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ORIGINAL RESEARCH

A Retrospective Study on the Effect of STA Anesthesia Technique in the Extraction of Impacted Teeth in Dental Outpatients and Its Impact on Patient Anxiety Levels

Jie Xu[1,*], Junsen Su[1,*], Guangfeng Liu[2], Wanggui Ying[3], Fang Yuan[4]

[1]Department of Stomatology, High-Tech District, Jinan Stomatological Hospital, Jinan, People's Republic of China; [2]Department of Stomatology, Wendeng Hospital of Traditional Chinese Orthopedics and Traumatology of Shandong Province, Weihai, Shandong, People's Republic of China; [3]Department of Stomatology, Shungeng District, Jinan Stomatological Hospital, Jinan, People's Republic of China; [4]Department of Prosthodontics, Jinan Stomatological Hospital, Jinan, People's Republic of China

*These authors contributed equally to this work

Correspondence: Wanggui Ying; Fang Yuan, Email ywy117@126.com; ynfm053@163.com

Objective: To analyze the effect of the Single Tooth Anesthesia (STA) technique in dental outpatient patients undergoing the extraction of impacted teeth and its impact on patient anxiety levels.
Methods: This retrospective study included clinical data from 130 patients who underwent the extraction of a single mandibular impacted tooth in our dental outpatient department between April 2022 and June 2024. According to the anesthesia method, patients were divided into two groups: the Traditional Group (n = 65, receiving traditional local injection anesthesia) and the STA Group (n = 65, receiving Single Tooth Anesthesia). Parameters including intraoperative bleeding, duration of anesthesia, extent of anesthetic infiltration, blood pressure [systolic blood pressure (SBP), diastolic blood pressure (DBP)], heart rate (HR), pain [visual analog scale (VAS)], compliance (Frankl treatment compliance scale), tolerance (Houpt behavior scale), and anxiety level [modified dental anxiety scale (MDAS)] were compared between the two groups.
Results: There were no significant differences in the amount of bleeding, anesthesia duration, or infiltration range between the two groups ($P > 0.05$). In the Traditional Group, SBP at 3 minutes after anesthesia and post-extraction was significantly higher than before anesthesia ($P < 0.05$), whereas DBP and HR showed no significant changes ($P > 0.05$). In the STA Group, SBP, DBP, and HR remained stable across the three time points ($P > 0.05$). Compared with the Traditional Group, the STA Group showed significantly lower pain scores, reduced anxiety, and higher rates of treatment compliance and tolerance ($P < 0.05$).
Conclusion: Within the limitations of this retrospective study, the STA anesthesia technique showed advantages over traditional local injection anesthesia in reducing pain and anxiety, while improving compliance and tolerance during impacted tooth extraction in dental outpatients.
Keywords: anxiety, impacted tooth extraction, pain, STA anesthesia technique, tolerance

Introduction

Impacted teeth, particularly deeply embedded mandibular third molars, often require complex surgical techniques for removal due to factors such as abnormal eruption paths and variations in crown-root morphology. These procedures may lead to considerable trauma, bleeding, and postoperative complications such as infection and prolonged pain.[1,2] Moreover, many patients report heightened psychological distress and anxiety, largely stemming from fear of dental procedures and anticipated pain, which can negatively impact both treatment compliance and postoperative recovery.[3,4]

Effective pain management and anxiety control during impacted tooth extraction remain major challenges in clinical dentistry. Conventional local anesthesia—typically involving manual injection of anesthetic agents—has been widely

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adopted to mitigate pain by blocking nerve transmission at the surgical site.[5] However, this method still has notable limitations. Pain from needle puncture, inconsistent anesthetic diffusion, and inadequate anesthetic depth may result in discomfort or ineffective anesthesia, potentially exacerbating dental anxiety and reducing treatment cooperation.[6,7]

To address these challenges, the Single Tooth Anesthesia (STA) technique has been increasingly applied in dental procedures. Developed using a computer-controlled local anesthetic delivery (CCLAD) system, STA offers precise control of injection pressure and anesthetic flow, enabling gradual infiltration and minimizing discomfort. This technique not only ensures effective anesthetic coverage but also reduces procedural fear and improves patient compliance and satisfaction.[8,9]

Given the promising advantages of STA in enhancing patient comfort, it is important to examine its clinical effectiveness specifically in the extraction of impacted molars, especially under routine outpatient settings. A relevant study on anxiety responses during retained molar extraction also emphasizes the psychological burden associated with such procedures.[10] Therefore, this retrospective study was designed to compare the STA anesthesia technique with traditional injection anesthesia in terms of both anesthetic effectiveness and psychological outcomes in dental outpatients. The objective was to evaluate which method provides better support for pain control, anxiety relief, and overall patient experience during impacted tooth extraction.

