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# Evaluation of the effect of Low-Level LASER Therapy on Anxiety Level in 6 to 12-year-old Children undergoing Dental Treatment under Local Anesthesia: A Randomized Controlled Trial

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## Abstract

**Background:** Dental anxiety is a common challenge in pediatric dentistry and can negatively affect cooperation and treatment outcomes, particularly during procedures involving local anesthesia. Safe, non-invasive interventions that reduce anxiety are therefore of clinical interest. The present study aimed to evaluate the effect of low-level laser therapy (LLLT) delivered as laser acupuncture on anxiety levels in children undergoing dental treatment under local anesthesia.

**Materials and Methods:** This randomized controlled in vivo study included 80 children aged 6–12 years who required dental treatment under local anesthesia. Participants were randomly allocated to an LLLT group (n = 40) or a placebo control group (n = 40). Laser acupuncture was applied at auricular and hand Shenmen points 15 minutes before anesthesia in the intervention group, while the control group received a sham procedure. Anxiety was assessed using physiological parameters (pulse rate and oxygen saturation) and a psychological measure (Facial Image Scale, FIS). Statistical analysis was performed with a significance level set at $p < 0.05$.

**Results:** Baseline pulse rate and oxygen saturation were comparable between groups ($p > 0.05$). Post-intervention, the LLLT group showed a significantly greater reduction in pulse rate (−4.13 ± 5.66 bpm) compared with the control group (−0.23 ± 3.24 bpm; $p = 0.0003$). Oxygen saturation increased in the LLLT group (+0.40 ± 1.13%) but decreased slightly in controls

(−0.20 ± 1.36%; p = 0.035). Mean FIS scores were significantly lower in the LLLT group (1.85 ± 0.95) than in the control group (2.25 ± 1.01; p = 0.03).
**Conclusion:** Pre-procedural low-level laser acupuncture significantly reduced both physiological and subjective indicators of dental anxiety in children undergoing treatment under local anesthesia, supporting its use as a practical adjunct in pediatric dental care.
**Keywords:** Pediatric Dentistry; Dental Anxiety; Photobiomodulation; Dental Fear



## INTRODUCTION

Dental anxiety is a prevalent and clinically relevant concern in pediatric dentistry, influencing a child's willingness to pursue treatment, ability to cooperate, and overall care experience (Besiroglu et al., 2024). Anticipation of invasive or new procedures, particularly those requiring local anesthetic, frequently exacerbates anxiety-related behaviors (Bologa et al., 2025). In standard practice, heightened anxiety may result in disruptive movements, diminished tolerance for treatment, and an amplified impression of pain (Al Homoud et al., 2023), hence prolonging chairside duration and complicating the delivery of safe, effective therapy (Appukuttan, 2016). Chronic stressful experiences may strengthen avoidance behavior and delay the presentation of more advanced disease, complicating critical therapies (Winkler et al., 2023). As a result, there is sustained interest in non-invasive supplemental approaches that are appropriate for children and feasible in outpatient settings.

Researchers have investigated various laser types, including hard-tissue lasers for cavity preparation and low-level laser/photobiomodulation applications, to determine their potential in reducing pain and enhancing patient acceptance during treatments (Sachelarie et al., 2024). A clinical study evaluating Er:YAG laser cavity preparation in children demonstrated that laser technology was associated with diminished pain reports and improved behavioral tolerance relative to conventional mechanical preparation, notwithstanding a longer preparation time, suggesting its potential effectiveness in anxious pediatric patients (Liu et al., 2006). Recent randomized split-mouth trials demonstrate that Er:YAG-assisted caries removal is associated with reduced anxiety and pain levels, along with a lower requirement for local anesthetic, compared to conventional rotary instruments (Abdrabuh et al., 2023). Alongside operative dentistry, acupoint-targeted low-level laser therapy has proven effective in reducing procedure-related discomfort; specifically, stimulation of the PC6 acupoint has been observed

to suppress the gag reflex and improve physiological parameters while decreasing anxiety during impression-taking in pediatric patients (Goel et al., 2017).

