Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i6.6652

EFFECT OF NSAIDS IN COMBINATION WITH SERRATIOPEPTIDASE VS. DIODE LASER ON POST ENDODONTIC PAIN IN PATIENTS WITH VITAL AND NON-VITAL TEETH: A RANDOMISED CLINICAL TRIAL.

Dr. Pradnya Nagmode[1], Dr. Sayali Gosavi[2*], Dr. Sathish Abraham[3], Dr. Nitin Lokhande[4], Dr. Gayatri Gundap[5]

[1]MDS Professor and Guide at Department of Conservative Dentistry and Endodontics, S.M.B.T. Dental College and Hospital, Sangamner. Email id- pradnyanagmode2@gmail.com
[2*]MDS Post Graduate Student at Department of Conservative Dentistry and Endodontics, S.M.B.T. Dental College and Hospital, Sangamner. Email id- drsayaligosavi@gmail.com
[3]MDS Professor and Head at Department of Conservative Dentistry and Endodontics, S.M.B.T. Dental College and Hospital, Sangamner. Email id- abrahamsats@gmail.com
[4]MDS Reader and Guide at Department of Conservative Dentistry and Endodontics, S.M.B.T. Dental College and Hospital, Sangamner. Email id- drnlokhande@gmail.com
[5]MDS Post Graduate Student at Department of Conservative Dentistry and Endodontics, S.M.B.T. Dental College and Hospital, Sangamner. Email id- gayatrigundap@gmail.com

***Corresponding Author:** Dr. Sayali Gosavi
MDS Post Graduate Student at Department of Conservative Dentistry and Endodontics, S.M.B.T. Dental College and Hospital, Sangamner. Email id- drsayaligosavi@gmail.com

Abstract:

Aim: Endodontic treatment encompasses the holistic approach to pre-, intra, and post-operative care, including addressing the risk of chronic post-operative endodontic pain. This pain is prevalent, multifactorial, and potentially linked to acute periapical inflammation resulting from various factors during treatment. Serratiopeptidase affiliated with the class of drugs identified as non-steroidal anti-inflammatory drugs (NSAID) is employed to alleviate pain, especially post-traumatic inflammation, in a variety of illnesses. Therefore, the present study is formulated to assess the influence of NSAIDs in combination with serratiopeptidase compared with diode laser on post-endodontic pain in patients with vital and non-vital teeth.

Methods: A randomized clinical trial was carried out in the department of conservative dentistry and endodontics. After fulfilling the eligibility criteria, 40 patients were involved in this study. Patients who met the requirements for inclusion were then randomly split into two distinct categories, in which 20 patients were in Group A (NSAIDs with serratiopeptidase) and 20 patients were in Group B – diode laser).

Results: In total, 40 patients were involved in this study. The postoperative pain score after both treatment groups A and B showed a difference in pain scores that was statistically significant at all-time points ($p < 0.0001$). In group A, the proportion of patients experiencing no pain significantly increased over time. In group B, there was a remarkable trend in pain severity among patients over various time intervals.

Conclusion: The study findings indicated that the effectiveness of diode laser therapy was less effective than NSAIDS used in conjunction with Serratiopeptidase.

Keywords: Diode laser treatment; Endodontic pain; Non-steroidal anti-inflammatory drugs;Serratiopeptidase; Steroidal anti-inflammatory drugs.

Introduction:

Pain is a critical factor in dentistry and pain relief thereby is the ultimate goal to achieve with any dental treatment.[1] An unpleasant sensory and emotional experience connected to existing or probable damage to tissues, or a sensation represented in terms of this damage, is known as pain. [2,3]

Endodontic pain constitutes an uncomfortable encounter that frequently demands prompt intervention. Patients anticipate a decrease in pain after root canal therapy. However, despite the anticipation of pain alleviation, the occurrence of post-endodontic pain varies, spanning from 3% to 58%. [4] Post-instrumentation pain emerges due to intricate and multifaceted factors. Inadequate instrumentation can result in periapical tissue injury, while the expulsion of irrigants or debris, the spread of caustic medicaments, and occlusal imbalances are recognized causes of initiating such pain. Additionally, patient-related variables, the specific tooth affected, and the proficiency of the clinician also contribute to post-instrumentation pain. Notably, the existence of moderate to intense preoperative pain has been identified as a primary factor impacting subsequent postoperative discomfort. [5,6]

The management of post-endodontic pain has received numerous management recommendations. Analgesics, as well as steroidal and nonsteroidal anti-inflammatory drugs, are prescribed as one of them. In this regard, medications that modulate the inflammatory response must be taken into account for the avoidance and management of post-endodontic pain. [7]

NSAIDs as well as steroidal anti-inflammatory drugs operate at distinct stages of the inflammatory process, effectively reducing inflammation through different mechanisms [7]. NSAIDs function by obstructing cyclooxygenase, an enzyme crucial for the production of prostaglandins, which are potent mediators of inflammation. [8] Enzyme-based therapies like trypsin, chymotrypsin, papain, and serratiopeptidase offer selectivity, safety, and efficacy. [9]Serratiopeptidase is recognized in medicine and dentistry for anti-inflammatory and analgesic effects. [10] While NSAIDs and steroids are common, research explores alternatives like enzymes for inflammation, including combining serratiopeptidase with antibiotics for bacterial biofilm infections. [11] But, the analgesic actions of serratiopeptidase are the subject of debate and there is currently no conclusive statement on their efficacy.

