A RANDOMIZED CLINICAL TRIAL INVESTIGATING PAIN ASSOCIATED WITH CONVENTIONAL NICKEL-TITANIUM ARCH WIRES WHEN EXPOSED TO LLLT (LOW LEVEL LASER THERAPY) DURING THE INITIAL HOURS OF LEVELING AND ALIGNING PHASE OF ORTHODONTIC TREATMENT

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Abstract

Orthodontic force application for aligning teeth,causes initiation of acute inflammatory processes leading to periodontal ligament tissue injury. It is advised that light continuous forces should be used during orthodontic treatment to minimize tissue damage and subsequent pain and discomfort.(1) The present study was aimed to evaluate the effect of using low-level laser therapy (LLLT) to control pain and discomfort during the initial hours of levelling and aligning phase of orthodontic treatment. The methodology was to compare and evaluate the pain perception using an Visual Analogue Scale (VAS) between patients who were given 0.016 Conventional NiTi(Group 1) and0.016 Conventional NiTi with exposure to LLLT, AIGaAs diode, (810 nm, 100 mW, 2J/cm2) (Group 2) at regular intervals of 24 hours, 48 hours and 72 hours each consisting of a sample size of 7. A total of 14 subjects participated in the study, each group consisting of 7 subjects. The mean pain perception score was 1.71±0.48 and 1.71±0.48 at 0 hours, 2.42±0.97 and 2.42±0.53 at 24 hours, 3.42±0.53 and 2.71±0.48 at 48 hours, 3.85±0.69 and 3.00±0.57 at 72 hours, for Group 1 and Group 2 respectively. There was no significant difference between the two groups, but at 72 hours the difference improved (p=0.004) in group 2 indicating there was a decrease in pain perception with time. It was concluded that there was no statistically significant difference between the two groups. However, subjects with nickel–titanium arch wires when exposed to LLLT had a significantly lower pain at peak level.

Keywords: LLLT, pain perception, conventional Niti, leveling and aligning

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1. Introduction

Orthodontic force application for aligning teeth,causes initiation of acute inflammatory processes leading to periodontal ligament tissue injury. The production of pro-inflammatory mediators such as cytokines and prostaglandins play an important role in orthodontic pain mediation.[1] Hence, it is recommended to use light forces during orthodontic treatment to minimizepain and discomfort caused to the patient.[2,3]Nickel–titanium (NiTi) alloy archwires are commonly used during the initial leveling and aligning phase of fixed appliance because these wires are generally used to fulfill the requirements of an initial archwire.[4]

In patients who experience a higher degree of pain, the orthodontist may recommend the use of pharmacological agents or nonpharmacological methods for pain relief, considering their pain sensitivity threshold or reported emotional condition. As a nonpharmacological method, low-level laser therapy (LLLT) has recently been used. It has analgesic properties and anti-inflammatory effects[3,5,6]through increasing the local blood flow by reduction of prostaglandin levels E2 and inhibition of cycloxygenase-2. [7,8]

As pain is a subjective response, it can be significantly influenced by several factors, including age, sex and clinical characteristics such as orthodontic force level.The degree of crowding is directly proportional to the inter-bracket distance, which can significantly influence deactivation forces of initial arch wires.[9]

The aim of developing this study was to evaluate the effect of using LLLT on pain experienced by patients undergoing initial leveling and aligning.