However, the clinical effectiveness of low-level laser/photobiomodulation approaches appears to depend on particular settings and characteristics, with results in pediatric dentistry applications demonstrating significant diversity (Shekarchi et al., 2025). An earlier study demonstrated that a laser acupuncture pen at the LI4 point reduced pain perception during local anesthetic administration and a decrease in dental anxiety, indicating potential effectiveness for injection-related distress (Pooja et al., 2023). Another previous study using 810-nm photobiomodulation as an adjunct to topical anesthetic demonstrated no significant improvement in pain alleviation during injection relative to placebo irradiation (Seraj et al., 2023). Similarly, low-level laser therapy has not consistently demonstrated effectiveness for postoperative pain management after pediatric extractions in randomized investigations (Elbay et al., 2016).

Current literature demonstrates biological plausibility and favorable indicators for laser-based anxiety regulation, while also emphasizing the diversity of outcomes across various indications, methods, and endpoints. Therefore, rigorously structured randomized controlled clinical trials focusing on children's dental anxiety in the context of therapy performed under local anesthesia are necessary. This randomized controlled trial aimed to evaluate the effects of Low-Level LASER Therapy on anxiety levels in children aged 6–12 years undergoing dental procedures with local anesthetic, with the goal of informing therapeutically pertinent, child-centered anxiety management approaches.

Dental anxiety is widely recognized as a significant behavioral challenge in pediatric dentistry because it can negatively influence children's cooperation, treatment acceptance, and overall clinical outcomes. Children frequently experience heightened anxiety when undergoing invasive dental procedures, particularly those involving local anesthesia injections. This anxiety may lead to disruptive behavior, increased perception of pain, and longer treatment time, which complicates dental care delivery. Recent advancements in pediatric dentistry have explored non-pharmacological and minimally invasive approaches to reduce anxiety during dental procedures. Laser technology has emerged as a promising modality in this area. Hard-tissue lasers such as Er:YAG have been reported to reduce discomfort during cavity preparation and improve behavioral acceptance compared with conventional rotary instruments. Similarly, low-level laser therapy (LLLT) or photobiomodulation has been investigated for its potential

to reduce pain, inflammation, and stress responses in dental treatments. Furthermore, several studies have examined laser acupuncture, where low-level laser stimulation is applied to specific acupoints instead of traditional needle-based acupuncture. Previous research indicates that stimulation of acupoints such as PC6 or LI4 can reduce gag reflex, procedural pain, and anxiety during dental treatments in children. However, the effectiveness of LLLT in pediatric dentistry remains inconsistent due to variations in laser parameters, stimulation sites, treatment timing, and study outcomes. Some studies demonstrate significant benefits, while others report minimal or no effect on anxiety or pain reduction. Consequently, although laser-based interventions are increasingly explored as anxiety management tools in dentistry, the evidence regarding their effectiveness—particularly laser acupuncture for anxiety reduction during local anesthesia procedures in children—remains limited and heterogeneous.

## MATERIALS AND METHODS

### Study design and participants

This randomized controlled, in vivo clinical study was conducted in the Department of Pediatric and Preventive Dentistry. A total of 80 children (male and female) aged 6 to 12 years who required administration of local anesthesia for dental treatment were enrolled. The study was performed in accordance with the Declaration of Helsinki and followed Occupational Safety and Health Administration (OSHA) recommendations for clinical safety. Written informed consent was obtained from the parent/legal guardian of every participant prior to enrolment, and verbal assent was obtained from the child. To ensure confidentiality, all participants were assigned numerical identifiers, and no personal identifiers were used during data handling.

### Ethical approval

Ethical approval was obtained from the Institutional Ethical Review Board (Ref. letter no. 1156/2024). All procedures were explained to parents/guardians and participating children in an age-appropriate manner prior to participation, and participation was voluntary with the option to withdraw at any stage without affecting treatment.

### Study setting

All procedures were carried out in a controlled clinical environment to standardize conditions and minimize external stimuli that could influence anxiety. The operatory

maintained a quiet, child-friendly atmosphere with adequate illumination and minimal distractions, and all participants underwent the intervention and clinical procedures under similar chairside conditions.

**Sample size calculation**

Sample size estimation was performed using G*Power version 3.0.1 (Franz Faul, Universität Kiel, Germany). With an assumed effect size of 0.7, a two-tailed significance level of 0.05, and 80% power, the required sample size was calculated as 68 participants. This was increased to 80 to account for potential dropouts and to strengthen study robustness. Participants were equally allocated into two groups (n = 40 per group).

