A comparative evaluation of mandibular incisor decrowding with coaxial and optiflex arch wires and their load-deflection rates

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ABSTRACT

Aim: The aim of this study is to determine and compare the load-deflection rate of optiflex arch wire with that of coaxial arch wire and to determine and compare the decrowding efficiency of optiflex arch wire with coaxial arch wire within a period of 45 days. **Materials and Methods:** Load-deflection rates of optiflex and coaxial wires were found using the INSTRON (4300) machine. A steady load was given to the wire to make it deflect, and the load required to deflect the wire for every 1 mm up to 5 mm, were noted and tabulated. A total of 10 patients, 10-25 years of age (seven males and three females) were selected. All patients had angles Class I malocclusion with a crowding discrepancy of 3-9 mm (according to little's index). All patients required first premolar extraction. Pre (0 day) and post (45th day) treatment study models and lateral cephalograms were taken for all patients and evaluated. **Results:** Optiflex had a low load-deflection when compared to coaxial wire. Clinically, optiflex and coaxial wire had similar decrowding efficiency. In both, study model and cephalometric analysis, there was no statistically significant value when comparing their mean variables. **Conclusion:** Optiflex is an appropriate wire for patients seeking esthetics during fixed appliance therapy as it combines esthetics and efficiency by delivering light continuous forces.

KEY WORDS: Coaxial arch wire, decrowding, load-deflection, optiflex

In the modern era of orthodontics, the development of materials is tremendous. The orthodontist is left with the job of combining both esthetics and clinical efficiency. The most perplexing phenomenon in orthodontics is the crowding of the anterior teeth, which remains as one of the most prevalent conditions of malocclusion, with esthetic and functional aberrations.

Multi stranded wires, 0.014 stainless steel, M-NiTi, A-NiTi, Cu-NiTi, optiflex, etc., are some of the most efficient wires available for aligning crowded and rotated anteriors. Coaxial arch wire has a central core for stability with outer wires wrapped around for resilience and flexibility. In modern orthodontics, with esthetics governing the newer materials, one nonmetallic wire already has been offered for clinical use called "optiflex designed by Dr. Talass[1] with a highly esthetic appearance. The wires for initial alignment require a combination of excellent strength, excellent springiness, and a long range of action. Ideally, they could be an almost flat load-deflection curve, with the wire delivering 50 g (the optimum force for tipping) at almost any degree of deflection. The variables in selecting appropriate arch wires for alignment are the arch wire material, its diameter, and the distance between attachments.

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Aims and objectives

The aim of our study is to determine and compare the load-deflection rate and decrowding efficiency of optiflex arch wire with that of coaxial arch wire within a period of 45 days.

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Materials and Methods

This study was carried out at the Division of Orthodontics, Rajah Muthiah Dental College and Hospital, Annamalai University and the Fiber Reinforced Plastic Research Center at the Indian Institute of Technology, Chennai. The study involved the Comparison of: (1) Load-deflection rate of two aligning arch wires (i) coaxial 0.016" (ii) optifle × 0.0175". (2) To find out the decrowding efficiency of the lower anterior crowding using the arch wires within a period of 45 days.

To find out the load-deflection rates, the wires were fixed on a fabricated fixtures, which simulated the inter bracket distance of the lower anterior. This was fixed on a fully computerized universal testing machine-the INSTRON (4300) having a capacity of 500 kg. At Fiber Reinforced Plastic Research Center, an Inter Disciplinary Centre at Indian Institute of Technology, Chennai. A steady load was given to the wire to make it deflect and the load required to deflect the wire for every 1 mm up to 5 mm, were noted and tabulated. To find out the clinical efficiency of the wire for lower anterior decrowding, a total of 10 patients, 10-25 years of age (seven males and three females) were selected. All patients had angle s Class I malocclusion with a crowding discrepancy of 3-9 mm (according to little's index[2]). All patients required first premolar extraction. The clinical procedure given below was followed for standardization. (a) Pretreatment records consisted of study models lateral cephalogram photographs (three intra oral and three extra oral). (b) All cases were started within 5 days from the last extraction. (c) The mandibular crowding was quantified using "the irregularity index of little" after bonding and banding the following wires were placed, (i) coaxial 0.016" (round) Group 1 (ii) optiflex - 0.0175" (round) Group 2 and secured to the bracket with elastic modules and 0.009" stainless steel ligature wire where ever necessary, except for optiflex where only modules were used. 0.018 ROTH prescriptions were used. All patients were instructed to report immediately if there were any loose brackets or bands. All patients were asked to report on the 45th day.

