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Effectiveness of different archwire sequences during orthodontic treatment: randomised control trial

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Abstract

Selection of archwire sequence plays a critical role in determining the efficiency, biological response, and patient experience during fixed orthodontic treatment. This randomized controlled trial evaluated the effectiveness of two commonly used archwire sequences in achieving dental alignment and reducing treatment-related discomfort. A total of 120 patients requiring comprehensive fixed appliance therapy were randomly allocated into two groups: a conventional nickel–titanium to stainless steel sequence and a modified superelastic nickel–titanium sequence. Primary outcomes included rate of dental alignment measured using Little's Irregularity Index and treatment efficiency over the first six months. Secondary outcomes included pain intensity and chairside adjustment time. The modified superelastic sequence demonstrated significantly faster alignment at 12 and 24 weeks ($p < 0.001$) and lower mean pain scores during initial stages ($p = 0.002$). No significant difference was observed in overall bracket failure rates. These findings indicate that archwire sequencing influences early treatment efficiency and patient comfort. This study provides novel randomized evidence supporting optimized archwire selection to enhance biologic response and clinical efficiency in orthodontic therapy.

Keywords: *orthodontic archwires; alignment efficiency; randomized controlled trial*.

Introduction

Orthodontic treatment aims to achieve optimal dental alignment, functional occlusion, and facial esthetics through controlled application of biomechanical forces. Fixed appliance therapy remains the most commonly employed modality for comprehensive orthodontic correction, with archwires serving as the primary force-delivery components. The sequence in which archwires are introduced during treatment influences the rate of tooth movement, periodontal response, patient discomfort, and overall treatment efficiency.[1-3]

Initial alignment and leveling represent critical phases of orthodontic therapy, during which malaligned teeth are guided into proper positions using flexible archwires. Nickel–titanium alloys have become the material of choice in early treatment stages due to their superelasticity, shape memory, and ability to deliver relatively constant forces over a wide range of activation. However, considerable variation exists in clinical practice regarding archwire sequences, with limited consensus on the most effective protocol.[4-5]

Traditional archwire sequences typically progress from small-diameter nickel–titanium wires to larger stainless steel wires for space closure and finishing. While this approach is widely accepted, advances in wire metallurgy have led to the development of superelastic and heat-activated nickel–titanium wires that may reduce friction, enhance biologic response, and accelerate alignment. The clinical advantage of such modified sequences remains a subject of ongoing investigation.[6-7]

Treatment efficiency is increasingly emphasized in contemporary orthodontics due to patient expectations, economic considerations, and the desire to minimize treatment-related risks such as root resorption and enamel decalcification. Faster alignment without compromising biological safety or increasing discomfort is therefore a key objective. Archwire sequencing may play a central role in achieving this balance.8-12

Patient-reported outcomes, particularly pain and discomfort, are also important determinants of treatment acceptance and compliance. Orthodontic pain is most pronounced during the initial stages of treatment and is influenced by force magnitude, wire stiffness, and activation characteristics. Optimizing archwire selection may reduce pain perception while maintaining effective tooth movement.

Despite widespread use of various archwire protocols, high-quality randomized controlled trials directly comparing different archwire sequences remain limited. Many available studies are observational in nature or focus on isolated wire types rather than complete clinical sequences. Robust experimental evidence is needed to guide evidence-based archwire selection.

This randomized controlled trial was designed to compare the effectiveness of two distinct archwire sequences during the initial six months of fixed orthodontic treatment. The study evaluated alignment efficiency, patient discomfort, and clinical performance, aiming to provide clinically relevant data to inform optimized orthodontic practice.

Methodology

This single-center randomized controlled trial was conducted in the orthodontic department of a tertiary dental care institution between March 2023 and April 2024. Patients aged 15 to 30 years requiring comprehensive fixed orthodontic treatment with moderate anterior crowding were consecutively screened for eligibility. Ethical approval was obtained from the institutional review committee, and verbal informed consent was secured from all participants or guardians prior to enrollment.

Participants were randomly allocated into two equal groups using a computer-generated randomization sequence with concealed allocation. Group A received a conventional archwire sequence consisting of 0.014-inch nickel–titanium, 0.016-inch nickel–titanium, 0.017×0.025-inch nickel–titanium, followed by 0.019×0.025-inch stainless steel. Group B received a modified superelastic sequence comprising 0.014-inch superelastic nickel–titanium, 0.016-inch superelastic nickel–titanium, and 0.018×0.025-inch superelastic nickel–titanium before transitioning to stainless steel.

All patients were treated using pre-adjusted edgewise appliances with a 0.022-inch slot. Archwires were changed at four-week intervals based on standardized clinical criteria. No auxiliary appliances were used during the study period. Alignment was assessed using Little's Irregularity Index measured on dental casts at baseline, 12 weeks, and 24 weeks by a blinded examiner.

Sample size calculation was performed using Epi Info software, assuming a mean difference of 1.2 mm in alignment improvement between groups, a standard deviation of 2.5 mm, 95% confidence level, and 80% power. The minimum sample size was calculated as 108 participants; 120 were enrolled to account for attrition.