Prior research has demonstrated that diode laser therapy has shown positive effects in alleviating pain [12] and expediting wound healing. [13] With the continuous advancement of laser technology and a deeper understanding of its tissue interactions (bio-interactions), the scope of clinical applications of lasers in endodontics has expanded considerably. [14,15] One prevalent application involves employing diode lasers for low-level laser therapy and the activation of root canal irrigants. [16] Moreover, it has been reported that laser therapy could potentially lead to reduced postoperative pain. [17] Therefore, the present study evaluated the impact of NSAIDs when combined with serratiopeptidase compared with Diode Laser on post-endodontic pain among individuals with both vital and non-vital teeth.

Subjects and Methods:

A randomized non-blinded clinical trial was carried out in the post-graduate department of conservative dentistry plus endodontic. Block randomization using the permuted block method was performed. Sequence generation was done using Microsoft Excel computer software (Microsoft Corporation, Redmond, WA, USA). The patients were aware of the assigned group throughout the study. The ethical approval was taken from the Institutional Ethical Committee.

The research protocol conforms to the provisions of the Declaration of Helsinki. Before the initiation, Institutional ethical clearance was obtained to conduct this clinical trial (EC/NEW/INST/2021/181). The study was reported following the Consolidated Standards of Reporting Trials (CONSORT) guidelines. **(Figure 1)**

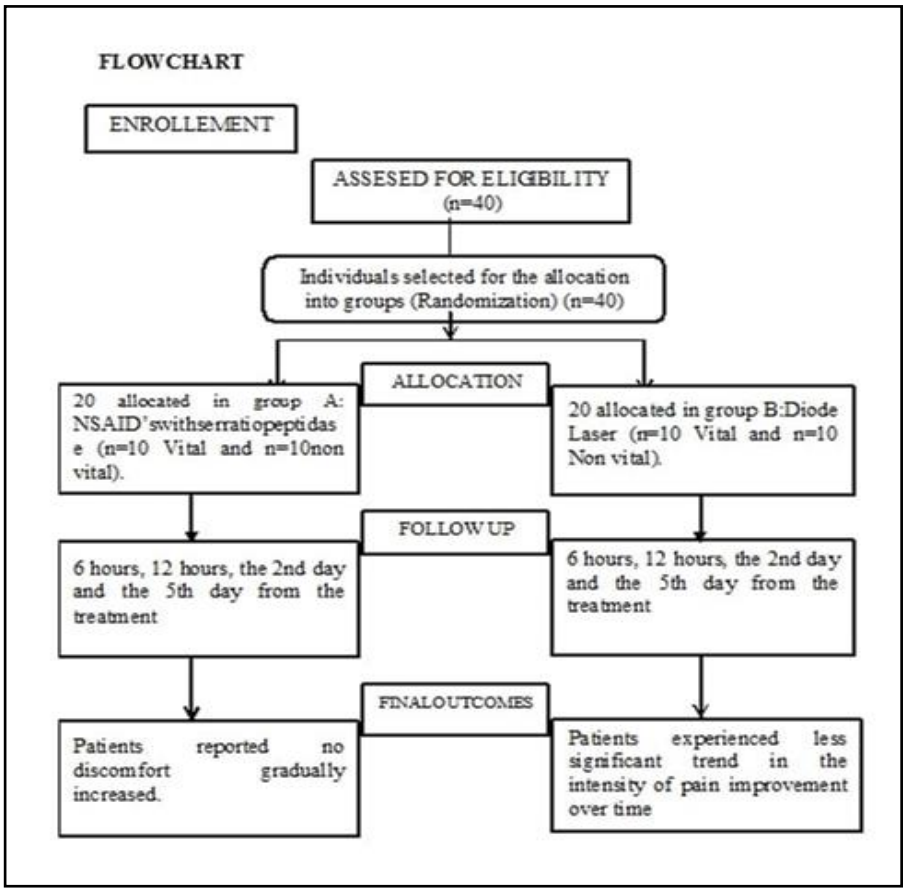


Figure 1: Flow diagram CONSORT for randomized clinical trials.