Model analysis

The mandibular dental casts were evaluated using the following parameters and the results were compared [Figure 1].

1. Arch length
2. Arch depth[3]
3. Mandibular inter-canine width[4]
4. Mandibular second inter-premolar width
5. Mandibular first inter-molar width[5]
6. Irregularity index

Cephalometric analysis

The following cephalometric landmarks were used and the results were compared with each group.

1. Lower incisor to NB (angular) and (linear)
2. Incisor mandibular plane angle (IMPA)
3. N-pog to incisor axis
4. Reference point to lower molar
5. Reference point to lower incisor [Figure 2].

Results

The load-deflection rates of coaxial wire and optiflex wire were determined. It was found that at 4.2 mm of deflection, there was permanent deformation of the coaxial wire and at 4.06 mm of deflection; there was permanent deformation of the optiflex wire.

In this study, the wires coaxial and optiflex were compared clinically to find out the efficiency for decrowding the lower anteriors m 45 days. Study cast analysis and cephalometricanalysis were done. The mean of the '0' day and 45th day values were tabulated and compared using Student's *t*-test.

The observations are shown as study cast analysis values for six characters such as arch length, arch depth, inter-canine width, inter-premolar width, inter-molar width, and irregularity index for '0' day and 45th day, as shown in Table 1.

The observations of the cephalometric analysis values for six characters-lower incisor to NB (angular), lower incisor to NB[6] (linear), IMPA,[7] N-pog to incisor axis[8] (angular), reference point to lower molar[9] (linear) and reference point to lower incisor[9] (linear) are shown in Table 2.

Table 1: Study cast analysis

Character	Group 1	Group 2	*T* value	*P* value
Arch length	5.4 (1.833)	1.8 (0.8602)	−1.78	0.1133
Arch depth	1.2 (0.2900)	1.4 (0.2449)	0.63	0.5447
Inter-canine width	1.1 (1.0049)	−1 (0.7745)	−1.66	0.1365
Inter-premolar width	0.6 (1.0295)	0 (1.140 1)	−0.38	0.7063
Inter-molar width	0.8 (0.4898)	0 (0.4472)	−1.21	0.2623
Irregularity index	4.6 (0.7483)	4.1 (0.7483)	−0.47	0.6492

Values in parenthesis indicate the estimates of standard errors of means

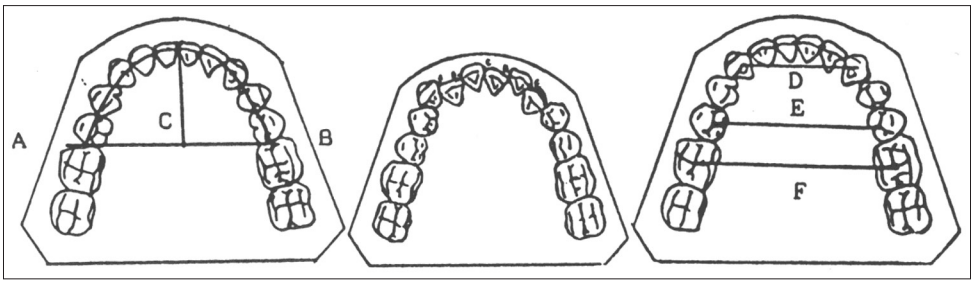


Figure 1: Parameters for model analysis

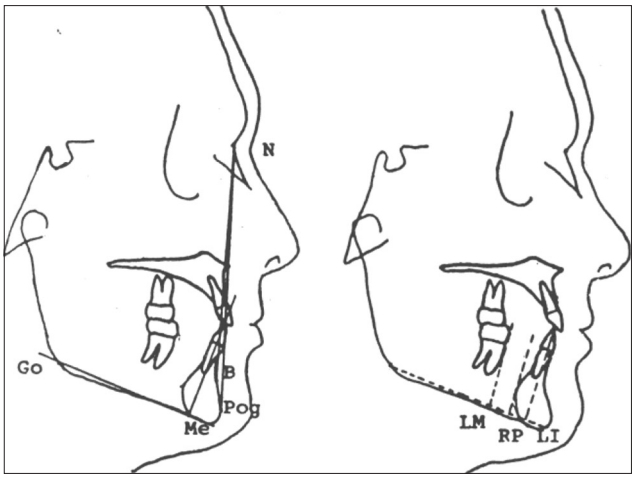


Figure 2: Parameters for chephalometric analysis

The linear and angular measurements of lower incisor to NB are statistically insignificant. IMPA angle was increased in Group 2, indicating that the lower incisor proclined during decrowding, but no statistically significant difference in both groups.

