-316. doi: 10.3290/j.qi.b937003. PMID: 33533237.

Objectives

Histologically evaluate the effects of cross-linked HA alone or combined with a collagen matrix (CM = Fibro Gide) on the periodontal wound healing/regeneration in intrabony defects.

Material and methods

Two-wall intrabony defects (5 mm wide, 5 mm deep) were surgically created at the distal and mesial aspects of mandibular premolars in six beagle dogs. The 24 defects were randomly treated as follows: open flap debridement (OFD) + HA, OFD + CM, OFD + HA+ CM (HA/CM) and OFD alone (control). At 2 months, the animals were euthanized for histological evaluation.

Results

The HA (2.43 ± 1.25 mm) and HA/CM (2.60 ± 0.99 mm) groups yielded statistically significantly ($P < 0.05$) greater formation of new attachment (i.e., linear length of NC adjacent to newly formed bone, with inserting collagen fibers) compared with OFD (0.55 ± 0.99 mm) group. Among the 4 treatment groups, the HA/CM group demonstrated the highest amount of regenerated tissues, although no statistically significant differences in any of the histometric parameters were observed between the HA and HA/CM groups.

Within their limits, it can be concluded that cross-linked HA alone or combined with CM promotes periodontal wound healing/ regeneration in two-wall intrabony defects in dogs.

Conclusion

The present data have for the first time provided histologic evidence for periodontal regeneration of gingival recession defects following treatment with CAF and HA.

Božić D, Čatović I, Badovinac A, Musić L, Par M, Sculean A. [Treatment of Intrabony Defects with a Combination of Hyaluronic Acid and Deproteinized Porcine Bone Mineral](#). Materials (Basel). 2021 Nov 11;14(22):6795. doi: 10.3390/ma14226795. PMID: 34832196; PMCID: PMC8624958.

Background

This study evaluates the clinical outcomes of a novel approach in treating deep intrabony defects utilizing papilla preservation techniques with a combination of hyaluronic acid (xHyA) and deproteinized porcine bone mineral.

Clinical Procedure

23 patients with 27 intrabony defects were treated with a combination of HA and deproteinized porcine bone mineral. Clinical attachment level (CAL), pocket probing depth (PPD), gingival recession (REC) were recorded at baseline and 6 months after the surgery.

Outcomes

At 6 months, there was a significant CAL gain of 3.65 ± 1.67 mm ($p < 0.001$) with a PPD reduction of 4.54 ± 1.65 mm ($p < 0.001$), which was associated with an increase in gingival recession (0.89 ± 0.59 mm, $p < 0.001$). The percentage of pocket resolution based on a PPD ≤ 4 mm was 92.6% and the failure rate based on a PPD of 5 mm was 7.4%.

Conclusion

The present findings indicate that applying a combined HA and xenograft approach in deep intrabony defects provides clinically relevant CAL gains and PPD reductions compared to baseline values and is a valid new approach in treating intrabony defects.

Pilloni A, Zeza B, Kuis D, Vrazic D, Domic T, Olszewska-Czyz I, Popova C, Kotsilkov K, Firkova E, Dermendzieva Y, Tasheva A, Orrù G, Sculean A, Prpić J. [Treatment of Residual Periodontal Pockets Using a Hyaluronic Acid-Based Gel: A 12 Month Multicenter Randomized Triple-Blinded Clinical Trial](#). Antibiotics (Basel). 2021 Jul 30;10(8):924. doi: 10.3390/antibiotics10080924. PMID: 34438976; PMCID: PMC8388804.

Abstract

The aim of the present study was to evaluate the adjunctive effect of hyaluronic acid (HA) gel in the treatment of residual periodontal pockets over a 12-month period.

Clinical Procedure

Periodontal patients presenting at least one residual periodontal pocket 5–9 mm of depth in the anterior area were recruited from six university-based centers. Each patient was randomly assigned to subgingival instrumentation (SI) with the local adjunctive use of HA for test treatment or adjunctive use of local placebo for control treatment at baseline and after 3 months. Clinical parameters () probing depth (PD), bleeding on probing (BoP), plaque index (PI), recession (REC), clinical attachment level (CAL)) and microbiological samples for the investigation of the total bacterial count (TBC) and presence of specific bacterial species (*Porphyromonas gingivalis*, *Treponema denticola*, *Tannerella forsythia*, *Fusobacterium nucleatum*) were taken at baseline and every 3 months, until study termination. PD was determined as the primary outcome variable.