After determining that they met the inclusion criteria, forty cases who attended the postgraduate clinic in the conservative dentistry in addition endodontics department were signed up for the study. Inclusion conditions comprised patients with molar teeth showing irreversible pulpitis, symptomatic or asymptomatic apical periodontitis, and pulpal necrosis, eligible for root canal treatment, possessing mature apex and lacking root resorption. Exclusion criteria involved patients with alternative pulpal pathologies, a record of NSAID allergies, ongoing analgesic or anti-inflammatory drug use [Sanctus Drug and Pharmaceuticals Pvt limited], radiographic signs of periapical pathosis, and medically compromised patient.

Informed consent was obtained from all patients in both English and their respective regional languages, ensuring their comprehension. The medical history of patients was documented, and only individuals without a prior history of systemic illnesses were eligible for participation in this clinical trial with the age group 18-40 years.To assess pulp vitality, thermal testing (utilizing heat or cold) was performed, followed by the use of an electric pulp tester. The instruments utilized in the procedure had a taper of 0.04%, ensuring precise and effective treatment.

Subsequently, patients meeting all inclusion criteria were randomly allocated into two distinct groups, Group A – NSAIDs with serratiopeptidase(n=10 Vital and n=10 Nonvital); Group B – Diode Laser [Biolase] (n=10 Vital and n=10 Nonvital). By their assigned groups, patients in Group A received tablets, 30 minutes before the start of their endodontic therapy. Following the patient's signature on the attached consent form, profound anesthesia with1.8 ml of 2% lidocaine containing 1:80000 epinephrineswas administered, and a rubber dam was applied.Biomechanical

preparationwas performed with an endomotor (J Morita) and rotary files (Trunatomy) under rubber dam isolation. **(Figure 2A**)Standard chemo-mechanical preparation parameters were adhered to, which included using a Master Apical File ranging from size #25 to #40 k-files, adjusted based on the anatomical characteristics of the roots.

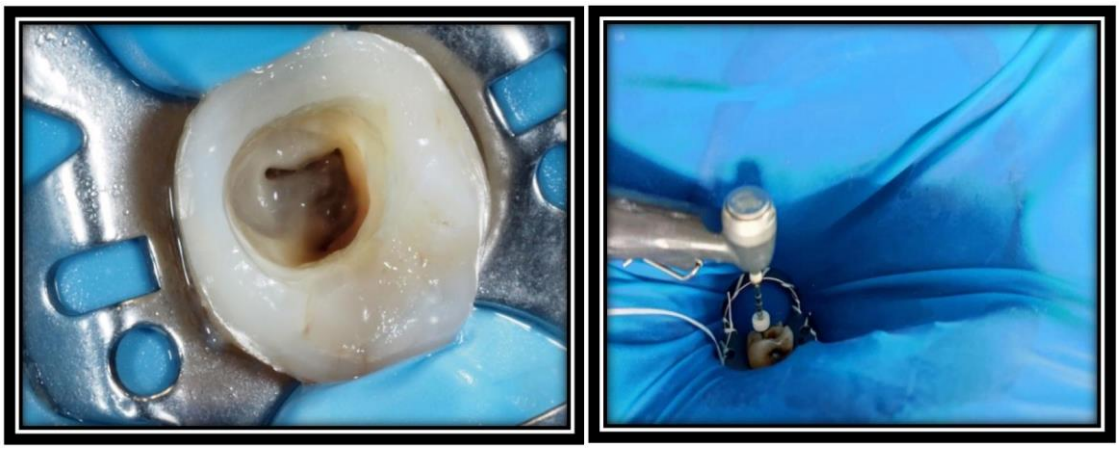


Figure 2 (A): Access cavity and biomechanical preparation.

Any necrotic tissue present inside the root canal was removed by irrigating the root canal with normal saline [Sanctus Drug and Pharmaceutical] through a -2.5 ml syringe [unolock] employing the sonic activation protocol.The obturation process was carried out using the single cone technique.

In Group B, the diode laser tip was positioned approximately 10 mm away from the tissues surrounding the apices of the treated roots in accordance with endodontic procedures, as shown in **Figure 2 B**. After the completion of obturation and sealing of the access cavity, Low-Level Laser Therapy (LLLT) was administered using a 940nm wavelength diode laser (EPIC™ BIOLASE) directed towards the tissues surrounding the roots of the treated molars.