**Sampling technique, randomization, and allocation**

Eligible participants were recruited consecutively from children reporting to the department and screened against the inclusion and exclusion criteria. Allocation was performed using a simple randomization (lottery) method. Each eligible child was assigned a unique number, and random selection was used to allocate participants to either the Low-Level LASER Therapy (LLLT) group or the placebo group. Coding and participant identifiers were maintained by an investigator not involved in outcome recording to support confidentiality.

**Eligibility criteria**

Inclusion criteria comprised children aged 6–12 years requiring dental treatment involving local anesthesia; children with Frankl Behavior Rating Scale scores of 2 (negative) or 3 (positive); children with no previous exposure to acupuncture or LASER therapy; children with no history of prior anxiety management therapies; and children whose behavior permitted completion of the planned clinical procedure. Children with systemic diseases or neurological disorders; children with known hypersensitivity to light-based therapies; and children whose parents/guardians declined consent were excluded from the study.

**Materials and equipment**

The materials used included a LASER acupuncture device (635 nm wavelength, red spectrum; 2–3 mW power output), protective LASER eyewear for the child and operator, a pulse oximeter for recording pulse rate and oxygen saturation, a 2 mL dental syringe with a 26-

gauge long needle for administration of local anesthesia, cotton rolls and gauze, topical benzocaine gel (20%), local anesthetic solution (2% lignocaine with 1:100,000 adrenaline), and a Facial Image Scale (FIS) proforma for anxiety assessment. Standard dental instruments required for examination and extraction (including a mouth mirror, dental explorer, Moon's probe, and deciduous molar extraction forceps) were used.

**Interventions**

Participants were allocated into two groups. In the LLLT group, laser acupuncture was performed at two predefined acupoints: Shenmen 1 (auricular "Heavenly Gate" point) and Shenmen 2 (hand "Spirit Gate" point). LASER stimulation was delivered 15 minutes prior to local anesthesia administration using a 635 nm red-spectrum device with 2–3 mW output (Figure 1). Exposure duration followed the study protocol: 5–10 seconds for the auricular point and 20–40 seconds for the hand point. The LASER tip was positioned over the target point, and both the child and operator wore protective eyewear throughout irradiation. In the placebo group, identical procedural steps and timing were followed, including placement of the device at the same acupoints and use of protective eyewear; however, the LASER device remained switched off to provide placebo exposure while maintaining participant and parent blinding to group assignment.