Outcomes

From a total of 144 enrolled, 126 participants (53 males, 73 females) completed the entire protocol. Both treatments resulted in statistically significant clinical and microbiological improvements compared to baseline.

Conclusions

Although the local application of HA showed a tendency for better results, there was a lack of statistically significant differences between the groups.

Guldener K, Lanzrein C, Eliezer M, Katsaros C, Stähli A, Sculean 'A Treatment of Single Mandibular Recessions with the modified coronal advanced tunnel or laterally closed tunnel, hyaluronic acid, and subepithelial connective tissue graft :a report of 12 cases.' Quintessence Int 2020;51:2-9;doi: 10.3290/j.qi.a44492

Objective

To clinically evaluate the healing of mandibular Miller Class I and II isolated gingival recessions treated with the modified coronally advanced tunnel (MCAT) or laterally closed tunnel (LCT) combined with hyaluronic acid (HA) and subepithelial connective tissue graft (SCTG).

Methodology

Twelve healthy patients exhibiting one isolated mandibular Miller Class I or II (Cairo Class 1) gingival recession of a depth of ≥ 3 mm, were consecutively treated with the MCAT or LCT in conjunction with HA and SCTG. Treatment outcomes were assessed at baseline and at least 6 months postoperatively. The primary outcome variable was complete root coverage (CRC).

Results

Postoperative pain and discomfort were low and no complications such as postoperative bleeding, allergic reactions, abscesses, or loss of SCTG occurred. After a mean follow-up of 18.9 ± 10 months, statistically significant ($P < .0001$) root coverage was obtained in all 12 defects. CRC was measured in six out of the 12 cases (50%), four cases showed a root coverage of over 95%, while the remaining two cases reached 80% and 85%. Mean root coverage was 96.09%. Mean keratinized tissue width increased from 1.6 ± 0.8 mm to 4.9 ± 1.3 mm ($P < .0001$) from baseline to follow-up, while mean probing depth showed no statistically significant changes (1.8 ± 0.9 mm vs 1.3 ± 0.5 mm).

Conclusion

Within their limits, the present results indicate that the described treatment approach may lead to predictable root coverage of isolated mandibular Miller Class I and II (Cairo Class 1) gingival recessions.

Lanzrein C, Guldener K, Imber JC, Katsaros C, Stähli A, Sculean A. [Treatment of multiple adjacent recessions with the modified coronally advanced tunnel or laterally closed tunnel in conjunction with cross-linked hyaluronic acid and subepithelial connective tissue graft: a report of 15 cases](#). Quintessence Int. 2020;51(9):710-719. doi: 10.3290/j.qi.a44808. PMID: 32577705.

Objectives

To evaluate the healing of multiple adjacent type 1 and 2 gingival recessions (RT1 and RT2) treated with the modified coronally advanced tunnel (MCAT) or the laterally closed tunnel (LCT) in conjunction with a cross-linked hyaluronic acid and subepithelial palatal connective tissue grafts.

Method and materials

Fifteen healthy patients exhibiting multiple adjacent mandibular or maxillary RT1 and RT2 of a depth of ≥ 2 mm, were treated with the MCAT or LCT in conjunction with cross-linked hyaluronic acid and subepithelial palatal connective tissue grafts. Results were assessed at baseline and after a minimum of 6 months. The primary outcome variable was root coverage. Esthetic outcomes were evaluated on photographs using the root coverage esthetic score.

Results

Postoperative pain and discomfort were low and no complications occurred. Data analyses were performed at patient level. After a mean follow-up of 17 ± 5.4 months, statistically significant root coverage was obtained in all 15 cases ($P < .0001$). Complete root coverage was obtained in 3 out of 15 cases (20%). Root coverage amounted to $> 95\%$ in three patients, was between 90% and 95% in four patients, and reached 87.5% in another patient. In three further patients root coverage measured 75%, 77%, and 64.6%, respectively. Mean root coverage measured $85.1 \pm 23.2\%$. Mean keratinized tissue width increased from 2.5 ± 1.0 mm to 3.7 ± 0.7 mm ($P < .0001$) from baseline to follow-up, while mean probing depth showed no statistically significant changes (1.3 ± 0.5 mm vs 1.5 ± 0.5 mm). The mean root coverage esthetic score was 7.9 ± 1.9 , while in the three cases exhibiting complete root coverage, a maximum root coverage esthetic score (10) was given for all treated teeth.

