Republic of Iraq
Ministry of Higher Education
and Scientific Research
University of Baghdad
College of Dentistry

PREPARATION, OPTIMIZATION AND ASSESSMENT OF NOVEL GINGIVAL RETRACTION PASTES BASED ON AQUEOUS EXTRACT OF *BOSWELLIA PAPYRIFERA* WITH AND WITHOUT ALUMINUM CHLORIDE (COMPARATIVE ANIMAL AND *IN VITRO* STUDIES)

A Thesis

Submitted to the Council of the College of Dentistry/University of Baghdad, in Partial Fulfillment of the Requirements for the degree of Doctor of Philosophy in Conservative Dentistry

By

Hiba Abdulkareem Salman

B.D.S, M.Sc.

Supervised by

Assist. Professor

Dr. Manhal Abdul-Rahman Majeed

B.D.S. M.Sc. Ph.D.

(Conservative Dentistry)

Professor

Dr. Eaman Ali Al-Rubaee

B.Sc. M.Sc. Ph.D.

(Biochemistry)

2021 A.D **1442 A.H**

ABSTRACT

Background: Aluminum chloride ($AlCl_3$) with concentration of 5-25% are the most predominant astringent agents incorporated in gingival retraction pastes that are used in tissue retraction prior to impression taking in fixed prosthodontics. However, a more than 10% of $AlCl_3$ was reported to increase the acidity of the retraction agent, and inhibit the polymerization process of some impression materials, hence, affecting the quality of the impression and the health of the tooth and supporting structures. Therefore, new gingival retraction pastes were developed to replace the $AlCl_3$ by a natural herbal biocompatible material (*Boswellia papyrifera*) as a potent astringent agent in attempt to efficiently retract the soft tissues while decreasing the acidity of the gingival retraction paste and enhance compatibility to impression materials.

Materials and Methods: A pilot study was performed to select the proper concentration of *Boswellia papyrifera* (BP) aqueous extract to be included in the developed formula. Four concentrations (2, 5, 10, and 15%) were prepared and investigated in term of pH, homogeneity, and color at room and low temperatures for three months. The (2, 5, 10) % of BP was selected for further investigations since it maintained a clear homogenous observation within the experimental time period. Six formulations of gingival retraction pastes (F1, F2, F3, F4, F5, and F6) were prepared depending on the concentrations of BP with and without $AlCl_3$. Only four (F3, F4, F5, and F6) were selected since they showed a similar viscosity to the control gingival retraction paste (CGRP) (Astringent Retraction Paste, 3M ESPE, Germany). By evaluating the horizontal gingival displacement on beagle dogs, F4 (5% BP) and F5 (5% BP with 7.5% $AlCl_3$) exhibited

acceptable results that exceeded the minimum requirement (>200µm) of horizontal tissue displacement. Therefore, the formulas F4 and F5 were chosen as experimental gingival retraction pastes (EGRPs) and assigned as (5% BP), (5% BP with 7.5% $AlCl_3$) respectively, and then evaluated in comparison to the control paste in this study. The characterization and chemical mapping analysis of the novel retraction pastes were carried out via using scanning electron microscopy (SEM), energy dispersive x-ray spectroscopy (EDS) and Fourier-transform infrared spectroscopy (FTIR). The pH was measured with 1:10 dilution in distilled water at 21°C (n=3), and then the mean values were calculated. The cytocompatibility of both EGRPs and CGRP was performed by using Methyl Thiazolyl Tetrazolium test (MTT) at different exposure times (2 min., 10 min., and 24 hrs.). While the efficacy of horizontal and vertical tissue displacement was measured under digital microscope on three Beagle dogs using four teeth and three sites for each tooth (first molar, second molar, fourth premolar, and stomach tooth), (n= 36). The compatibility with polyvinylsiloxane (PVS) impression material was carried out using viscometer considering the standard-setting time of PVS (without mixing with the gingival retraction paste) as the ultimate compatibility time polymerization index (CTPI) (100%) and then compared to those mixed with EGRPs and CGRP. The statistical analysis methods that used in the study were ANOVA and Tukey's multiple comparisons for the study of cytocompatibility, Kruskal Wallis H test (KWH) test, Mann-Whitney U test (MWU) multiple comparisons test, and Wilcoxon Signed Ranks Test (WSR) test for the study of efficacy of gingival displacement. KWH test and MWU test for the study of compatibility with PVS impression material. All comparisons were considered statistically significant if $p<0.05$.

