RESEARCH PAPER

# Effects of Pranayama on Anxiety, Pain Perception, and Cardiovascular Parameters in Patients Undergoing Surgical Extraction of Mandibular Impacted Third Molar: A Randomized Controlled Trial.

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**Abstract**

**Background**: Dental anxiety associated with third molar extraction elevates sympathetic activity, increasing heart rate, blood pressure, and perceived pain. Pranayama, a yogic breathing technique, modulates autonomic balance by enhancing parasympathetic tone. This study evaluated the effects of a short pranayama session on anxiety, pain perception, and cardiovascular parameters in patients undergoing mandibular third molar surgery.

**Methods:** In this prospective randomized controlled trial (CTRI/2021/09/036961), 80 ASA I-II patients (18–60 years) with mesio-angular impacted mandibular third molars (Pell & Gregory Class I/II, Position A/B) were randomized into two groups (n=40 each). Group 1 practiced 15 minutes of Sukha, Chandrabhedana, and Bhramari pranayama; Group 2 performed self-relaxation (quiet sitting). Blood pressure (sphygmomanometer), heart rate (pulse oximeter), anxiety (10-point Likert scale), and pain (Visual Analog Scale, VAS 0–10) were recorded pre-intervention, post-intervention, intra-operatively, and post-operatively. All procedures were performed by the same surgeon under local anesthesia. Data were analyzed using independent t-tests and repeated-measures ANOVA (SPSS v17/25; $p<0.05$ significant).

**Results:** Baseline parameters were comparable between groups. Post-pranayama, Group 1 showed significant reductions versus Group 2 in heart rate (77.63 ± 10.11 vs 87.88 ± 12.46 bpm, p=0.001), systolic BP (112.05 ± 8.86 vs 117.85 ± 12.68 mmHg, p=0.002), diastolic BP (76.48 ± 4.89 vs 80.33 ± 7.20 mmHg, p=0.004), and anxiety (2.03 ± 0.97 vs 2.28 ± 1.36, p=0.003). Intra-operatively, Group 1 maintained lower values: heart rate (84.28 ± 12.65 vs 102.38 ± 15.46 bpm, p=0.001), systolic BP (117.25 ± 11.44 vs 132.93 ± 15.59 mmHg, p=0.001), diastolic BP (78.45 ± 6.08 vs 86.03 ± 7.07 mmHg, p=0.001), anxiety (2.38 ± 1.30 vs 3.80 ± 1.70, p=0.004), and pain perception. Post-operative differences remained significant ($p<0.05$). No adverse effects were observed.

**Conclusion:** A single 15-minute pranayama session significantly reduced anxiety, pain perception, and cardiovascular stress responses during third molar extraction. Pranayama offers a safe, non-pharmacological, cost-effective adjunct for anxiety management in minor oral surgery.

**Keywords:** Pranayama, dental anxiety, third molar extraction, heart rate variability, blood pressure, pain perception, autonomic modulation, non-pharmacological intervention

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**Introduction:**

Surgical removal of impacted mandibular third molars is one of the most common procedures in oral and maxillofacial surgery and frequently induces significant patient anxiety.[1] Anxiety activates the sympathetic nervous system, elevating cortisol, heart rate, blood pressure, and perceived pain while increasing aesthetic and analgesic requirements. [2]

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Conventional pharmacological anxiolytics carry risks of respiratory depression, sedation, and dependency.[3] Non-pharmacological approaches, including yogic breathing (pranayama), promote parasympathetic dominance, reduce sympathetic outflow, and enhance GABA, serotonin, and dopamine levels, thereby lowering stress and inflammatory markers[3,4].

Although yoga and pranayama demonstrate cardiovascular benefits in hypertension, heart failure, and general anxiety[5], their application in acute dental surgical settings remains underexplored. This randomized controlled trial assessed whether a brief, standardized pranayama protocol could attenuate psycho-physiological stress responses during third molar extraction, with implications for bioanalytical monitoring of stress biomarkers and patient-centred care in clinical settings.

**Objective:** To evaluate the effects of pranayama versus self-relaxation on anxiety (Likert scale), pain perception (VAS), heart rate, and blood pressure before, during, and after mandibular third molar surgery.