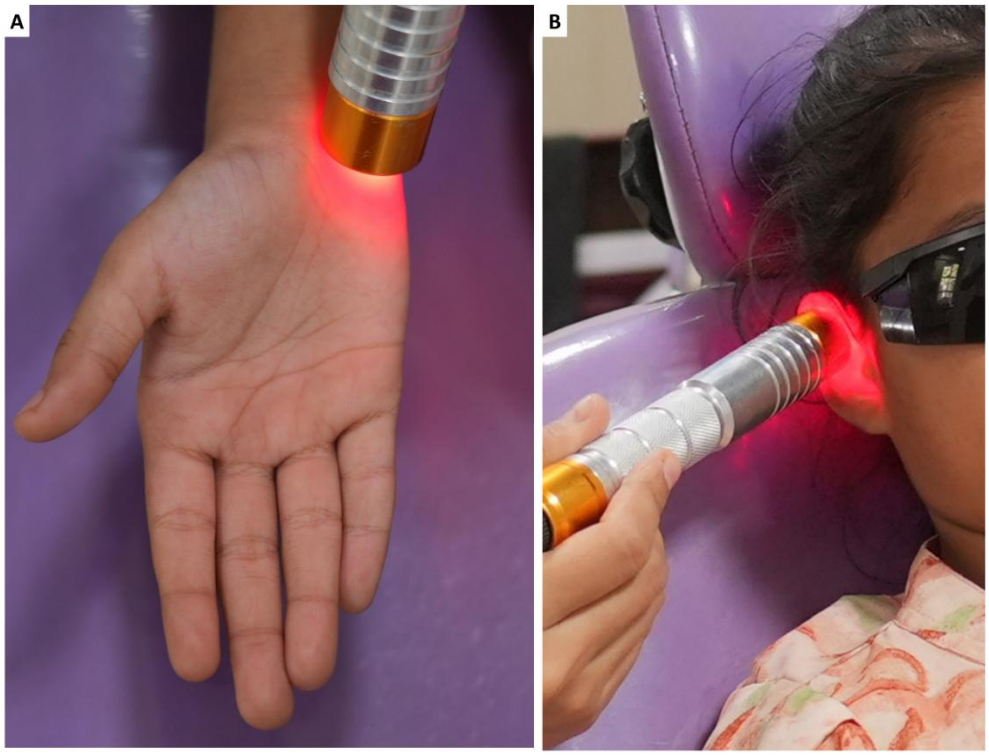


**Figure 1: Laser acupuncture performed at A) Shenmen 1 (auricular "Heavenly Gate" point) and B) Shenmen 2 (hand "Spirit Gate" point).**

**Standardized clinical procedure**

After completion of the assigned intervention (LLLT or placebo) and immediately prior to injection, the inferior alveolar nerve block (IANB) site was prepared with topical 20% benzocaine. IANB was administered using a 26-gauge long needle delivering 1.5 mL of 2% lignocaine with 1:100,000 adrenaline. A supplementary long buccal nerve block was then administered using 0.5 mL of the same anesthetic solution to achieve comprehensive anesthesia for the mandibular primary molar region. A fixed latency period of 5 minutes was observed for anesthetic onset. Adequacy of anesthesia was verified using subjective indicators (reported lip/tongue numbness) and objective testing (gingival probing with a dental explorer). For children requiring extraction, the procedure was standardized: periodontal attachment was severed using a Moon's probe, followed by extraction of the mandibular primary molar using deciduous molar forceps. The socket was inspected, and a gauze pressure pack was placed at the conclusion of the procedure to ensure consistent postoperative compression across participants.

### Outcome measures

Anxiety response was assessed using both physiological and psychological measures at defined time points. Physiological parameters included pulse rate (PR) and oxygen saturation ($SpO_2$), recorded using a pulse oximeter placed on the child's index finger. Measurements were obtained at baseline and after local anesthesia administration to assess the autonomic stress response. Psychological anxiety was assessed using the Facial Image Scale (FIS), a validated, child-friendly tool comprising five facial expressions ranging from very happy (score 1) to very sad (score 5). Children were asked to select the face that best represented their feelings before and after the administration of local anesthesia.

### Data handling and statistical analysis

All observations were entered into a structured proforma and analyzed using SPSS software version 21.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were summarized using mean and standard deviation. Data normality was assessed using the Shapiro–Wilk test. Intergroup comparisons were performed using the chi-square test for categorical/ordinal outcomes (FIS distribution) and an unpaired t-test for quantitative variables (pulse rate and $SpO_2$). A 95% confidence interval was used, the level of significance was set at $\alpha = 0.05$, and $p < 0.05$ was considered statistically significant.

## RESULTS

### Participant characteristics and baseline comparability

Eighty children (6–12 years) were randomized equally into the LLLT and placebo control groups (n = 40 each). Baseline autonomic measures, used as physiological proxies for anxiety, were similar between groups, with closely comparable pre-intervention pulse rates and oxygen saturations (Table 1). The age distribution was broadly similar across arms, while the control group had a higher proportion of female participants.

**Table 1. Baseline characteristics and pre-intervention physiological measures (n = 80).**

| Variable | LLLT (n = 40) | Control (n = 40) |
|---|---|---|
| **Age group, n (%)** | | |

| | | |
|---|---|---|
| 6–9 years | 25 (62.5) | 18 (45.0) |
| 10–12 years | 15 (37.5) | 22 (55.0) |
| **Gender, n (%)** | | |
| Male | 20 (50.0) | 10 (25.0) |
| Female | 20 (50.0) | 30 (75.0) |
| **Pulse rate (bpm), mean ± SD** | 96.28 ± 7.76 | 96.70 ± 7.43 |
| **$SpO_2$ (%), mean ± SD** | 97.95 ± 1.15 | 98.13 ± 1.11 |

**Effect of LLLT on physiological anxiety markers (Pulse Rate and $SpO_2$)**

As shown in Table 2, baseline pulse rate and baseline $SpO_2$ were comparable between groups. Following the intervention, the LLLT group demonstrated a significantly lower post-intervention pulse rate compared with controls, and the mean reduction in pulse rate (ΔPR) was significantly greater in the LLLT group than in the placebo group ($p = 0.0003$).