Conclusion

Within their limits, the present results indicate that the described treatment approach may lead to predictable root coverage of multiple mandibular and maxillary RT1 and RT2.

Asparuhova M, Chappuis V, Stähli A, Buser D, Sculean A, [‘Role of hyaluronan in regulating self-renewal and osteogenic differentiation of mesenchymal stromal cells and pre-osteoblasts’](#), Clin Oral Investig. 2020 Mar 31. doi: 10.1007/s00784-020-03259-8.

Objectives

The aim of the study was to investigate the impact of two hyaluronan (HA) formulations on the osteogenic potential of osteoblast precursors.

Methodology

Proliferation rates of HA-treated mesenchymal stromal ST2 and pre-osteoblastic MC3T3-E1 cells were determined by 5-bromo-20-deoxyuridine (BrdU) assay. Expression of genes encoding osteogenic differentiation markers, critical growth, and stemness factors as well as activation of downstream signalling pathways in the HA-treated cells were analysed by quantitative reverse transcription-polymerase chain reaction (qRT-PCR) and immunoblot techniques.

Results

The investigated HAs strongly stimulated the growth of the osteoprogenitor lines and enhanced the expression of genes encoding bone matrix proteins. However, expression of late osteogenic differentiation markers was significantly inhibited, accompanied by decreased bone morphogenetic protein (BMP) signalling. The expression of genes encoding transforming growth factor- β 1 (TGF- β 1) and fibroblast growth factor-1 (FGF-1) as well as the phosphorylation of the downstream signalling molecules Smad2 and Erk1/2 were enhanced upon HA treatment. We observed significant upregulation of the transcription factor Sox2 and its direct transcription targets and critical stemness genes, Yap1 and Bmi1, in HA-treated cells. Moreover, prominent targets of the canonical Wnt signalling pathway showed reduced expression, whereas inhibitors of the pathway were considerably upregulated. We detected decrease of active β -catenin levels in HA-treated cells due to β -catenin being phosphorylated and, thus, targeted for degradation.

Conclusions

HA strongly induces the growth of osteoprogenitors and maintains their stemness, thus potentially regulating the balance between self-renewal and differentiation during bone regeneration following reconstructive oral surgeries.

Clinical relevance

Addition of HA to deficient bone or bony defects during implant or reconstructive periodontal surgeries may be a viable approach for expanding adult stem cells without losing their replicative and differentiation capabilities.

Asparuhova M, Kiryak D, Eliezer M, Mihov D, Sculean A. '[Activity of two hyaluronan preparations on primary human oral fibroblasts](#)'. J Periodontal Res 2018 Sep 27. Epub 2018 Sep 27

Objective

The potential benefit of using hyaluronan (HA) in reconstructive periodontal surgery is still a matter of debate. The aim of the present study was to evaluate the effects of two HA formulations on human oral fibroblasts involved in soft tissue wound healing / regeneration.

Methodology

Metabolic, proliferative, and migratory abilities of primary human palatal and gingival fibroblasts were examined upon HA treatment. To uncover the mechanisms whereby HA influences cellular behaviour, wound healing-related gene expression and activation of signalling kinases were analysed by qRT-PCR and Results: The investigated HA formulations maintained the viability of oral fibroblasts, and increased their proliferative and migratory abilities. They enhanced expression of genes encoding type III collagen and transforming growth factor- β 3, characteristic of scarless wound healing. The HAs upregulated the expression of genes encoding pro-proliferative, pro-migratory, and pro-inflammatory factors, with only a moderate effect on the latter in gingival fibroblasts. In palatal but not gingival fibroblasts, an indirect effect of HA on the expression of matrix metalloproteinases 2 and 3 was detected, potentially exerted through induction of pro-inflammatory cytokines. Finally, our data pointed on Akt, Erk1/2 and p38 as the signalling molecules whereby the HAs exert their effects on oral fibroblasts.

Conclusion

Both investigated HA formulations are biocompatible and enhance the proliferative, migratory and wound-healing properties of cell types involved in soft tissue wound healing following regenerative periodontal surgery. Our data further suggest that in gingival tissues, the HAs are not likely to impair the healing process by prolonging inflammation or causing excessive MMP expression at the repair site.