An increase in the N-pog to incisor axis angle in Group 2 indicates that, there is proclination of the lower incisor teeth during decrowding. However, the comparison of the means in both groups revealed no statistical significance.

There was a decrease in this linear measurement (reference point to lower molar and reference point to lower incisor) indicates that some amount of lower incisor retraction and mesial movement of lower first molars took place in both groups. However, the changes were statistically insignificant.

Discussion

Crowding of the anteriors remains one of the most prevalent conditions, which brings patients to orthodontists seeking remedy due to its esthetic and functional consequences. Correction of crowding is one of the objectives in the initial stage of treatment in any treatment mechanics.

In the early years, stainless steel wires of smaller dimensions were used for correction of crowding. With recent advances, varied arrays of wires that exhibit a wide spectrum of properties are available today.

In the recent years, esthetics is a prime consideration and governs the development of newer materials. The task of combining both esthetics and clinical aspects has become challenging. The *in vitro* study revealed that optiflex had a low load-deflection when compared with the coaxial wire. It reaches its proportional limit much earlier, whereas coaxial showed a steady deformation rate during the loading process [Table 3].

In the *in vivo* study, when the means of arch length of the 45th day values for Group 1 and 2 were compared, there was a decrease in arch length in both groups, but the decrease in arch length in Group 2 is less than that of Group 1. This indicates

Table 2: Cephalometric analysis

Character	Group 1	Group 2	*T* value	*P* value
Lower incisor to NB (angular)	1 (1.1401)	−1 (1.0488)	−1.29	0.2328
Lower incisor to NB (linear)	0 (0.6519)	0.1 (0.4582)	0.13	0.9032
IMPA (angular)	1 (1.0488)	−1 (0.8366)	−1.49	0.1744
N-pog to incisor axis (angular)	0.4 (1.1224)	−1.8 (1.1575)	−1.36	0.2096
Reference point to lower molar (linear)	1.5 (0.6708)	0.6 (0.1870)	−1.29	0.2323
Reference point to lower incisor (linear)	−0.1 (0.6595)	0.2 (0.5830)	0.34	0.7420

IMPA: Incisor mandibular plane angle, NB: Nasion to point B

Table 3: Load deflection rate

Archwires	1 mm	2 mm	3 mm	4 mm	5 mm
Coaxial	0.57	3.76	5.92	6.95	7.85
Optiflex	0.07	0.22	0.38	0.5	0.39

that when optiflex is used, the anterior teeth did not move in to the extraction space as in Group 1. A decrease in arch depth value of the 45th day was seen in both groups; however, they were statistically insignificant. The mean for inter-canine width and inter-molar width of the 45th day value increased in both groups. Group 2 showed less increase when compared to Group 1 indicating that optiflex did not cause any significant expansion in the canine and molar region. Group 1 and 2 showed similar changes in irregularity index values for 45th day values. This indicates that optiflex and coaxial have similar decrowding efficiency.

The mean values of 45th day values of lower incisor to NB (angular), IMPA and N-pog to incisor axis of Group 2 increased while Group 1 showed a decrease. This indicates that the decrowding was more due to proclination of lower anteriors when optiflex was used. Mesial movement of the lower molar took place in both groups, but less with the optiflex wire. Retraction of lower incisor took place in both groups, but less with the optiflex wire. The comparison of changes in both groups was statistically insignificant. When the means of the six variables of study cast analysis and the six variables of the cephalometric analysis were compared and statistically analyzed, none of the values were statistically significant ($P < 0.05$).

Conclusion

From the study, the following conclusions were drawn: The optiflex wire showed a low load-deflection when compared with the coaxial wire. It can be concluded that decrowding with the optiflex wires had taken place mainly by labial crown proclination. The optiflex wire is the culmination of an amazing evolution in orthodontic wires. The optiflex wire is a nonmetal stain resistant arch wire that can be used for initial alignment. It produces less force for the same amount of deflection when compared with coaxial. No new technology 1s without disadvantages. The optiflex wire is expensive and has to be changed every 4-6 weeks. The optiflex wire is an appropriate wire

for patients who seek esthetics during treatment as it satisfies both the orthodontist and the patient by combining both aesthetics and efficiency by delivering a light continuous force.

The optiflex wire should be compared with other aligning archwires. Further studies and research have to be done with the optiflex in order to make it more rigid so that, not only decrowding, but also retraction and finishing can be done with the optiflex wire. This will make the entire orthodontia treatment highly esthetic and "invisible."

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