**Table 2. Pulse rate (PR) and oxygen saturation ($SpO_2$) before and after intervention, with between-group comparisons (n = 40/group).**

| Outcome | Timepoint | LLLT (Mean ± SD) | Control (Mean ± SD) | Between-group p-value |
|---|---|---|---|---|
| Pulse rate (bpm) | Pre (PR−) | 96.28 ± 7.76 | 96.70 ± 7.43 | 0.803 |
| | Post (PR+) | 92.15 ± 7.18 | 96.48 ± 6.82 | 0.0071 |
| | Change (ΔPR = PR+ − PR−) | −4.13 ± 5.66 | −0.23 ± 3.24 | 0.0003 |
| $SpO_2$ (%) | Pre ($SpO_2$−) | 97.95 ± 1.15 | 98.13 ± 1.11 | 0.492 |
| | Post ($SpO_2$+) | 98.35 ± 1.08 | 97.93 ± 1.05 | 0.039 |
| | Change (Δ$SpO_2$ = $SpO_2$+ − $SpO_2$−) | +0.40 ± 1.13 | −0.20 ± 1.36 | 0.035 |

*Δ indicates the within-participant change from pre- to post-intervention; negative ΔPR denotes a reduction in pulse rate.*

The between-group difference in mean ΔPR was −3.90 bpm (LLLT vs control), indicating a clinically relevant attenuation of autonomic arousal in the LLLT arm. For oxygen saturation, the LLLT group showed a small increase in $SpO_2$ after intervention, whereas the control group

showed a slight decrease. The between-group difference in mean $\Delta SpO_2$ was +0.60% (LLLT vs control), and the difference in change was statistically significant ($p = 0.035$), consistent with a modest favorable physiological shift in the LLLT group.

**Effect of LLLT on self-reported anxiety (Facial Image Scale)**

Table 3 summarizes anxiety levels measured using the Facial Image Scale (FIS). Overall, children in the LLLT group demonstrated a shift toward lower anxiety scores compared with the control group. The proportion of children selecting the least anxious category (FIS = 1) was higher in the LLLT arm, while comparatively more children in the control arm selected mid-range scores (FIS = 3) and the maximum score (FIS = 5) was observed only in the control group.

**Table 3. Distribution of Facial Image Scale (FIS) scores by study group (n = 40/group).**

| FIS score | Interpretation | LLLT n (%) | Control n (%) |
|---|---|---|---|
| 1 | Very happy / least anxious | 18 (45.0) | 10 (25.0) |
| 2 | Happy | 13 (32.5) | 15 (37.5) |
| 3 | Neutral | 6 (15.0) | 11 (27.5) |
| 4 | Sad | 3 (7.5) | 3 (7.5) |
| 5 | Very sad / most anxious | 0 (0.0) | 1 (2.5) |
| **Mean ± SD** | — | **1.85 ± 0.95** | **2.25 ± 1.01** |
| **Between-group p-value** | — | | **0.03** |

Consistent with this distributional shift, the mean FIS score was significantly lower in the LLLT group than in the placebo group ($p = 0.03$), indicating that laser acupuncture was associated with reduced self-reported anxiety during treatment under local anesthesia.

**Subgroup analyses by age and gender**

**Table 4. Subgroup analyses of intervention effects by age group and gender.**

| Subgroup | Outcome | LLLT (Mean ± SD) | Control (Mean ± SD) | Between-group p-value |
|---|---|---|---|---|
| **Age 6–9 years** | ΔPulse rate (bpm) | −4.88 ± 6.22 | −0.32 ± 3.80 | 0.003 |
| | FIS score (mean ± SD) | 1.76 ± 0.93 | 2.24 ± 1.04 | 0.008 |
| **Age 10–12 years** | ΔPulse rate (bpm) | −2.64 ± 4.58 | −0.07 ± 2.16 | 0.07 |
| | FIS score (mean ± SD) | 2.00 ± 1.12 | 1.00 ± 1.03 | 0.47 |
| **Gender: Male** | ΔPulse rate (bpm) | −4.45 ± 6.79 | −0.35 ± 4.03 | 0.721 |
| | FIS score (mean ± SD) | 1.75 ± 1.02 | 2.30 ± 1.08 | 0.757 |
| **Gender: Female** | ΔPulse rate (bpm) | −3.80 ± 4.42 | −0.10 ± 2.29 | 0.512 |
| | FIS score (mean ± SD) | 1.95 ± 0.89 | 2.20 ± 0.95 | — |