Eliezer M, Imber JC, Sculean A, Pandis N, Teich S, [‘Hyaluronic acid as adjunctive to non-surgical and surgical periodontal therapy: a systematic review and meta-analysis’](#), Clin O Inv 2019; doi: s00784-019-03012-w

Objectives

To evaluate the potential added benefit of the topical application of hyaluronic acid (HA) on the clinical outcomes following non-surgical or surgical periodontal therapy.

Materials and method

A systematic search was performed in Medline, Embase, Cochrane, Web of Science, Scopus and Grey literature databases. The literature search was preformed according to PRISMA guidelines. The Cochrane risk of bias tool was used in order to assess the methodology of the included trials. Weighted mean differences (WMDs) and 95%confidence intervals (CIs) between the treatment and controls were estimated using the random-effect model for amount of bleeding on probing (BOP), probing depth (PD) reduction and clinical attachment level (CAL) gain. In order to minimize the bias and to perform meta-analysis, only randomized clinical studies (RCTs) were selected.

Results

Thirteen RCTs were included: 11 on non-surgical periodontal treatment and two on surgical periodontal treatment. Overall analysis of PD reduction, CAL gain and BOP reduction in non-surgical therapy with adjunctive HA presented WMD of – 0.36 mm (95% CI – 0.54 to – 0.19 mm; $p < 0.0001$), 0.73 mm (95%CI 0.28 to 1.17 mm; $p < 0.0001$) and – 15% (95% CI – 22 to – 8%; $p < 0.001$) respectively, favouring the application of HA. The overall analysis on PD and CAL gain in surgical therapy with adjunctive HA presented WMD of – 0.89 mm (95% CI – 1.42 to – 0.36 mm; $p < 0.0001$) for PD reduction and 0.85 mm (95% CI 0.08 to 1.62 mm; $p < 0.0001$) for CAL gain after 6–24 months favouring the treatment with HA. However, comparison presented considerable heterogeneity between the non-surgical studies and a high risk of bias in general.

Conclusion

Within their limits, the present data indicate that the topical application of HA may lead to additional clinical benefits when used as an adjunctive to non-surgical and surgical periodontal therapy. However, due to the high risk of bias and heterogeneity, there is a need for further well-designed RCTs to evaluate this material in various clinical scenarios.

Clinical relevance

The adjunctive use of HA may improve the clinical outcomes when used in conjunction with non-surgical and surgical periodontal therapy.

Olszewska-Czyz I, Kralik K, Prpic J. Biomolecules in Dental Applications: Randomized, [Controlled Clinical Trial Evaluating the Influence of Hyaluronic Acid Adjunctive Therapy on Clinical Parameters of Moderate Periodontitis](#). Biomolecules. 2021 Oct 9;11(10):1491. doi: 10.3390/biom11101491. PMID: 34680123; PMCID: PMC8533205.

Introduction

The biological activity of hyaluronic acid (xHyA) has been well-researched during the past decades; however, there are few randomized, controlled trials of its clinical effects in periodontal therapy.

Objectives

The purpose of this study was to evaluate the effect of hyaluronic acid on the principal parameters of periodontal healing. A specific, commercially available formulation designed and registered for professional dental application, composed of 16 mg/mL of cross-linked and 2 mg/mL of non-cross-linked xHyA, was used as an adjunctive to non-surgical periodontal therapy, and clinical parameters were evaluated after 3 months.

Results

The addition of xHyA to periodontal therapy demonstrated more favorable clinical results regarding reduction in inflammation, measured by bleeding on probing (-6% compared to the control group) and gain in periodontal attachment (1 mm more than control group), while it had no effect on probing depth reduction. No side effects were reported.

Conclusion

Our study demonstrated that xHyA is a safe and easy-to-use biological agent; due to its wide array of properties, it may significantly improve the results of periodontal therapy. However, more long-term studies are needed to investigate whether these favorable effects remain over time.

Eliezer M, Sculean A, Miron RJ, Nemcovsky C, Weinberg E, Weinreb M, Zoabi H, Bosshardt DD, Fujioka-Kobayashi M, Moses O. [Hyaluronic acid slows down collagen membrane degradation in uncontrolled diabetic rats.](#) J Periodontal Res. 2019 Dec;54(6):644-652. doi: 10.1111/jre.12665. Epub 2019 Jun 12. PMID: 31190426.

Aim:

To examine the in vitro biokinetics of hyaluronic acid (HA) from a collagen membrane (CM) and to evaluate the in vivo effect of immersion of the CM in HA solution on its degradation in streptozotocin (STZ)-induced diabetes conditions in a rat calvaria subcutaneous model.

