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Evaluation and Comparison of Biomechanical Properties of a New "PRP Loop" with that of Opus Loop and L-Loop - a FEM Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Study Protocol

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ABSTRACT

Introduction: Closure of space is a salient factor in orthodontic treatment. Friction and frictionless mechanics are the methods of extraction space closure. Retraction loops eg. T loop, Opus loop, K Sir loop, L loop etc used force system as frictionless mechanics. An attempt has been made to blend the design of both Opus and L loops to form a new loop called "PRP loop" so that the beneficial properties of L loop and Opus loop can be integrated into the new loop. This study is therefore undertaken to evaluate the biomechanical effect of PRP loop and compare it to the "L loop and Opus loop".

Objectives: To evaluate and compare the moment to force ratio of PRP loop, Opus loop and L loop fabricated in "0.019×0.025 inch" and "0.017×0.025 inch" "TMA wire with and" without any " preactivation bends" and to "compare the moment to force ratio" of PRP loop with "Opus loop", and L loop fabricated in 0.019×0.025 wire with those fabricated in 0.017×0.025 wire.

Methodology: PRP loop, "L loop and Opus loop" will be fabricated in "0.019×0.025 and 0.017×0.025 inch TMA wire" without pre activation bends. Using the dHAL software moment to force ratio will be calculated for PRP loop of "0.019×0.025 inch" and "0.017×0.025 inch" "TMA wire with and" without different degrees of alpha pre-activation bends.

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Ansys 16.0 finite element analysis software will be used to form the loops of three dimensional model after that the forces and moments in all three dimensions will be studied.
Expected Result: The moment to force of PRP loop will be evaluated to so that optimum force level can be determined to prove its clinical efficiency.
Conclusion: No such study has been done on PRP loop. Hence, a study is planned to evaluate and compare the ”biomechanical properties of PRP loop with that of Opus loop and L loop”

Keywords: PRP “loop”; Opus loop; L loop; biomechanical effect.

1. INTRODUCTION

Closure of space is a salient factor in orthodontic treatment [1]. Closure of extraction space is carried out by the anterior teeth retraction and posterior teeth protraction, depends upon the type of anchorage [2]. Friction and frictionless mechanics are the methods of extraction space closure in pre adjusted “edgewise appliance” treatment [3]. The major benefit is dissipation of force is not their by friction in frictionless mechanics. Retraction loops eg. T loop, Opus loop, K Sir loop, L loop etc used force system as frictionless mechanics. The retraction loop should be easy to fabricate and have an appropriate size in the vestibule. For translatory movement of tooth, retraction loop must have high moment to force ratio to maintain desired force level for a longer period of time [4]. There are different modification in the “loop design, degree of bends, dimension, types and material of arch wire”. The fabrication of L loop is simple, but the “moment to force ratio” of loop is not adequate. Opus loop introduced by Dr Raymond Siatowski inherently produces moment to force ratio close to 10:1 [5] but the major demerit with this type of retraction loop is that it causes tissue impingement. An attempt has been made to blend the design of both Opus and L loops to form a new loop called “PRP loop” so that the beneficial properties of L loop and Opus loop can be integrated into the new loop. In order to use the PRP loop for maximum clinical efficiency, its biomechanical properties need to be analysed. There is no analysis done yet about the biomechanical properties of PRP loop. This study is therefore undertaken to “evaluate the biomechanical effect” of PRP loop and compare it to the “L loop and Opus loop”.

2. AIM AND OBJECTIVES

2.1 Aim

To evaluate and compare the biomechanical properties of PRP loop with that of Opus loop and L loop.

2.2 Objectives

1. To evaluate the” moment to force ratio” of PRP loop, “Opus loop and L loop” fabricated in “0.019×0.025 inch” TMA wire with and without any “preactivation bends”
2. To evaluate the “moment to force ratio” of PRP loop, “Opus loop and L loop” fabricated in “0.017×0.025 inch TMA wire” with and without any “preactivation bends”.
3. To compare the “moment to force ratio” of PRP loop with “Opus loop, and L loop” fabricated in “0.019×0.025 inch and 0.017× 0.025-inch wire with and without preactivation bends”.
4. To compare the” moment to force ratio” of PRP loop with “Opus loop, and L loop” fabricated in “0.019×0.025 wire with those fabricated in 0.017×0.025 wire”.

Study design: FEM study.

3. MATERIALS AND METHODS

The study will be carried out in the department of Orthodontics and Dentofacial Orthopaedics, Sharad Pawar Dental College, Sawangi (M), Wardha with the technical assistance from the Department of Mechanical Engineering IIT Goa. Approval has been obtained from the Ethical committee (with reference no.)

PRP loop, “L loop and Opus loop” will be fabricated in “0.019×0.025 and 0.017×0.025 inch TMA wire” without pre activation bends. The need for precise evaluation in loops led to more advanced studies like finite element analysis being used in orthodontics [6-7].