The results: The EGRPs showed a homogenous morphology under SEM, in which the filler particle size was larger than the control paste (3 -

20 µm, 5 - 10 µm, respectively). The elemental analysis via the EDS confirmed the presence of the BP, and Polyvinylpyrrolidone (PVP) within the matrix, while the presence of Silicon, Aluminum, and Potassium might be related to the kaolin filler. Mapping analysis showed a uniform distribution of the elements in experimental gingival retraction pastes. FTIR analysis showed the presence of hydroxyl, alkene, and carboxyl functional groups at absorption peaks (3414- 3417, 2953- 2927, 1664- 1714) cm^{-1} respectively indicating the presence of Boswellic acid as an active ingredient in both EGRPs.

EGRP (5% BP) showed a marked decrease in the acidity (pH 6.1) as compared to EGRP (5% BP with 7.5% $AlCl_3$) and the control groups (pH 4.5, 4.43, respectively. There were statistically no significant differences in the cell viability among retraction pastes at 2 min. and 24 h (p=0.095) and (p=0.9592) respectively, however, after 10 min, the cell viability of EGRP (5% BP with 7.5% $AlCl_3$) was statistically significantly higher than EGRP (5% BP) (p=0.042). Even though, the recorded cell viability of all pastes, which decreased over time, was higher than 60% indicating a mild toxicity behavior of all tested pastes.

All pastes showed a similar horizontal gingival displacement (p=0.052) which exceeded the clinical requirement of a gingival retraction paste (>200µm), while in vertical displacement, the CGRP recorded the highest value (p=0.024) followed by EGRP (5% BP with 7.5% $AlCl_3$) and then EGRP (5% BP) (p=0.002), which might be attributed to the differences in injection methods and the filler particle size between the control and experimental pastes. However, the Wilcoxon Signed Ranks Test showed statistically no significant differences among groups regarding the recovery of gingival attachment ($p>0.05$).

The compatibility time polymerization index was higher in both EGRPs (5% BP) and (5% BP with 7.5% $AlCl_3$) (87%) in comparison to the CGRP (80%) indicating the presence of BP within the gingival retraction paste can enhance the compatibility with the PVS impression materials.

Conclusions: The presence of *Boswellia papyrifera* (BP), as a potent biocompatible astringent agent, within the content of a retraction paste is an effective alternative to reduce or even replace the $AlCl_3$ ingredient, which can retract the gingival tissue efficiently while decreasing the acidity and enhance compatibility to impression materials.

.

جمهورية العراق
وزارة التعليم العالي والبحث لعلمي
جامعة بغداد
كلية طب الأسنان

تحضير ,ضبط وتقييم معاجين ازاحة اللثة المبتكرة المتكونة من المستخلص المائي لنبات اللبان الحبشي مع او بدون مادة كلوريد الالمنيوم (دراسة مقارنة مختبرية وتجريبية)

أطروحة

مقدمة إلى مجلس كلية طب الأسنان / جامعة بغداد كجزء من متطلبات نيل درجة الدكتوراه في معالجة الأسنان

من قبل

هبة عبد الكريم سلمان

بكالوريوس طب وجراحة الفم والأسنان

ماجستير معالجة الأسنان

باشراف

أ.م. د منهل عبد الرحمن مجيد

بكالوريوس طب وجراحة الفم والأسنان

ماجستير معالجة الأسنان

دكتوراه معالجة الأسنان

أ. د ايمان علي الربيعي

بكالوريوس علوم كيمياء

ماجستير كيمياء حياتية

دكتوراه كيمياء حياتية

2021 م

1442 هـ