*ΔPulse rate represents change from pre- to post-intervention (post − pre); negative values indicate reduction.*

Subgroup analyses suggested that the physiological effect of LLLT on pulse rate reduction was more pronounced among younger children (6–9 years), with a significantly greater decrease than with placebo ($p = 0.003$). In contrast, among children aged 10–12 years, the between-group difference in pulse rate change did not reach statistical significance ($p = 0.07$). A similar age-related pattern was observed for self-reported anxiety: in the 6–9-year subgroup, FIS scores were significantly lower in the LLLT group ($p = 0.008$), whereas no significant difference was detected in the 10–12-year subgroup.

When stratified by gender, there was no statistically significant differential effect of LLLT on pulse rate change within the male or female strata (p-values > 0.05). Overall, these subgroup findings should be interpreted cautiously and considered exploratory, given the limited sample sizes within strata and the observed imbalance in sex distribution between study arms.

## DISCUSSION

This randomized controlled study examined whether low-level laser acupuncture delivered before local anesthesia could reduce dental anxiety in children aged 6–12 years. Across outcomes, the findings were consistent: compared with placebo, the LLLT group demonstrated a greater reduction in pulse rate, a modest improvement in oxygen saturation, and lower Facial Image Scale (FIS) scores. Taken together, these results suggest that brief,

needle-free laser stimulation at calming acupoints may attenuate procedural distress during pediatric dental care under local anesthesia.

The present results align with earlier work indicating that laser-based approaches can improve children's procedural acceptance and reduce distress-related responses in the dental setting (Kumari et al., 2025). Studies evaluating hard-tissue lasers for cavity preparation have reported higher comfort and preference compared with conventional rotary instrumentation, which supports the broader concept that laser-based interventions may be less anxiety-provoking for children (Liu et al., 2006; Abdrabuh et el., 2023). While those investigations focused primarily on operative discomfort and behavioral tolerance during caries removal rather than acupoint stimulation, their findings are directionally consistent with our observation that children exposed to laser-based procedures may show reduced physiologic arousal and improved subjective experience.

More directly comparable are studies using low-level laser stimulation at acupoints to influence anxiety-related or stress-linked responses (Goel et al., 2017). Goel et al. (2017) reported that LLLT at the PC6 point reduced gag reflex severity during impression making, accompanied by favorable changes in pulse rate and oxygen saturation—physiological indicators that parallel the autonomic outcomes used in the current trial. Similarly, trials targeting anxiety or injection-related distress using laser acupuncture have reported beneficial effects on perceived pain/anxiety and physiologic markers in some pediatric cohorts (Pooja et al, 2023). These converging findings support the plausibility that laser stimulation at selected points may reduce anticipatory stress and improve tolerance to procedures that children commonly perceive as threatening, such as local anesthetic administration.

At the same time, the pediatric dental literature on low-level laser/photobiomodulation remains heterogeneous, and our results should be interpreted in light of conflicting evidence (Bahrami et al., 2023). For example, Seraj et al. (2023) found that photobiomodulation used as an adjunct to topical anesthesia did not significantly reduce injection pain compared with placebo (Seraj et al., 2023), and Elbay et al. (2023) similarly reported non-significant differences across varying PBM application times prior to injection (Seraj et al., 2023). These discrepancies may reflect important differences in therapeutic target and study design: our protocol delivered stimulation to auricular and hand Shenmen points and was timed before anesthesia to influence anxiety/autonomic arousal, whereas injection-site PBM studies primarily address nociception at the puncture site. In addition, wavelength, power, exposure

duration, and point selection vary substantially across studies, likely contributing to inconsistent outcomes and complicating direct comparisons (Goel et al., 2017; Elbay et al., 2016).