Using the dHAL software moment to force ratio will be calculated for PRP loop of “0.019×0.025 inch and 0.017×0.025 inch TMA wire” with and without different degrees of alpha preactivation bends.

Ansys 16.0 finite element analysis software will be used to form the loops of three dimensional model after that the forces and moments in all three dimensions will be studied.

Dimensions of the loop models will be based on the prescription given by their respective author:

L loop: occluso-gingival height will be kept 10 mm and mesio-distally extended to 10 mm (Fig. 1).

Opus loop: occluso-gingival height will be kept 10 mm and mesio-distally extended to 10mm (Fig. 2).

PRP loop: occluso-gingival height will be kept 10 mm and mesio-distally extended to 10 mm (Fig. 3).

The horizontal length (distance between anterior and posterior nodes) will be kept 2mm, 3mm and 5mm considering the inter-bracket distance from 2nd premolar mid-point to the canine midpoint.

Loop models will be prepared in “0.019×0.025 inch and 0.017×0.025 inch TMA wire”.

Following loop models will be prepared for the study:

1) Opus loop in“0.019×0.025 inch TMA wire with 0°alpha preactivation bend”.
2) L loop in “0.019×0.025 inch TMA wire with 0°alpha preactivation bend”.
3) RP loop in “0.019×0.025 inch TMA wire with 30°alpha preactivation bend”.
4) PRP loop in “0.017×0.025 inch TMA wire with 30°alpha preactivation bend”.

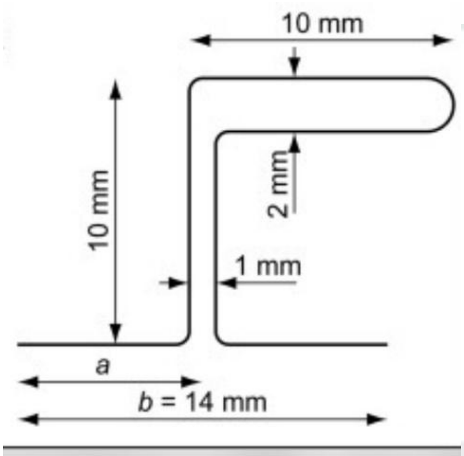

Fig. 1. L- LOOP

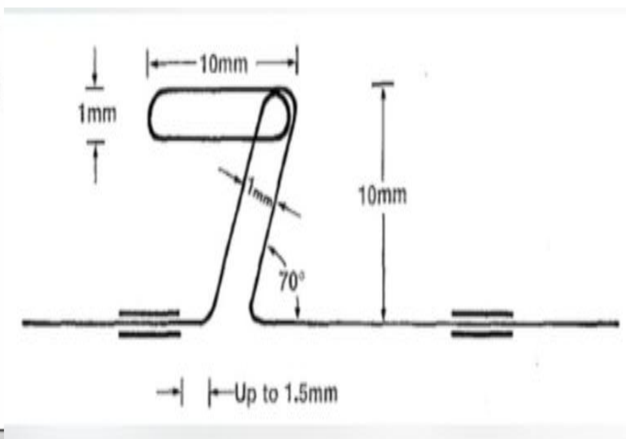

Fig. 2. OPUS LOOP

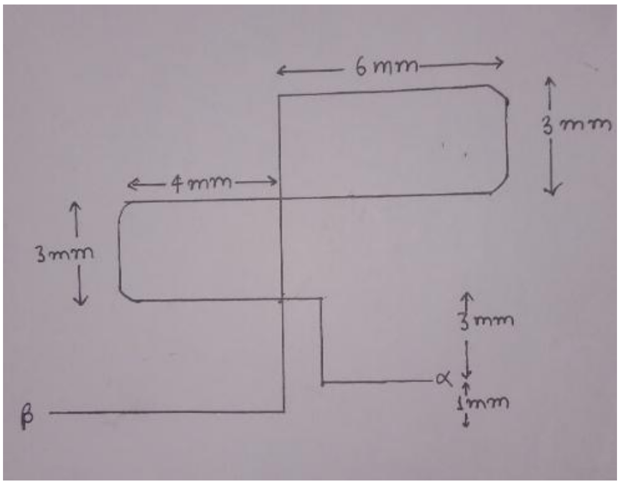

Fig. 3. PRP LOOP

4. METHODOLOGY

1. The 3D modelling of the PRP loop “0.019×0.025 inch” and “0.017×0.025 inch” TMA wire will be done using either SOLIDWORKS or CATIA software and the 3D design of loop will be saved in .stl format.
2. Then the saved 3D design will be imported to the HYPERMESH software where the meshing of the model will be done.
3. The meshed model will be imported in the ANSYS 16.0 software or FEA where the material property (“young’s modulus, poisson’s ratio” etc.) as well as geometric properties of the element (length, area etc) will be defined. Loop Geometric will be characterized into nodes and beam elements for the purpose of analysis.
4. Then the boundary conditions will be applied along with the definition of the loading on the model with and without alpha preactivation bends.
5. The software will start the solution process by computing the unknown values of the primary variables.
6. Then the computed values will be used to compute variables such as reaction forces, deformation etc.
7. In the post processing part the result will be interrogated and various modifications can be done for verifying and validating the results.