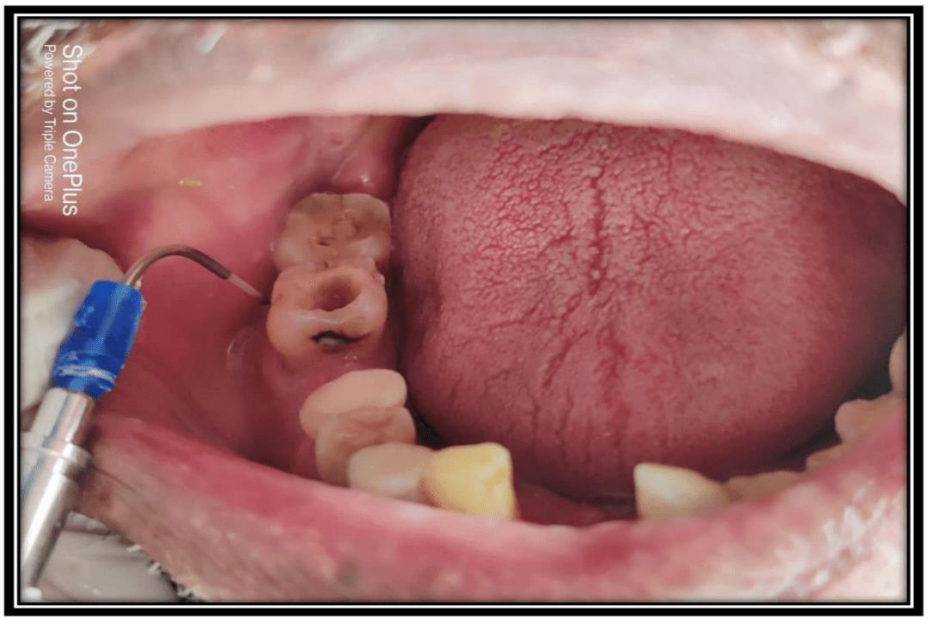


Figure 2B: Clinical photograph showing use of diode laser.

All patients were provided with instructions to complete a survey at home. Pain levels were assessed using a Visual Analog Scale (VAS) based on patient follow-up at specific intervals: 6 hours, 12 hours, the 2nd day, and the 5th day following root canal treatment. Patients who resorted

to taking analgesics post-treatment were advised to document this usage as well.**(Figure 3)** The data collected via the VAS Scale included both the occurrence and the intensity of post-endodonticpain. Pain intensity was gauged using a numeric rating scale (VAS) ranging from 0, representing "no pain," to 10, signifying "unbearable pain" as shown in Figure 3.

Figure 3: Postoperative radiograph of patient's teeth

Statistical analysis:
Data was input into Microsoft Excel (2021) and analyzed using SPSS (version 22). Categorical variables were presented as the number of cases and the corresponding percentage of patients. To assess the significance of categorical variables, with a significant level of p 0.05, the chi-square test was used.

Results:
Patients who met all inclusion criteria were randomly assigned to two groups: Group A, which received NSAIDs with serratiopeptidase, and group B, which received Diode Laser [Biolase]. Each group was further divided into four subgroups: A1, consisting of patients receiving NSAIDs with Vital; B1, comprising patients receiving Diode laser with vital; A2, including patients receiving NSAIDs with non-vital; and B2, comprising patients receiving Diode laser with non-vital. Each subgroup consisted of 10 patients.
The sample size was estimated by using G power 3.1.9.2 software with effect size of 0.25, with power of study 80% and confidence limit of 95% and significance level set at 5%. The sample size was determined to be 20 in each group using the formula:
n= 2 x S2 (Z1+Z2)2 / (M1-M2)2
Total sample size contains 40 patients considering two study groups.

In the NSAID group, it is evident that as time progressed from 6 hours to 72 hours post-treatment, the percentage of participants reporting no pain steadily increased, reaching 95% at the 72-hour mark. Conversely, the percentage of participants experiencing mild, moderate, or severe pain decreased over time. A statistical analysis using the Chi-square (X2) test showed a highly significant difference (p value < 0.001) among the groups in terms of pain reduction, indicating that NSAID treatment effectively alleviated pain in this study.

Table 1: Post-operative pain score after treatment in Oral diclofenac sodium with serratiopeptidase group and diode laser.

NSAID Group	Pain	6 Hrs	12 Hrs	18 Hrs	24 Hrs	48 Hrs	72 Hrs	X2 test	p-value

	No pain	3 (15%)	10 (50%)	14 (70%)	17 (85%)	18 (90%)	19 (95%)	44.32	**<0.001**
	Mild	11 (55%)	7 (35%)	4 (20%)	3 (15%)	2 (10%)	1 (5%)		
	Moderate	6 (30%)	3 (15%)	2 (10%)	0 (0%)	0 (0%)	0 (0%)		
	Severe	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)		
Diode laser group	No pain	2 (10%)	7 (35%)	12 (60%)	15 (75%)	17 (85%)	18 (90%)	42.64	**<0.001**
	Mild	11 (55%)	9 (45%)	5 (25%)	4 (20%)	3 (15%)	2 (10%)		
	Moderate	7 (35%)	4 (20%)	3 (15%)	1 (5%)	0 (0%)	0 (0%)		
	Severe	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)		

Similarly, in the diode laser group, there was a noticeable trend of increasing pain relief over time, with the percentage of participants reporting no pain reaching 90% at 72 hours post-treatment. Conversely, the percentage of participants with mild, moderate, or severe pain diminished over time. (**Table 1)** The statistical analysis, the Chi-square test, demonstrated an extremely significant difference (p-value < 0.001).