**Materials and Methods**

***Study Design and Participants***

This prospective, randomized controlled trial was conducted at the Department of Oral and Maxillofacial Surgery, Indira Gandhi Institute of Dental Sciences, Pondicherry, India (IEC approval IGIDSIEC2021NRP31PGRJOMS; CTRI/2021/09/036961). Eighty patients (18–60 years, ASA I/II) requiring surgical extraction of mesio-angular impacted mandibular third molars (Pell & Gregory Class I/II, Position A/B) were enrolled via consecutive sampling after written informed consent.

***Exclusion criteria:*** Pregnancy, psychosis/cognitive impairment, prior yoga practice, traumatic dental history, or use of antihypertensives/sedatives/hypnotics.

***Randomization and Interventions***

Patients were block-randomized (1:1) into:

- ***Group 1 (Pranayama):*** 15 minutes of guided Sukha pranayama (equal 6-count inhale/exhale in Sukhasana), Chandrabhedana pranayama (left-nostril inhale, right-nostril exhale; 9 rounds), and Bhramari pranayama (humming exhalation with Shanmukhi mudra; ≥9 rounds), preceded and followed by quiet sitting.

**Figure.1: Pranayama**

- ***Group 2 (Control):*** 15 minutes of self-relaxation (quiet sitting).

All surgeries were performed by the same experienced surgeon under inferior alveolar and long buccal nerve blocks (2% lidocaine with 1:80,000 epinephrine). Standard surgical technique included ward's incision, mucoperiosteal flap elevation, bone removal, odontectomy if needed, irrigation, and 3-0 silk closure. Post-operative antibiotics (amoxicillin 500 mg) and analgesics (diclofenac 50 mg) were prescribed.

**Figure.2: Armamentarium**

***Outcome Measures***

- ***Cardiovascular parameters:*** Systolic/diastolic blood pressure (manual sphygmomanometer) and heart rate (pulse oximeter) recorded pre-intervention, post-intervention, intra-operatively (peak stress phase), and post-operatively.
- ***Anxiety:*** 10-point Likert scale (0 = calm, 10 = extremely anxious).

***Figure 3:*** **Likert scale**

- ***Pain perception***: 10-cm Visual Analog Scale (VAS; 0 = no pain, 10 = worst imaginable).

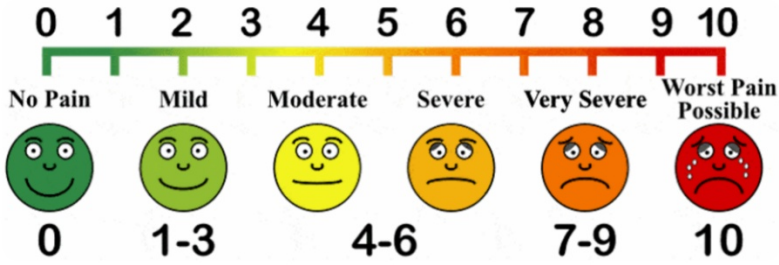



***Figure 4:*** **Visual Analogue Scale**

Measurements were taken at consistent time points by a blinded assessor where feasible.

***Statistical Analysis***

Data were expressed as mean ± SD. Inter-group comparisons used independent t-tests (with Levene's test for equality of variances). Intra-group changes were assessed via repeated-measures ANOVA. Statistical significance was set at $p < 0.05$. Analyses were performed using SPSS version 17/25.

***Ethical Considerations***

The study complied with the Declaration of Helsinki. All participants provided informed consent. No external funding was received.

**Results:**

Demographic characteristics were comparable between groups. Mean age was 28.75 years (Group 1) and 29.35 years (Group 2). Gender distribution showed no significant difference (Group 1: 19 male/21 female; Group 2: 20 male/20 female; $p > 0.05$).