5. EXPECTED RESULTS

The moment to force of PRP loop will be evaluated to so that optimum force level can be determined to prove its clinical efficiency.

6. DISCUSSION

This study will be designed to enhance the use of PRP loop by knowing its biomechanics and then we will compare this with Opus loop and L-loop.

Ray Vanderby, Charles burstone et al. [8] analysed F/M ratio of the three retraction loops L loop, T loop and rectangular loop from "0.010×0.021 inch SS wire"(stainless steel). standardized loop height was 6 mm. The activation of 1mm, 2mm and 3 mm were done on loops. The result was that with increase in activation the anterior to posterior ratio of the moments decreases, but in rectangular loop ratio was more horizontal which shows its superiority.

Mohammad Reza Safavi, Allahyar Geramy, Amir kamyar khezri [9] compared the moment to ratio of opus loop, T loop and L loop and vertical helical closing loop with FEM in segmented arch. Loops were made with "0.016×0.022 inch" Stainless steel wire. Preactivation bends of 10°were generated in all loops except opus loop. The M/F ratio, vertical and horizontal forces were recorded in different mm intervals of activation. Result shows that by L-loop highest vertical and horizontal forces was produced and by VHC loop lowest forces was produced by VHC loop. There is marked difference in moment to force ratio with preactivation bends and without any preactivation moment to force ratio is low or constant on activation [10]. Highest moment to force were seen in T loop and Opus loop without preactivation bends. Few related studies were reviewed [11-12].

7. CONCLUSION

No such study has been done on PRP loop. Hence, a study is planned to evaluate and compare the biomechanical properties of PRP loop with that of Opus loop and L loop.

CONSENT

As per international standard or university standard, Participants’ written consent will be collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval will be collected and preserved by the author(s) (DMIMS/IEC/2020-21/9399).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rao PR, Shrivastav SS, Joshi RA. Evaluation and Comparison of Biomechanical Properties of Snail Loop with that of Opus loop and Teardrop Loop for en masse Retraction of Anterior Teeth: FEM Study. J Ind Orthod Soc. 2013;47(2): 62-67.
2. Braun S, Sjursen RC, Legan HL. On management of extraction site. Am J

Orthod Dentofacial Orthop. 1997;112:645-55.

3. Staggers JA, Germane N. Clinical consideration in the use of retraction mechanics. J Clin Orthodont 1991;25(6): 346-69.
4. Burstone CJ, Koeng HA. Optimizing anterior and canine retraction. AM J Orthod. 1976;70(1):1-18.
5. Siatowski RE. Continuousarchwire closing loop design optimization and verification. Part 1. Am J Orthod Dentofac Orthop. 1997;112:393-402.
6. Thote A, Uddanwadiker R, Sharma K, Shrivastava S. Optimum en-masse retraction of six maxillary anterior teeth in lingual orthodontics: A numerical investigation with 3-dimensional finite element analysis. Molecular & Cellular Biomechanics. 14(1):1–17.
7. Thote A, Sharma K, Uddanwadiker R, Shrivastava S. Pure intrusion of a mandibular canine with segmented arch in lingual orthodontics: A numerical study with 3-dimensional finite element analysis. Biocybernetics and Biomedical Engineering. 2017;37(3):590–598.
8. Ra Vanderby, Charles J Burstone, David J Solonche, John A Ratches. Experimentally determined force systems from vertically activated orthodontic loops. Angle orthodontics.1977;47(4):272-279.
9. Mohammad Reza Safavi, AllahyarGeramy, Amir Khezri. M/F ratios of four different closing loops: 3D analysis using the finite element method (FEM). AustOrthod J. 2006;22:121-126.
10. Chiara Menghi, Jens Planert, Birte Melsen. 3D experimental identification of force systems from orthodontic loops activated for first order corrections. Angle orthodontics. Angle orthodontics. 1990; 69(1):49-57.
11. Thote, Abhishek M, Rashmi V. Uddanwadiker, Krishna Sharma, and Sunita Shrivastava. Optimum Force System for Intrusion and Extrusion of Maxillary Central Incisor in Labial and Lingual Orthodontics. Computers in Biology and Medicine. 2016;69:112–19. Available:https://doi.org/10.1016/j.compbiomed.2015.12.014.
12. Thote, Abhishek M., Krishna Sharma, Rashmi V. Uddanwadiker, and Sunita Shrivastava. Optimum Pure Intrusion of a Mandibular Canine with the Segmented Arch in Lingual Orthodontics. Bio-Medical Materials and Engineering. 2017;28(3): 247–56. Available:https://doi.org/10.3233/BME-171671.

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