The current findings also help contextualize reports in which lasers reduce pain without clearly altering anxiety. For instance, Tunç et al. (2020) observed lower postoperative pain and analgesic use with Er, Cr: YSGG laser during implant second-stage surgery but no significant change in anxiety scores, suggesting that anxiety may be driven by broader cognitive and situational factors beyond nociceptive input alone (Tuna et al., 2020). Likewise, Elbay et al. (2016) reported no significant benefit of LLLT for postoperative pain after primary molar extraction, which may be unsurprising given that postoperative inflammatory pain control differs from acute, anticipatory dental anxiety during local anesthesia (Elbay et al., 2016).

Exploratory subgroup patterns in the present study suggested stronger effects in younger children (6–9 years) than in older children (10–12 years). Developmentally, younger children may show greater autonomic reactivity and fewer established coping strategies, potentially making reductions in physiologic arousal more detectable. However, subgroup results should be interpreted cautiously due to smaller stratum sizes.

Several limitations deserve emphasis. The groups were imbalanced by sex distribution, which may introduce confounding if anxiety expression differs by sex. The $SpO_2$ changes, though statistically significant, were small and best viewed as supportive physiological evidence rather than a stand-alone endpoint. Future studies should consider incorporating additional validated anxiety measures (e.g., standardized dental anxiety questionnaires and/or salivary biomarkers) and using adjusted analyses to account for baseline imbalances. Despite these constraints, the concordant direction of effect across physiologic and self-reported outcomes suggests that LLLT laser acupuncture may be a practical adjunct to routine behavior guidance for reducing anxiety in children undergoing dental treatment under local anesthesia.
The novelty of this study lies in several aspects:

1. Application of low-level laser acupuncture specifically targeting Shenmen acupoints (auricular and hand) to reduce dental anxiety in children.
2. Evaluation of anxiety using both physiological indicators (pulse rate and oxygen saturation) and psychological assessment (Facial Image Scale) to provide a multidimensional measurement of anxiety.

3. Randomized controlled trial design with placebo comparison to strengthen the clinical evidence regarding LLLT effectiveness.
4. Focus on anxiety reduction prior to local anesthesia administration, a critical moment that commonly triggers anxiety in pediatric patients.
5. Integration of photobiomodulation with behavioral management strategies as a non-invasive and child-friendly adjunct in pediatric dental care.

This approach expands current knowledge by examining laser acupuncture as a practical chairside anxiety-management tool in pediatric dentistry.

Despite growing interest in laser applications for dental procedures, several research gaps remain:

1. Limited evidence on LLLT for anxiety management in pediatric dental injections Most previous studies focused on pain reduction, cavity preparation, or gag reflex control rather than specifically addressing anxiety during local anesthesia procedures.
2. Inconsistency of findings across previous photobiomodulation studies. Differences in wavelength, laser power, stimulation points, and intervention protocols have produced heterogeneous outcomes, making clinical recommendations difficult.
3. Lack of randomized controlled trials evaluating laser acupuncture in children undergoing dental treatment under local anesthesia. Few studies have rigorously tested this approach using controlled experimental designs.
4. Insufficient integration of physiological and psychological anxiety indicators Many previous studies relied on either subjective or physiological measures alone, limiting the comprehensive evaluation of anxiety responses.
5. Limited evidence on age-related responses to laser anxiety management techniques in pediatric patients**.** The potential differential effects across pediatric age groups have not been adequately explored.

While laser technology and photobiomodulation have been explored in dentistry, clear evidence regarding the effectiveness of low-level laser acupuncture for reducing dental anxiety during local anesthesia in children remains limited. This study addresses that gap by providing controlled clinical evidence on the potential benefits of LLLT as a non-invasive anxiety-management strategy in pediatric dental practice.

## CONCLUSION

Low-level laser acupuncture administered before local anesthesia significantly reduced anxiety in children aged 6–12 years, as reflected by lower pulse rate, modestly improved oxygen saturation, and reduced Facial Image Scale scores compared with placebo. These findings support LLLT as a safe, non-invasive, chairside adjunct that can enhance pediatric patient comfort and cooperation during routine dental procedures requiring injections. Standardizing laser parameters and validating outcomes in larger, methodologically robust trials will strengthen its clinical translation and establish its role within evidence-based pediatric anxiety management.

## BIBLIOGRAPHY

Abdrabuh RE, El Meligy OA, Felemban OM, Farsi NM. Evaluation of the erbium-doped yttrium aluminum garnet laser and the conventional method on pain perception and anxiety level in children during caries removal: A randomized split-mouth study. International Journal of Clinical Pediatric Dentistry. 2023 Aug;16(Suppl 1):S39.