**Figure.5: STUDY PROTOCOL**

**Table.1: Age cross tabulation**

| Age | N | Minimum | Maximum | Mean |
|---|---|---|---|---|
| Group – 1 | 40 | 19 | 50 | 28.75 |
| Group – 2 | 40 | 18 | 48 | 29.35 |

**Table.2: Gender cross tabulation**

| | Male | Female | Total | p – value |
|---|---|---|---|---|
| Group – 1 | 19 (47.5%) | 21 (52.5%) | 40 | 0.05 |
| Group – 2 | 20 (50.0%) | 20 (50.0%) | 40 | |
| **Total** | 39 (48.75%) | 41 (51.25%) | **80** (100%) | |

***Heart Rate***

Pre-operative heart rate was similar (93.75 ± 14.21 vs 90.48 ± 11.45 bpm). Post-intervention, Group 1 exhibited a marked reduction (77.63 ± 10.11 vs 87.88 ± 12.46 bpm, p=0.001). Intra-operative (84.28 ± 12.65 vs 102.38 ± 15.46 bpm, p=0.001) and post-operative values (77.33 ± 9.30 vs 89.93 ± 12.10 bpm, p=0.001) remained significantly lower in the pranayama group.

**Table.3: Inter group comparison of Heart rates**

| Intergroup comparisons | Mean | Std. Deviation | Std. Error Mean | Equality of mean Sig .(2-tailed) | p value | Inference |
|---|---|---|---|---|---|---|
| **PRE-OPERATIVE HEART RATE** | | | | | | |
| Pranayama group Vs Control group | 93.75 | 14.207 | 2.246 | 0.260 | $p < 0.05$ | Not Significant |
| | 90.48 | 11.449 | 1.810 | | | |
| **HEART RATE FOLLOWING INTERVENTION** | | | | | | |
| Pranayama group Vs Control group | 77.63 | 10.109 | 1.598 | 0.001 | $p < 0.05$ | Significant |
| group Vs Control group | 87.88 | 12.462 | 1.970 | | | |
| **INTRA-OPERATIVE HEART RATE** | | | | | | |

**Graph.1: Inter group comparison of mean Heart rates (in beats/min)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Pranayama group Vs Control group | 84.28 | 12.645 | 1.999 | 0.001 | $p < 0.05$ | Significant |
| | 102.38 | 15.463 | 2.445 | | | |
| **POST-OPERATIVE HEART RATE** | | | | | | |
| Pranayama group Vs Control group | 77.33 | 9.300 | 1.470 | 0.001 | $p < 0.05$ | Significant |
| | 89.93 | 12.101 | 1.913 | | | |

***Blood Pressure***

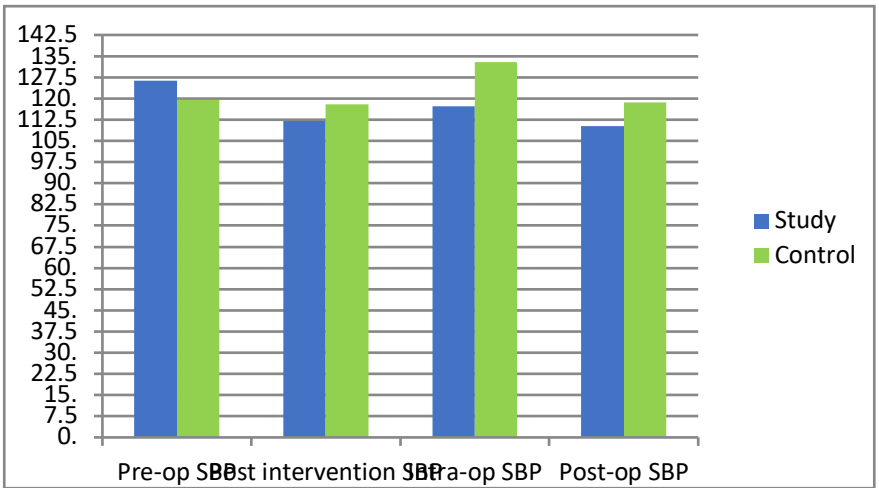
***Systolic BP:*** Pre-operative values showed minor baseline difference (126.40 ± 13.53 vs 119.58 ± 12.04 mmHg). Post-pranayama, Group 1 had lower systolic BP (112.05 ± 8.86 vs 117.85 ± 12.68 mmHg, p=0.002). Intra-operative rise was blunted in Group 1 (117.25 ± 11.44 vs 132.93 ± 15.59 mmHg, p=0.001), with sustained post-operative benefit (110.33 ± 8.20 vs 118.65 ± 10.42 mmHg, p=0.001).