Background:

CM degradation is accelerated in uncontrolled diabetic rats. Immersion of CM in HA has been suggested to decrease their resorption rate without interfering with their tissue integration and structural degradation. However, it is unknown to what extent CM degradation may be influenced by its immersion in HA solution under a condition mimicking a medically compromised situation with an increased inflammatory level such as diabetes.

Materials and Methods:

CMs were soaked in cross-linked HA. Protein adsorption and the HA release were quantified by ELISA. Diabetes was induced in sixteen rats, while 16 healthy rats served as control. CM was prepared and labeled prior to implantation with Biotin. Seventeen CM were immersed in HA and 17 CM in PBS. In each animal, one test or one control disk was implanted. In order to compare the collagen content, two similar non-implanted CM were used as baseline. Fourteen days after surgery, thirty-two animals were sacrificed. The entire calvaria including the skin above, was chemically fixed, decalcified, and embedded in paraffin. Five- μ m-thick sections were analyzed histologically and histomorphometrically using H&E and avidin-peroxidase staining.

Results:

The in vitro results demonstrated that the CM adsorbed roughly 80% of the total HA content. After 10 days, 36.3% of the initial HA remained on the CM. The in vivo results demonstrated that diabetes significantly reduced the thickness of the CM, while HA had a significant effect on keeping the membrane thickness. HA increased the residual collagen content in the diabetic group ($P < 0.0001$) but no such effect was observed in the healthy group.

Conclusion:

Immersion of CM in HA prior to the implantation delays membrane degradation in uncontrolled diabetic compared with normoglycemic rats.

Fujioka-Kobayashi M, Müller H, Mueller A, Lussi A, Sculean A, Schmidlin PR, Miron RJ '[In vitro effects of hyaluronic acid on human periodontal ligament cells](#)' BMC Oral Health (2017)

17:44 DOI 10.1186/s12903-017-0341-1

Background

Hyaluronic acid (HA) has been reported to have a positive effect on periodontal wound healing following nonsurgical and surgical therapy. However, to date, a few basic in vitro studies have been reported to investigating the potential of HA on human periodontal ligament (PDL) cell regeneration. Therefore, the aim of this study was to investigate the effect of HA on PDL cell compatibility, proliferation, and differentiation in vitro.

Methodology

Either non-cross-linked (HA_ncl) or cross-linked (HA_cl) HA was investigated. Human PDL cells were seeded in 7 conditions as follows (1) Control tissue culture plastic (TCP) (2) dilution of HA_ncl (1:100), (3) dilution of HA_ncl (1:10), 4) HA_ncl directly coated onto TCP, (5) dilution of HA_cl (1:100), 6) dilution of HA_cl (1:10) and (7) HA_cl directly coated onto TCP. Samples were then investigated for cell viability using a live/dead assay, an inflammatory reaction using real-time PCR and ELISA for MMP2, IL-1 and cell proliferation via an MTS assay. Furthermore, the osteogenic potential of PDL cells was assessed by alkaline phosphatase (ALP) activity, collagen1 (COL1) and osteocalcin (OCN) immunostaining, alizarin red staining, and real-time PCR for genes encoding Runx2, COL1, ALP, and OCN.

Results

Both HA_ncl and HA_cl showed high PDL cell viability (greater than 90%) irrespective of the culturing conditions. Furthermore, no significant difference in both mRNA and protein levels of proinflammatory cytokines, including MMP2 and IL-1 expression was observed. Both diluted HA_ncl and HA_cl significantly increased cell numbers compared to the controlled TCP samples at 3 and 5 days. HA_ncl and HA_cl in standard cell growth media significantly decreased ALP staining, COL1 immunostaining and down-regulated early osteogenic differentiation, including Runx2, COL1, and OCN mRNA levels when compared to control samples. When osteogenic differentiation medium (ODM) was added, interestingly, the expression of early osteogenic markers increased by demonstrating higher levels of COL1 and ALP expression; especially in HA 1:10 diluted condition. Late stage osteogenic markers remained inhibited.

Conclusions

Both non-cross-linked and cross-linked HA maintained high PDL cell viability, increased proliferation, and early osteogenic differentiation. However, HA was consistently associated with a significant decrease in late osteogenic differentiation of primary human PDL cells. Future in vitro and animal research is necessary to further characterize the effect of HA on periodontal regeneration.