Al Homoud RA, Alshellatie AK, Alzumaie AS, Al-Bayati SA. Behavior and anxiety levels in pediatric patients: The behavioral changes and anxiety of pediatric patients in the dental clinic. Clinical and experimental dental research. 2023 Dec;9(6):1223-31.

Appukuttan DP. Strategies to manage patients with dental anxiety and dental phobia: literature review. Clinical, cosmetic and investigational dentistry. 2016 Mar 10:35-50.

Bahrami R, Pourhajibagher M, Gharibpour F, Hosseini S, Bahador A. The impact of low-level laser therapy (photobiomodulation) on the complications associated with conventional dental treatments and oral disorders: A literature review. Journal of Dental Sciences. 2025 Apr 1;20(2):901-10.

Besiroglu-Turgut E, Kayaalti-Yuksek S, Bulut M. Evaluation of the relationship between dental anxiety and oral health status of mothers and their children. BMC Oral Health. 2024 Jun 28;24(1):749.

Bologa E, Tărăboanță-Gamen AC, Tărăboanță I, Boișteanu O, Platon AL, Stelea ȘO, Simionescu AM, Grădinariu AI, Jehac A, Bologa C, Stelea CG. Assessment of Anxiety and Local Anesthesia Experiences in Dental Students Using the Modified Dental Anxiety Scale (MDAS). Dentistry Journal. 2025 Sep 28;13(10):445.

Elbay ÜŞ, Tak Ö, Elbay M, Uğurluel C, Kaya C. Efficacy of low-level laser therapy in the management of postoperative pain in children after primary teeth extraction: A randomized clinical trial. Photomedicine and Laser Surgery. 2016 Apr;34(4):171-7.

Goel H, Mathur S, Sandhu M, Jhingan P, Sachdev V. Effect of low-level laser therapy on P6 acupoint to control gag reflex in children: a clinical trial. Journal of acupuncture and meridian studies. 2017 Oct 1;10(5):317-23.

Kumari P, Dhull KS, Devraj IM, Agrawal PK, Thakre UA, Khan H, Thakkar PK, Surana P. Future of laser pediatric dentistry: Emerging technologies and clinical applications. Bioinformation. 2025 Aug 31;21(8):2304.

Liu JF, Lai YL, Shu WY, Lee SY. Acceptance and efficiency of Er: YAG laser for cavity preparation in children. Photomedicine and laser surgery. 2006 Aug;24(4):489-93.

Pooja B, Kamatham R, Anchala K, Avisa P. Effectiveness of low-level laser therapy in reducing pain perception of children during dental local anesthetic administration using laser acupuncture pen on the LI4 point: a randomized clinical trial. European Archives of Paediatric Dentistry. 2023 Apr;24(2):219-27.

Sachelarie L, Cristea R, Burlui E, Hurjui LL. Laser technology in dentistry: from clinical applications to future innovations. Dentistry journal. 2024 Dec 23;12(12):420.

Seraj B, Bavaghar A, Hakimiha N, Hosseini Z, Kharazifard MJ, Ghadimi S. Effect of photobiomodulation therapy with an 810-nm diode laser on pain perception associated with dental injections in children: a double-blind randomized controlled clinical trial. Journal of Lasers in Medical Sciences. 2023 Jun 19;14:e19.

Shekarchi F, Hartoonian S, Fekrazad R, Mirebeigi-Jamasbi SS. The role of photobiomodulation in minimizing pain during dental injections in adults and children: a systematic review and meta-analysis. Lasers in Medical Science. 2025 Jul 16;40(1):318.

Tunç SK, Yayli NZ, Talmaç AC, Feslihan E, Kaplan V. Evaluation of Dental Anxiety in Patients Undergoing Second-Stage Surgery with Er, Cr: YSGG Laser Treatment: Randomized Clinical Trial. Eastern Journal of Medicine. 2020 Jan 1;25(1):45-54.

Winkler CH, Bjelopavlovic M, Lehmann KM, Petrowski K, Irmscher L, Berth H. Impact of dental anxiety on dental care routine and oral-health-related quality of life in a German adult population—a cross-sectional study. Journal of Clinical Medicine. 2023 Aug 14;12(16):5291.