**Table.4: Inter group comparison of Systolic blood pressure**

| Intergroup comparisons | Mean | Std. Deviation | Std. Error Mean | Equality of mean Sig .(2-tailed) | p value | Inference |
|---|---|---|---|---|---|---|
| **PRE-OPERATIVE SYSTOLIC BLOOD PRESSURE** | | | | | | |
| Pranayama group Vs Control group | 126.40 | 13.526 | 2.139 | 0.020 | $p < 0.05$ | Not Significant |
| | 119.58 | 12.042 | 1.904 | | | |
| **SYSTOLIC BLOOD PRESSURE FOLLOWING INTERVENTION** | | | | | | |
| Pranayama group Vs | 112.05 | 8.858 | 1.401 | 0.002 | $p < 0.05$ | Significant |
| | 117.85 | 12.683 | 2.005 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Control group | | | | | | |
| **INTRA-OPERATIVE SYSTOLIC BLOOD PRESSURE** | | | | | | |
| Pranayama group | 117.25 | 11.439 | 1.809 | 0.001 | p < 0.05 | Significant |
| Vs | 132.93 | 15.592 | 2.465 | | | |
| Control group | | | | | | |
| **POST-OPERATIVE SYSTOLIC BLOOD PRESSURE** | | | | | | |
| Pranayama group | 110.33 | 8.204 | 1.297 | 0.001 | p < 0.05 | Significant |
| Vs | 118.65 | 10.423 | 1.648 | | | |
| Control group | | | | | | |

**Graph.2: Inter group comparison of mean Systolic blood pressure (in mmHg)**



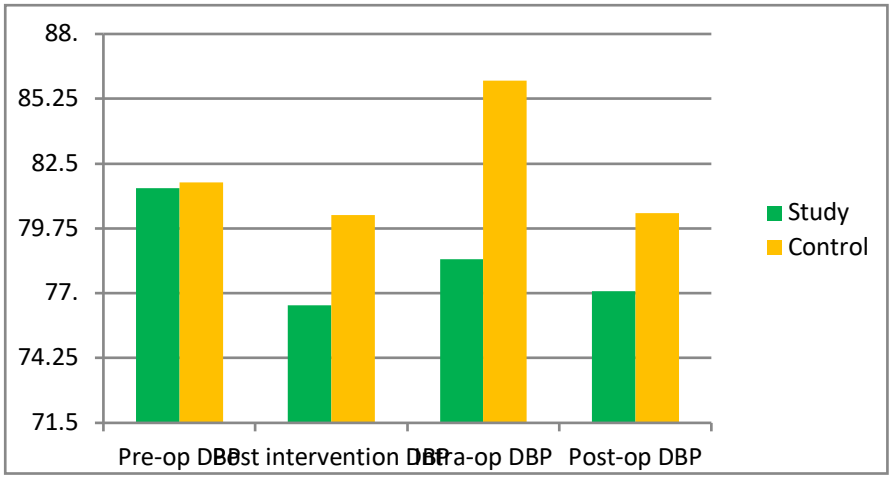

***Diastolic BP:*** Pre-operative values were equivalent (~81.5 mmHg). Significant reductions occurred post-intervention (76.48 ± 4.89 vs 80.33 ± 7.20 mmHg, p=0.004), intra-operatively (78.45 ± 6.08 vs 86.03 ± 7.07 mmHg, p=0.001), and post-operatively (77.08 ± 4.78 vs 80.40 ± 4.95 mmHg, p=0.003) in the pranayama group.

**Table.5: Inter group comparison of Diastolic blood pressure:**

| **Intergroup comparisons** | **Mean** | **Std. Deviation** | **Std. Error Mean** | **Equality of mean Sig .(2-tailed)** | **p value** | **Inference** |
|---|---|---|---|---|---|---|
| **PRE-OPERATIVE DIASTOLIC BLOOD PRESSURE** | | | | | | |
| Pranayama group | 81.45 | 5.769 | 0.912 | 0.846 | p < 0.05 | Not Significant |
| Vs | 81.70 | 5.671 | 0.897 | | | |
| Control group | | | | | | |
| **DIASTOLIC BLOOD PRESSURE FOLLOWING INTERVENTION** | | | | | | |
| Pranayama group | 76.48 | 4.894 | 0.774 | 0.004 | p < 0.05 | Significant |
| Vs | 80.33 | 7.195 | 1.138 | | | |
| Control group | | | | | | |
| **INTRA-OPERATIVE DIASTOLIC BLOOD PRESSURE** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Pranayama group Vs Control group | 78.45 | 6.080 | 0.961 | 0.001 | p < 0.05 | Significant |
| | 86.03 | 7.073 | 1.118 | | | |
| **POST-OPERATIVE DIASTOLIC BLOOD PRESSURE** | | | | | | |
| Pranayama group Vs Control group | 77.08 | 4.779 | 0.756 | 0.003 | p < 0.05 | Significant |
| | 80.40 | 4.950 | 0.783 | | | |