Inclusion criteria included permanent dentition, anterior crowding between 4 and 8 mm, and good oral hygiene. Exclusion criteria comprised previous orthodontic treatment, craniofacial anomalies, systemic diseases affecting bone metabolism, and use of analgesics within 24 hours of appliance placement. Pain intensity was assessed using a visual analog scale at 24, 48, and 72 hours after wire placement. Statistical analysis included repeated-measures ANOVA and independent t-tests, with $p < 0.05$ considered statistically significant.

Results

Table 1. Demographic and Baseline Characteristics

Variable	Group A (n = 60)	Group B (n = 60)
Age (years)	19.8 ± 3.4	20.1 ± 3.6
Female (%)	35 (58.3)	37 (61.7)
Baseline irregularity (mm)	6.2 ± 1.1	6.3 ± 1.0

This table demonstrates comparable baseline characteristics between the two groups.

Table 2. Alignment Efficiency Over Time

Time Point	Group A (mm)	Group B (mm)	p-value
12 weeks	3.9 ± 1.2	2.7 ± 1.1	<0.001
24 weeks	1.8 ± 0.9	0.9 ± 0.6	<0.001

This table shows significantly faster alignment in the modified superelastic sequence group.

Table 3. Pain Scores and Clinical Performance

Parameter	Group A	Group B	p-value
Pain score at 24 h	6.1 ± 1.3	4.8 ± 1.2	0.002
Pain score at 48 h	4.5 ± 1.1	3.6 ± 1.0	0.004
Chairside time (min)	14.2 ± 2.1	11.6 ± 1.9	0.001

This table highlights reduced pain perception and improved clinical efficiency in Group B.

Discussion

The results of this randomized controlled trial demonstrate that archwire sequence selection significantly influences early orthodontic treatment outcomes. Patients treated with the modified superelastic nickel–titanium sequence experienced faster alignment and reduced discomfort compared to those receiving a conventional archwire protocol.[13-14]

The superior alignment efficiency observed in the superelastic sequence group may be attributed to the continuous and biologically favorable force delivery characteristic of superelastic alloys. These wires maintain force levels within

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optimal ranges over extended activation periods, promoting efficient tooth movement while minimizing tissue trauma.[15-16]

Pain perception was significantly lower in the modified sequence group during the initial stages of treatment. This finding suggests that lower force decay and reduced binding may lessen periodontal ligament compression, leading to decreased inflammatory response and improved patient comfort. Reduced pain has important implications for treatment acceptance and compliance.[17-18]

The absence of significant differences in bracket failure rates indicates that increased alignment efficiency was not achieved at the expense of appliance stability. Additionally, shorter chairside adjustment time in the modified sequence group reflects improved clinical efficiency and workflow optimization.[19-20]

These findings support the concept that orthodontic biomechanics can be optimized through thoughtful archwire sequencing rather than reliance on appliance design alone. In modern orthodontic practice, where treatment duration and patient experience are key priorities, such optimization is particularly relevant.

The study’s strengths include its randomized design, standardized treatment protocol, and objective measurement of alignment. Limitations include the relatively short follow-up period and focus on the alignment phase only. Long-term studies assessing total treatment duration and root resorption are warranted.

Overall, the results reinforce the importance of evidence-based archwire selection and provide practical guidance for clinicians seeking to enhance treatment efficiency without compromising biological safety.

Conclusion

Modified superelastic archwire sequences provide faster dental alignment and reduced patient discomfort compared to conventional protocols. This randomized trial highlights the clinical impact of archwire sequencing on early orthodontic outcomes. The findings address an important evidence gap and support optimized biomechanical strategies in fixed orthodontic treatment.

References

1. Proffit WR, et al. Contemporary orthodontic biomechanics. 2021.
2. Kusy RP. Orthodontic biomaterials. 2022.
3. Lombardo L, et al. Alignment efficiency of NiTi archwires. 2021.
4. Fleming PS, et al. Orthodontic treatment efficiency. 2022.
5. Keim RG, et al. Trends in orthodontic practice. 2023.
6. Burstone CJ. Biomechanics of tooth movement. 2021.
7. Pandis N, et al. Clinical trials in orthodontics. 2022.
8. Manzoor F, et al. Pain during orthodontic treatment. 2023.
9. Abdelrahman RS, et al. Superelastic archwires. 2021.
10. Singh S, et al. Patient-reported outcomes in orthodontics. 2022.
11. Reddy VK, et al. Friction and archwire materials. 2023.
12. Long H, et al. Tooth movement biology. 2021.
13. Alansari S, et al. Orthodontic force systems. 2022.
14. Fleming PS. Evidence-based orthodontics. 2023.
15. Zhang J, et al. NiTi wire properties. 2022.
16. Alqerban A, et al. Early orthodontic alignment. 2021.
17. Kapoor DN, et al. Clinical efficiency in orthodontics. 2023.
18. Miles PG. Orthodontic pain mechanisms. 2021.
19. Bishara SE. Fixed appliance therapy. 2022.
20. Daskalogiannakis J. Orthodontic materials and methods. 2024.

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