At 6 hours, group A1 had 2 participants without pain, 6 patients with mild pain, and 2 patients with moderate pain. In contrast, group B1 at the same 6-hour time point had 1 participant without pain, 6 participants with mild pain, and 3 participants with moderate pain. The Chi-square test yielded a p-value of 0.76, demonstrating that there are no statistically significant differences in pain scores between the two groups at the 6-hour mark following the intervention.

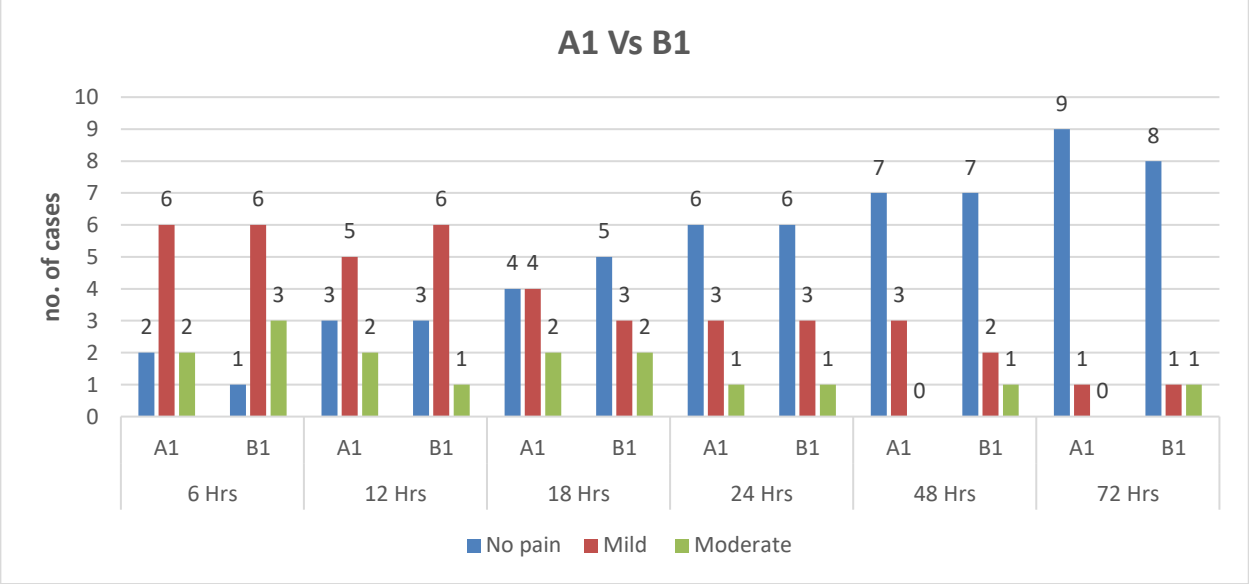
Table 2: Comparing the post-treatment visual analog pain scores between patients in the NSAID vital group and the diode laser vital group.

Intergroup Comparison		**Visual Analog Pain Score**			**Chi-square**	**P value**
		No pain	**Mild**	**Moderate**		
6 Hrs	A1	2	6	2	0.53	0.76
	B1	1	6	3		
12 Hrs	A1	3	5	2	0.42	0.80
	B1	3	6	1		
18 Hrs	A1	4	4	2	0.25	0.88
	B1	5	3	2		
24 Hrs	A1	6	3	1	0	1
	B1	6	3	1		
48 Hrs	A1	7	3	0	0.14	0.70
	B1	7	2	1		
72 Hrs	A1	9	1	0	0.006	0.93

	B1	8	1	1		

A1= NSAID with vital, B1= Diode laser with vital

Graph-1: Comparing the post-treatment visual analog pain scores between patients in the NSAID vital group and the diode laser vital group.



When examining the data at 72 hours, group A1 had 9 participants without pain, 1 participant with mild pain as well as no one with moderate pain. Conversely, in group B1 at the same 72-hour time point, 8 participants reported no pain, 1 participant had mild pain and 1 participant experienced moderate pain. The Chi-square test at 72 hours produced a notable p-value of 0.93 indicating no statistically significant disparity between the two groups in terms of pain scores at this specific time point.**(Table 2 graph 1)**

In group NSAID with non-vital teeth, at the 6-hour mark, 1 participant stated "No pain," 4 conveyed "Mild" pain, and 5 informed "Moderate" pain. In contrast, in group B2 at the same time point, 2 participants stated "No pain," 5 demonstrated "Mild" pain and 3 stated "Moderate" pain. The Chi-square test had a p-value of 0.62.