**Graph.3: Inter group comparison of mean Diastolic blood pressure (in mmHg)**




***Anxiety and Pain Perception***

Pre-operative anxiety was slightly higher in Group 1 (3.63 ± 1.31 vs 2.45 ± 1.32). Post-intervention anxiety decreased significantly in Group 1 (2.03 ± 0.97 vs 2.28 ± 1.36, p=0.003). Intra-operative anxiety (2.38 ± 1.30 vs 3.80 ± 1.70, p=0.004) and post-operative anxiety (1.40 ± 1.01 vs 2.13 ± 1.02, p=0.001) were lower in the yoga group.

Pain perception (VAS) post-intervention was reduced in Group 1 (2.05 ± 1.30 vs 2.63 ± 1.25, p<0.05), with corresponding lower intra- and post-operative scores.

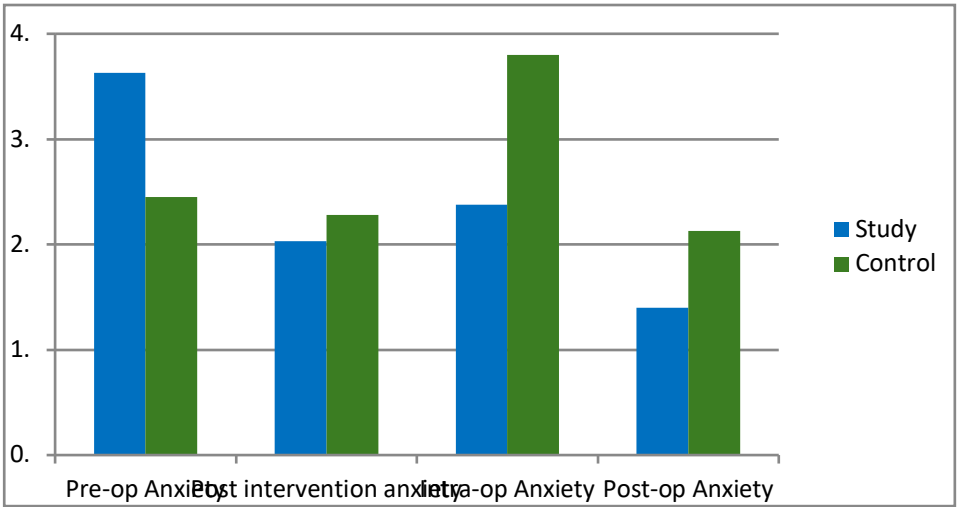
All inter-group differences post-intervention and during/after surgery were statistically significant (p<0.05), favoring pranayama. No adverse events related to the breathing exercises were reported.

**Table.6: Inter group comparison of Anxiety score**

| Intergroup comparisons | Mean | Std. Deviation | Std. Error Mean | Equality of mean Sig .(2-tailed) | p value | Inference |
|---|---|---|---|---|---|---|
| **PRE-OPERATIVE ANXIETY** | | | | | | |
| Pranayama group Vs Control group | 3.63 | 1.314 | 0.208 | 0.001 | p < 0.05 | Significant |
| | 2.45 | 1.319 | 0.209 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **ANXIETY FOLLOWING INTERVENTION** | | | | | | |
| Pranayama group Vs Control group | 2.03 | 0.974 | 0.154 | 0.003 | $p < 0.05$ | Significant |
| | 2.28 | 1.358 | 0.215 | | | |
| **INTRA-OPERATIVE ANXIETY** | | | | | | |
| Pranayama group Vs Control group | 2.38 | 1.295 | 0.205 | 0.004 | $p < 0.05$ | Significant |
| | 3.80 | 1.698 | 0.268 | | | |
| **POST-OPERATIVE ANXIETY** | | | | | | |
| Pranayama group Vs Control group | 1.40 | 1.008 | 0.159 | 0.001 | $p < 0.05$ | Significant |
| | 2.13 | 1.017 | 0.161 | | | |