2. Materials And Methods

We conducted a randomized controlled trial in Chennai, Tamil Nadu, India between October to November, 2022. A total of 14subjectsthat met all the inclusion criteria were enrolled in the study after retracting an informed consent. Inclusion criteria were:(1) Patients who required fixed orthodontic treatment along with extraction of first premolars; (2) Crowding of 4-9 mm (moderate to severe) in the mandibular anterior segment that was not severe enough to prevent bracket engagement;(3) eruption of all mandibular anterior teeth; (4) no history of medical problems/medication that could influence pain perception. Exclusion criteria were:(1) Presence of a deep bite that could affect bracket placement on the mandibular anterior teeth;(2) Malocclusion correction required treatment procedures other than continuous arch wire mechanics;(3) Subjectsthat have periodontal compromised teeth and are taking pain medications for chronic pain;(4) Subjects with a positive history of dental pain or pain in the orofacial region;(5) Medical condition that precluded the use of a fixed orthodontic appliance. The assessment of initial crowding was done by using Little's Irregularity index. Protocols regarding extractionwere based on in depth diagnosis and treatment planning. After extractions, subjects were scheduled for appointments at least 2week post extraction to allow a standardized minimum healing time since one of the prerequisites before trial initiation was that subjects should be pain free[10,11,12]. On the day of fixing the appliance, before bonding the backets, the pain assessment scale and written instructions were provided to patients for baseline pain assessment. Verbal instructions and guidance during the baseline assessment were provided to familiarize the subjects with the pain assessment procedure. For all subjects, the bonding procedure and initial wire placement were carried out in the morning, though on different days, keeping the time on check. This was done to ensure that the followup time period for pain assessment were the same. Pre-adjusted Edgewise Appliances (PEA) with 0.022×0.028inch slot twin brackets (MBT prescription, Gemini Metal Brackets; 3M Unitek Corporation, Monrovia, CA, USA) were bonded directly to the mandibular dentition using lightcure composite resin (Transbond XT; 3M Unitek Corporation) 0.014inch conventional nickel–titanium (3M Unitek Corporation) wire was inserted in both the groups. Group 2 received an AIGaAs diode LLLT (810 nm, 100 mW, 2J/cm2) application for 15 seconds per point (interdental papilla at the mesial, distal, and near the root apex) immediately after arch wire placement. Only the lower arch was bonded until the completion of the study. After initial arch wire placement, subjects were discharged with the booklets containing the pain assessment scale and written instructions.Subjects were requested to report back after every 24 hours (followup period), unless they experienced an emergency, such as mucosal injury or damage to the appliance. Outcome was assessed by using the Visual Analogue Scale (VAS), which is a 100mm long horizontal line where one end corresponds to 'no pain' and the other end indicates 'worst pain possible.[3] The VAS is a valid and reliable scale for pain assessment.[13] Pain was assessed at baseline and at every 24 hour pre-

specified follow up (post wire placement) time points.

Subjects were asked to mark a line across the scale corresponding to perceived pain at each time interval. The mark was measured from the left margin of the line to the nearest millimeter to quantify the pain and recorded a VAS score in mm.

3. Results

A total of 14 subjects who met the inclusion criteria were included in the study. There was no statistically significant difference between conventional nickel – titanium and Bio-kinetix plus arch wires for mean average VAS score across all time points (F value = 0.00, df = 12.00, P = 01.00 at 0 hours; F value = 2.227, df = 9.303, P = 0.161 at 24 hours; F value = 3.208, df = 8.824, P = 0.118 at 48 hours; F value = 0.671, df = 11.693, P = 0.027 at 72 hours). However, the significant interaction between the same group and Time (P = 0.004 and 0.004 at 48 hours and 72 hours respectively for Group 2) highlights the fact that the difference for VAS score between conventional nickel–titanium when exposed to LLLT was not insignificant across all the time points.

Table 1: The Mean VAS scores at each point for both Group 1 and Group 2

Group Statistics

	groups	N	Mean	Std. Deviation	Std. Error Mean
0 hours	1.00	7	1.7143	.48795	.18443
	2.00	7	1.7143	.48795	.18443
24 hours	1.00	7	2.4286	.97590	.36886
	2.00	7	2.4286	.53452	.20203
48 hours	1.00	7	3.4286	.97590	.36886
	2.00	7	2.7143	.48795	.18443
72 hours	1.00	7	3.8571	.69007	.26082
	2.00	7	3.0000	.57735	.21822

Table 2: Statistical analysis of Group 1 and Group 2 VAS scored (Independent ttest)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
0 hours	Equal variances assumed	.000	1.000	.000	12	1.000	.00000	.26082	-.56828	.56828
	Equal variances not assumed			.000	12.000	1.000	.00000	.26082	-.56828	.56828
24 hours	Equal variances assumed	2.227	.161	.000	12	1.000	.00000	.42056	-.91632	.91632
	Equal variances not assumed			.000	9.303	1.000	.00000	.42056	-.94867	.94867
48 hours	Equal variances assumed	3.208	.099	1.732	12	.109	.71429	.41239	-.18424	1.61281
	Equal variances not assumed			1.732	8.824	.118	.71429	.41239	-.22146	1.65004
72 hours	Equal variances assumed	.671	.429	2.521	12	.027	.85714	.34007	.11620	1.59809
	Equal variances not assumed			2.521	11.638	.027	.85714	.34007	.11363	1.60065

Table 3: Pair-wise comparisons of conventional NiTi arch wire for effect on pain at each time point.