Mueller A, Fujioka-Kobayashi M, Mueller HD, Lussi A, Sculean A, Schmidlin PR, Miron RJ. [‘Effect of hyaluronic acid on morphological changes to dentin surfaces and subsequent effect on periodontal ligament cell survival, attachment, and spreading’](#) Clinical Oral Investigations 2016 May .DOI 10.1007/s00784-016-1856-6

Objectives

Hyaluronic acid (HA) is a natural constituent of connective tissues and plays an important role in their development, maintenance, and regeneration. Recently, HA has been shown to improve wound healing. However, no basic in vitro study to date has investigated its mode of action. Therefore, the purpose of this study was to examine morphological changes of dentin surfaces following HA coating and thereafter investigate the influence of periodontal ligament (PDL) cell survival, attachment, and spreading to dentin discs.

Methodology

HA was coated onto dentin discs utilizing either non-cross-linked (HA) or cross-linked (HA cl) delivery systems. Morphological changes to dentin discs were then assessed using scanning electron microscopy (SEM). Thereafter, human PDL cells were seeded under three in vitro conditions including (1) dilution of HA (1:100), (2) dilution of HA (1:10), and (3) HA coated directly to dentin discs. Samples were then investigated for PDL cell survival, attachment, and spreading using a live/dead assay, cell adhesion assay, and SEM imaging, respectively.

Results

While control dentin discs demonstrated smooth surfaces both at low and high magnification, the coating of HA altered surface texture of dentin discs by increasing surface roughness. HA cl further revealed greater surface texture/roughness likely due to the cross-linking carrier system. Thereafter, PDL cells were seeded on control and HA coated dentin discs and demonstrated a near 100 % survival rate for all samples demonstrating high biocompatibility of HA at dilutions of both 1:100 and 1:10. Interestingly, non-cross-linked HA significantly increased cell numbers at 8 h, whereas cross-linked HA improved cell spreading as qualitatively assessed by SEM.

Conclusions

The results from the present study demonstrate that both carrier systems for HA were extremely biocompatible and demonstrated either improved cell numbers or cell spreading onto dentin discs. Future in vitro and animal research is necessary to further characterize the optimal delivery system of HA for improved clinical use.

Clinical relevance

HA is a highly biocompatible material that may improve PDL cell attachment or spreading on dentin.

Pilloni A, Schmdlin PR, Sahrman P, Sculean A, Rojas MA. [Effectiveness of adjunctive hyaluronic acid application in coronally advanced flap in Miller class I single gingival recession sites: a randomized controlled clinical trial](https://doi.org/10.1007/s00784-018-2537-4), Clinical Oral Investigations, 2018 <https://doi.org/10.1007/s00784-018-2537-4>

Objectives

The aim of this randomized controlled clinical trial was to evaluate the possible advantages of adjunctive hyaluronic acid (HA) application in the coronally advanced flap (CAF) procedure in single Miller class I/recession type 1 (RT1) gingival recession treatment.

Methodology

Thirty patients with one recession were enrolled; 15 were randomly assigned CAF + HA and 15 to CAF alone. The recession reduction (RecRed), clinical attachment level gain (CAL-gain), changes in probing pocket depth (PPD) and in the width of keratinized tissue (KT), complete root coverage (CRC), and mean root coverage (MRC) were calculated after 18 months. Post-operative morbidity (pain intensity, discomfort, and swelling) was recorded 7 days after treatment using visual analogue scale (VAS).

Results

After 18 months, RecRed was statistically significantly higher in the test group (2.7 mm [1.0]) than in the control group (1.9 mm [1.0]; $p = 0.007$). PPD were found to be slightly but statistically significantly increased in both groups. No statistically significant difference was found for KT gain between treatments. CRC was 80% for test and 33.3% for control sites ($p < 0.05$). A MRC of $93.8 \pm 13.0\%$ for test and $73.1 \pm 20.8\%$ for control sites was calculated ($p < 0.05$). The test group reported lower swelling and discomfort values 7-days post-surgery ($p < 0.05$). Statistically significant difference was not found for pain intensity.

Conclusions

The adjunctive use of HA was effective in obtaining CRC for single Miller class I/RT1 gingival recession sites.

Clinical relevance

Adjunctive application of HA in the coronally advanced flap procedure may improve the reduction of the recessions and increase the probability of CRC in Miller class I recessions.