**Graph.4: Inter group comparison of mean Anxiety score**




**Discussion**

The present randomized controlled trial provides robust evidence that a single, brief 15-minute session of structured pranayama (comprising Sukha, Chandrabhedana, and Bhramari techniques) significantly attenuates psycho-physiological stress responses in patients undergoing surgical extraction of mandibular impacted third molars. Specifically, the pranayama group demonstrated clinically and statistically meaningful reductions in heart rate (mean post-intervention difference of approximately 10 bpm, sustained intra- and post-operatively), systolic blood pressure (mean reduction of ~14 mmHg post-intervention with blunted intra-operative surge), diastolic blood pressure (~5 mmHg reduction), anxiety scores on the Likert scale, and subjective pain perception on the VAS compared with the self-relaxation control group (all $p<0.05$). These findings underscore the potential of pranayama as a simple, non-invasive, and cost-effective adjunctive intervention for managing acute procedural anxiety in outpatient oral and maxillofacial surgery settings[6].

Mechanistically, the observed benefits align closely with the established physiology of yogic breathing practices[7]. Pranayama techniques enhance parasympathetic (vagal) dominance while simultaneously down-regulating sympathetic adrenergic outflow[8]. This autonomic rebalancing is achieved through slow, controlled breathing patterns that stimulate pulmonary stretch receptors and baroreceptors, leading to decreased heart rate and vascular resistance. Concurrently, pranayama promotes the release of inhibitory neurotransmitters such as gamma-aminobutyric acid (GABA), serotonin, and dopamine, which exert natural anxiolytic and antidepressant effects. Melatonin secretion is also augmented, further supporting relaxation and improved sleep regulation—effects that may indirectly modulate pain thresholds[9]. These neurochemical changes

collectively interrupt the hypothalamic-pituitary-adrenal (HPA) axis hyperactivity typically triggered by anticipatory dental anxiety, thereby reducing cortisol-mediated vasoconstriction, tachycardia, and heightened nociception. The blunted intra-operative hemodynamic surge observed in the pranayama cohort (e.g., systolic BP limited to 117.25 mmHg versus 132.93 mmHg in controls) directly reflects this dampened stress cascade, preventing the vicious cycle of anxiety-induced sympathetic activation that can exacerbate perceived pain and complicate surgical conditions.

These results are consistent with and extend a substantial body of literature on the cardiovascular and psychological benefits of yoga and pranayama.[10] Multiple systematic reviews and meta-analyses have documented significant reductions in systolic and diastolic blood pressure following yoga interventions in hypertensive populations, with effect sizes comparable to those seen in the present study[11]. For instance, pranayama has been shown to lower resting heart rate, systolic BP, and diastolic BP through decreased sympathetic tone and increased parasympathetic activity, often within short intervention periods[12]. In the context of acute procedural stress, our intra-operative findings mirror reports from studies on coronary angiography patients, where combined music-yoga protocols (including pranayama-like breathing) reduced anxiety, respiratory rate, and blood pressure more effectively than music alone[13]. Furthermore, the reduction in anxiety and pain perception aligns with evidence from meta-analyses of hatha yoga demonstrating moderate to large effect sizes on anxiety symptoms, attributed to enhanced vagal tone and lowered inflammatory cytokines.[14]

Importantly, the present investigation addresses a critical gap in the literature: the application of pranayama specifically within the high-anxiety domain of dentoalveolar surgery. Prior dental anxiety research has consistently linked elevated pre-operative fear to increased intra-operative blood pressure variability and post-operative pain, yet few studies have tested accessible non-pharmacological countermeasures. Our data reveal that even a single session can produce immediate, measurable benefits, contrasting with longer-term yoga protocols (e.g., 12 weeks) evaluated in chronic conditions such as heart failure or psoriasis. The lack of gender differences in anxiety response in our cohort further broadens applicability, although some earlier reports suggested higher anxiety in females[15]. The absence of adverse events reinforces the safety profile of these techniques, even when performed immediately pre-operatively in an ambulatory setting.