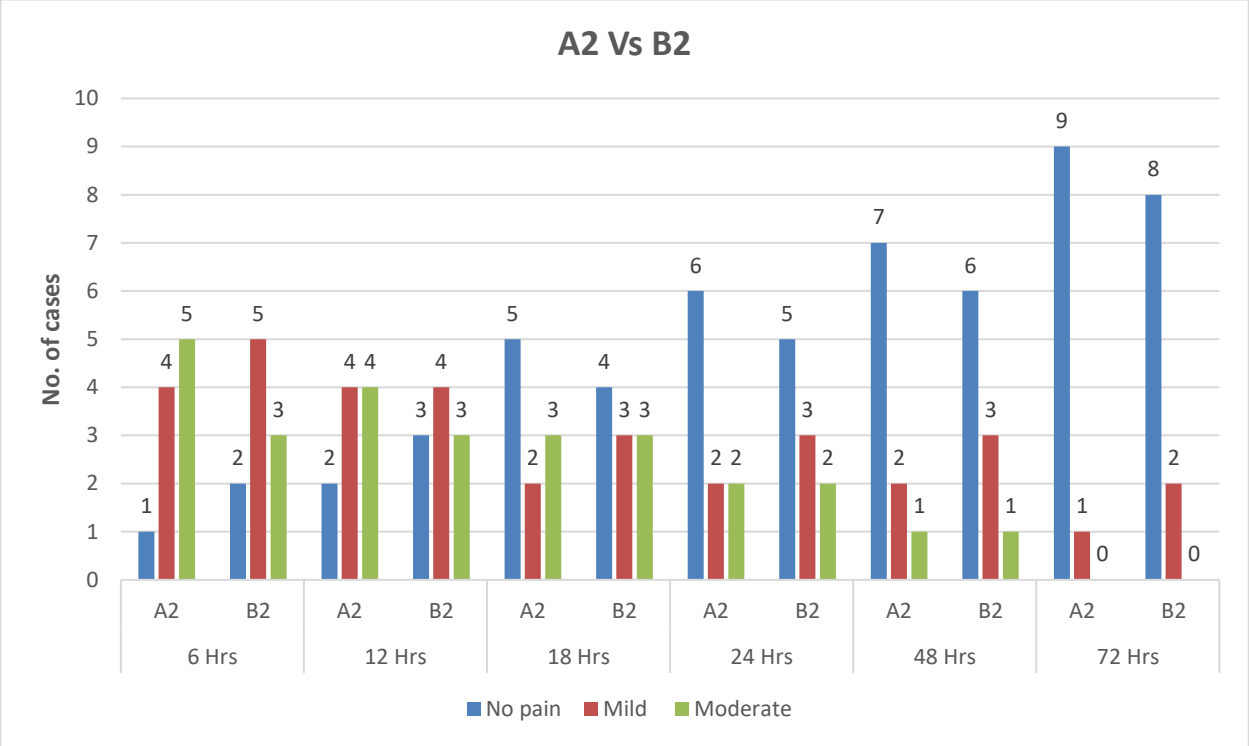
Table 3: Comparing the post-treatment visual analog pain scores between patients in the NSAID Non-vital group and the diode laser Non-vital group.

Intergroup Comparison		**Visual Analog Pain Score**			**Chi-square**	**P value**
		No pain	**Mild**	**Moderate**		
6 Hrs	A2	1	4	5	0.94	0.62
	B2	2	5	3		
12 Hrs	A2	2	4	4	0.34	0.84
	B2	3	4	3		
18 Hrs	A2	5	2	3	0.31	0.85
	B2	4	3	3		
24 Hrs	A2	6	2	2	0.29	0.86
	B2	5	3	2		
48 Hrs	A2	7	2	1	0.27	0.87
	B2	6	3	1		
72 Hrs	A2	9	1	0	0.39	0.53

	B2	8	2	0		

A2= NSAID with non-vital, B2= Diode laser with non-vital

Graph-2: Comparing the post-treatment visual analog pain scores between patients in the NSAID Non-vital group and the diode laser Non- vital group.



At 72 hours, nine subjects in the NSAID with a non-vital group reported "No pain," one participant reported "Mild" pain, and none reported "Moderate" pain. In comparison, 8 patients in the group that received a diode laser and non-vital at the same 72-hour mark reported "No pain," 2 participants experienced "Mild" pain, and none reported "Moderate" pain. With a p-value of 0.53 for the Chi-square test, it can be seen that there is no statistically significant difference between the two groups pain scores 72 hours after the intervention. **(Table 3 and graph 2)**

In other words, throughout time, the proportion of patients reporting no pain or just mild discomfort climbed intensely, whilst the proportion reporting moderate pain remained mostly stable. This suggests that the treatment was effective in reducing pain in both vital and non-vital teeth of patients.

Discussion:

Endodontic treatment also includes the management of postoperative pain and symptoms. [18]Serratiopeptidase is a well-known enzyme with a long history of use in medicine as a strong anti-inflammatory drug.[9] Hence, the present study focuses on the effect of NSAIDs in combination with serratiopeptidase anti-inflammatory drugs as well as diode laser therapy in post-endodontic pain with vital and non-vital teeth.