Paired Samples Test – Group 1

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	0 - 24	-.71429	.95119	.35952	-1.59399	.16542	-1.987	6	.094
Pair 2	0 - 48	-1.71429	.95119	.35952	-2.59399	-.83458	-4.768	6	.003
Pair 3	0 - 72	-2.14286	.69007	.26082	-2.78106	-1.50465	-8.216	6	.000
Pair 5	24 - 72	-1.42857	1.27242	.48093	-2.60536	-.25178	-2.970	6	.025
Pair 6	48 - 72	-.42857	1.27242	.48093	-1.60536	.74822	-.891	6	.407

Table 4: Pair-wise comparisons of conventional NiTi arch wire exposed to LLLT for effect on pain at each time point

Paired Samples Test – Group 2

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 0 - 24	-.71429	.75593	.28571	-1.41340	-.01517	-2.500	6	.047
Pair 2 0 - 48	-1.00000	.57735	.21822	-1.53396	-.46604	-4.583	6	.004
Pair 3 0 - 72	-1.28571	.75593	.28571	-1.98483	-.58660	-4.500	6	.004
Pair 4 24 - 48	-.28571	.48795	.18443	-.73699	.16556	-1.549	6	.172
Pair 5 24 - 72	-.57143	.53452	.20203	-1.06578	-.07708	-2.828	6	.030
Pair 6 48 - 72	-.28571	.48795	.18443	-.73699	.16556	-1.549	6	.172

Values illustrated in Table 3 indicated that there was a significant increase in the Visual Analog Scale scores from 24 hours to 72 hours, while the values illustrated in Table 4 indicated that there was a significant decrease in the Visual Analog Scale scores from 24 hours to 72 hours. This indicated that there was lesser pain perception by subjects under conventional NiTi arch wires when exposed to LLLT.

4. Discussion

In this study, orthodontic pain began 1 hour after initial arch wire placement and reached a peak on the morning of day 1 (24 hours). The pain further gradually increased after for subjects with conventional NiTi arch wires (Table 3), and gradually decreased after for subjects with conventional NiTi arch wires with exposure to LLLT (Table 4). There was no statistical significant difference between conventional nickel–titanium and when exposed to LLLT for overall pain during the entire study. However, compared to when exposed to LLLT, subjects who received conventional nickel–titanium wire reported greater pain at peak from 24 h after placement. The observed trend of pain perhaps reflects the underlying biological responses to orthodontic force application. Interleukin1beta (IL1beta) is the first mediator to regulate bone remodeling in response to orthodontic force, and it also plays a significant role in orthodontic pain by inducing the secretion of pain producing pro inflammatory mediators[1,3]. A recent stud[14]demonstrated that the IL1beta concentration increases after 1 h of orthodontic force application, peaks after 24 h, and subsequently declines approximately to baseline in 1week to 1month time-period. Compared to other studies, a significant reduction in pain levels when LLLT was applied was observed. [9,14,15]However, among the studies compared, there was a large variation inthe methodologies used, and there was a presence of methodological bias risk. Therefore, it was concluded that it was difficult to compare the results obtained and described in the various studies.[15,16] According to Li et al,[17]who considered the results of published studies, the use of LLLT was not considered a standard treatment for orthodontic pain. The reasons being the use of various commercial laser systems that differed in both technical specifications and in methods of application. The study designs were limited and posed a risk of bias. The LLLT that was used at a wavelength of 810 nm in the study, showed an analgesic action in all patients that participated in the study. Other studies confirmed this effect of LLLT when the wavelength was varying from 650 nm to 910 nm, with an average of830 nm.[18,19]

5. Conclusion

During the peak level of pain following the placement of an initial aligning arch wire (12 hours to 48 hours), subjects with conventional nickel–titanium wire reported significantly greater pain compared to those exposed to LLLT. However, there was no statistically significant difference between these two groups for mean average pain across all time points.

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