From a bioanalytical and clinical pharmacology perspective, these findings carry notable implications. Procedural anxiety introduces substantial pre-analytical variability in stress biomarker quantification (e.g., plasma cortisol, catecholamines, or inflammatory cytokines), which can confound pharmacokinetic/pharmacodynamic studies, therapeutic drug monitoring, or biomarker validation in oral surgery cohorts[16]. By stabilizing autonomic parameters and reducing sympathetic surges, pranayama may minimize such variability, thereby improving the reliability and reproducibility of bioanalytical assays performed on peri-operative samples. For example, lower cortisol and catecholamine spikes could yield cleaner baseline data for mass spectrometry-based metabolomics or immunoassays targeting HPA-axis mediators.[17] In regulatory contexts, where bioanalytical method validation demands tight control of physiological confounders, integrating standardized breathing protocols could represent a simple quality-by-design approach to enhance data integrity. Additionally, reduced analgesic requirements secondary to lowered pain perception may influence pharmacokinetic profiling of post-operative medications, offering a non-pharmacological strategy to optimize dosing regimens in anxious patient subpopulations[18].

The clinical translation of these results is particularly promising in resource-limited or outpatient settings where pharmacological anxiolytics are contraindicated or undesirable. Unlike benzodiazepines or opioids, pranayama requires no specialized equipment, incurs negligible cost, and empowers patients with a self-administered skill transferable to future dental visits.[19] This patient-centered approach aligns with growing emphasis on integrative medicine within oral health care and could reduce overall healthcare burden by decreasing sedation-related complications and improving procedural tolerance[20]

Nevertheless, several limitations warrant consideration. First, the study evaluated only the acute effects of a single 15-minute session; whether repeated pre-operative training or long-term home practice yields cumulative or sustained benefits remains unaddressed. Second, reliance on subjective Likert and VAS scales, while validated and widely used, introduces potential reporting bias despite objective corroboration from hemodynamic data. Third, the single-center design and restriction to mesio-angular impactions (Pell & Gregory Class I/II) limit generalizability to more complex cases or diverse populations. Fourth, although the surgeon and assessor were standardized, complete blinding was not feasible for the intervention. Finally, direct bioanalytical quantification of stress hormones (e.g., salivary or plasma cortisol) was not performed, representing an opportunity for future multimodal studies.

Strengths of the trial include its prospective randomized design, adequate powering (n=80, 90% power), strict inclusion/exclusion criteria, and use of standardized, reproducible pranayama techniques delivered by trained personnel. All surgeries followed a uniform protocol performed by a single operator, minimizing technical variability. The comprehensive assessment across four time points (pre-, post-intervention, intra-, and post-operative) provides a dynamic view of stress modulation rarely captured in prior yoga-dental research.

Future research directions should incorporate bioanalytical endpoints to bridge the physiological and biochemical domains. Planned extensions include measurement of heart rate variability (HRV) as a more sensitive index of autonomic balance, quantification of circulating or salivary stress biomarkers via validated LC-MS/MS or ELISA methods, and multi-center trials encompassing broader impaction classifications and demographic diversity. Longitudinal designs evaluating patient-reported outcomes and repeat procedure tolerance would further strengthen evidence. Integration with digital health tools (e.g., guided pranayama apps) could enhance scalability and adherence monitoring. Ultimately, large-scale studies validating pranayama within standardized pre-analytical protocols could position it as a recommended adjunct in clinical bioanalysis guidelines for stress-sensitive procedures.

In summary, the present findings robustly demonstrate that pranayama exerts rapid, significant, and multifaceted benefits on anxiety, pain perception, and cardiovascular stability during third molar extraction. By offering a mechanistic, evidence-based, and easily implementable non-pharmacological tool, this intervention not only improves immediate patient experience but also holds promise for enhancing the precision of bioanalytical measurements in peri-operative research and clinical practice.

## Conclusions

A brief pranayama intervention significantly reduced anxiety, pain perception, heart rate, and blood pressure in patients undergoing surgical third molar extraction compared with self-relaxation. These findings support pranayama as a safe, effective, and cost-efficient non-pharmacological adjunct for anxiety management in minor oral surgery. Its routine incorporation could enhance patient comfort and procedural outcomes while offering a simple tool for autonomic modulation in clinical bioanalysis and stress-related research.

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