In the present study, NSAIDs in combination with serratiopeptidase were utilized for the treatment of post-endodontic pain with vital and non-vital teeth. Similarly, Santini MF, Rosa RA, Ferreira MBC, *et al.*,[19] that NSAIDs are the most useful drugs for the control of postoperative pain. Likewise, the study done by T. H. Al-Khateeb et al., [20] demonstrated that the proteolytic enzyme serratiopeptidase was administered postoperatively, and this dramatically decreased the occurrence of post-surgical edema and endodontic discomfort. There are proven studies suggesting serratiopeptidase in combination with antibiotics has helped treat post-operative endodontic pain;

however, there are scarce studies in the literature that demonstrate how efficiently NSAIDs and serratiopeptidase work to relieve post-endodontic pain.

Serratiopeptidase also promotes cartilage matrix synthesis and tissue repair and also helps in decreasing swelling. It also has potent anti-inflammatory properties. It inhibits the formation of bacterial biofilm, thereby increasing the effectiveness of antibiotics. [21]

The results of this current study indicate that utilizing a diode laser for irradiation resulted in significantly reduced pain levels at 6, 12, 18, 24, 48, and 72 hours after the procedure, as shown in Table 3. These findings align with the research conducted by Berk *et al.*[22] and Pawar*et al.* [23], both of whom observed significantly diminished pain levels at 8, 24, and 48 hours, as well as 7 days following the procedure, when comparing diode laser treatment to conventional methods. Laser irradiation considerably reduced the number of microbes present in infected root canals, according to research by Gutknecht *et al.*[24] and Garcez *et al.*[25]The powerful antibacterial impact of diode lasers, according to Morsy *et al.*[26], also decreased post-endodontic pain.

This study reported that 85% of cases receiving NSAIDs plus serratiopeptidase experienced no pain after 24 hours. When treated with NSAIDs, 90% of the teeth treated in a single visit had little to no spontaneous discomfort at the end of the first day, according to the study by Fox *et al*. [27]

Also in this study, 50% of patients with vital teeth reported no discomfort, while 53% of participants with non-vital teeth reported no pain in NSAIDs with serratiopeptidase. According to a report by Mulhern *et al.*[28] on the occurrence of pain for non-vital teeth, 26.7% of teeth still suffer after a day. In the present study, the proportion of cases with no pain or mild pain improved significantly over time, while the proportion of cases with moderate pain remained relatively stable in the diode laser group; hence, it suggests that the diode laser treatment was effective in reducing pain in both vital and non-vital teeth of patients. Similar findings are shown in the study completed by ZeinabMostafa Omar,[29]They showed that both the ultrasonic-activated irrigation and the 970nm diode laser were equally successful in reducing the occurrence and severity of postoperative discomfort following endodontic therapy.

Conclusion:

Based on the aforementioned findings, we concluded that diode laser therapy and NSAIDS combined with serratiopeptidase are both beneficial for relieving post-endodontic pain. However, based on this research, after receiving post-operative care that included NSAIDs and serratiopeptidase (group A), the proportion of patients reporting no discomfort gradually increased. However, patients receiving post-operative diode laser treatment (Group B) experienced a less significant trend in the intensity of pain improvement over time.

References:

1. Ince B, Ercan E, Dalli M, Dulgergil CT, Zorba YO, Colak H. Incidence of postoperative pain after single-and multi-visit endodontic treatment in teeth with vital and non-vital pulp. Eur J Dent 2009;3:273-279.
2. Rosenberg PA. Endodontic pain: Diagnosis, causes, prevention and treatment. 1st ed. Heidelberg, Germany: Springer Publishing 2014;183 p. (Endodontic Topics).
3. Siqueira JF Jr. Reaction of periradicular tissues to root canal treatment: benefits and drawbacks. Endod Topics. 2005;10:123-147.
4. Sathorn C, Parashos P, Messer H. The prevalence of postoperative pain and flare-up in single- and multiple-visit endodontic treatment: a systematic review. IntEndod J 2008; 41:91–9.
5. Glennon JP, Ng YL, Setchell DJ, Gulabivala K. Prevalence of and factors affecting postpreparation pain in patients undergoing two-visit root canal treatment. IntEndod J 2004;37:29–37.
6. Sadaf D, Ahmad MZ. Factors associated with postoperative pain in endodontic therapy. Int J Biomed Sci 2014;10:243–7.

7. Jorge-Araújo AC, Bortoluzzi MC, Baratto-Filho F, Santos FA, Pochapski MT. Effect of premedication with anti-inflammatory drugs on post-endodontic pain: a randomized clinical trial. Brazilian dental journal 2018;29:254-60.
8. Shirvani A, Shamszadeh S, Eghbal MJ, Marvasti LA, Asgary S. Effect of preoperative oral analgesics on pulpal anesthesia in patients with irreversible pulpitis a systematic review and meta-analysis. Clinical oral investigations 2017;21:43-52.
9. Tiwari M. The role of serratiopeptidase in the resolution of inflammation. Asian J Pharm Sci 2017;12:209-215.
10. Ahmed A. An overview of inflammation: mechanism and consequences. Front Biol 2011;6:274–281.
11. Asnaashari M, Mohebi S, Paymanpour P. Pain reduction using low level laser irradiation in single visit endodontic treatment. J Lasers Med Sci 2011;2:139–143.
12. Dhobley A, Thombre AS, Sharma A, Deoghare A, Billaiya P, Dhopte A. Healing with low level laser therapy: a review. Annals of the Romanian Society for Cell Biology 2021;12:3918–3921.
13. Nabi S, Amin K, Masoodi A, Farooq R, Purra AR, Ahangar FA. Effect of preoperative ibuprofen in controlling postendodontic pain with and without low-level laser therapy in single visit endodontics: a randomized clinical study. Indian J Dent Res 2018;29:46.
14. Carneiro AM, Barros AP, de Oliveira RP, de Paula BL, Silva AM, de Melo AC, et al. The effect of photobiomodulation using low-level laser therapy on tooth sensitivity after dental bleaching: a systematic review. Lasers Med Sci 2022;21:1–4.
15. Kohli A, Anehosur V, Radder K. Comparative study of the efficacy of low-level laser therapy and dexamethasone in reducing the severity of post-operative inflammatory response following surgical extraction of mandibular third molars. Journal of Maxillofacial and Oral Surgery2023;22:165-171.
16. Ismail HH, Obeid M, Hassanien E. Efficiency of diode laser in control of post-endodontic pain: a randomized controlled trial. Clin Oral Investig 2023;27:2797-2804.
17. Koba K, Kimura Y, Matsumoto K, Watanabe H, Shinoki T, Kojy R, et al. Post-operative symptoms and healing after endodontic treatment of infected teeth using pulsed Nd: YAG laser. Endod Dent Traumatol1999;15:68–72.
18. Nixdorf DR, Moana-Filho EJ, Law AS, McGuire LA, Hodges JS, John MT.Frequency of persistent tooth pain after root canal therapy: a systematic review and meta-analysis. J Endod2010;36:224–30.
19. Santini MF, Rosa RA, Ferreira MB, Barletta F, Longo do Nascimento A, Weissheimer T, et al. Medications Used for Prevention and Treatment of Postoperative Endodontic Pain: A Systematic Review. EurEndod J 2021;6:15-24.
20. Al-Khateeb TH, Nusair Y. Effect of the proteolytic enzyme serrapeptase on swelling, pain, and trismus after surgical extraction of mandibular third molars. Int. J. Oral Maxillofac. Surg. 2008;37:264–268.
21. Jadhav SB, Shah N, Rathi A, Rathi V, Rathi A. Serratiopeptidase: Insights into the therapeutic applications. Biotechnol Rep (Amst) 2020;28:e00544.
22. Berk G, Ulucam U, Berk N: Clinical healing process and symptoms of two cases of chronic periapical lesions treated with Er, Cr: YSGG laser. Journal of Oral Laser Application 2004;4:211–5.
23. PawarSS, Pujar MA, Makandar SD, KhaiserMI.Postendodontic treatment pain management with low-level laser therapy. Journal of Dental Lasers 2014;8:60–3.
24. Gutknecht N, Franzen R, Schippers M, Lampert F. Bactericidal effect of a 980-nm diode laser in the root canal wall dentin of bovine teeth. J Clin Laser Med Surg. 2004;22:9–13.
25. Silva Garcez A, Núñez SC, Lage-Marques JL, Jorge AO, Ribeiro MS. Efficiency of NaOCl and laser-assisted photosensitization on the reduction of Enterococcus faecalis in vitro. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 2006;102:e93–8.

26. Morsy DA, Negm M, Diab A, Ahmed G. Postoperative pain and antibacterial effect of 980 nm diode laser versus conventional endodontic treatment in necrotic teeth with chronic periapical lesions: a randomized control trial. F1000Research. 2018;7:1795.
27. Fox J, Atkinson JS, Dinin AP, Greenfield E, Hechtman E, Reeman CA, et al. Incidence of pain following one-visit endodontic treatment. Oral Surg Oral Med Oral Pathol1970;30:123−30.
28. Mulhern JM, Patterson SS, Newton CW, Ringel AM. Incidence of postoperative pain after one-appointment endodontic treatment of asymptomatic pulpal necrosis in single-rooted teeth. J. Endod. 1982;8:370–5.
29. Omar ZM, El Shinawy H, Eid GH. Effect of diode laser-activated irrigation on postoperative pain in single visit endodontic treatment: a randomized controlled trial. Acta Scientific Dental Sciences. 2020;4(2):1-6.