Materials and Methods

Clinical Data

A retrospective analysis was conducted on the clinical data of 130 patients who underwent the extraction of a single mandibular impacted tooth at our dental outpatient department between April 2022 and June 2024. The inclusion and exclusion criteria are shown in Table 1. According to the type of local anesthesia administered, the patients were divided into the Traditional Group (n=65, receiving traditional injection local anesthesia) and the STA Group (n=65, receiving STA anesthesia technique local anesthesia). This study was approved by the Medical Ethics Committee of Jinan Stomatological Hospital (Approval No. KQBY00011, approved on March 15, 2023), and was conducted in accordance with the ethical standards of the Declaration of Helsinki. All patients signed informed consent forms prior to participation in the study.

Anesthesia Methods

In this study, all patients received Mepivacaine Hydrochloride Epinephrine Injection (Yangtze River Pharmaceutical Group Co., Ltd., Approval No. H20110213; Specification: 1.8 mL/vial) as the local anesthetic. The anesthesia and surgical procedures were performed by the same experienced attending physician. To ensure the consistency and reproducibility of the anesthesia procedure, all procedures were repeated at least twice by the attending physician to verify the results. Patients were divided into two groups according to the anesthesia method: the Traditional Group and the STA Group. In the Traditional Group, local anesthesia was administered using a metal core syringe with a pressure injector, maintaining a steady and uniform injection rate during the procedure. A standard 27-gauge (0.4 mm × 35 mm) dental needle was used for the injection. The injection time typically lasted 30–60 seconds, and the anesthesia effect usually began to show after 2–4 minutes. In the STA Group, local anesthesia was administered using the STA anesthesia technique with the STA dental local anesthesia device produced by Milestone, USA, controlling a low flow rate of 0.5

Table 1 Inclusion and Exclusion Criteria of the Study

Criteria Type	Specific Criteria
Inclusion Criteria	1. Aged 18–65 years, any gender, with good communication and comprehension abilities; 2. Diagnosed with a mandibular impacted tooth, scheduled for single tooth extraction; 3. No severe systemic diseases (eg, heart disease, liver/kidney failure), able to tolerate local anesthesia; 4. Exhibiting high levels of anxiety before surgery; 5. Voluntarily participated and signed informed consent.
Exclusion Criteria	1. Complex oral diseases (eg, severe periodontitis, root remnants, gingival tumors); 2. Pregnant or breastfeeding; 3. Allergic to anesthetics or with contraindications to study procedures; 4. Severe mental disorders or inability to comprehend treatment plan; 5. History of adverse reactions to local anesthesia or serious complications after tooth extraction.

drops/s. A 30-gauge (0.3 mm × 21 mm) ultra-thin STA-compatible needle was used to minimize tissue trauma and discomfort. The injection time generally lasted 120–240 seconds, with the anesthesia effect typically beginning to manifest after 5–7 minutes. After successful local anesthesia, the extraction of the impacted tooth was performed according to the planned treatment. Both groups received the same preoperative evaluation and postoperative management.

Observation Indicators

The amount of bleeding during tooth extraction, duration of local anesthesia, and range of anesthesia infiltration were uniformly recorded by designated medical staff in the outpatient clinic. Bleeding volume was measured using a standardized suction device and quantified by collecting the blood in a calibrated suction container. The total bleeding volume was recorded in milliliters (mL) immediately after the extraction and any additional bleeding during the procedure was also noted. The measurement was taken by the same trained clinical staff for all patients to ensure consistency. The blood pressure [systolic blood pressure (SBP), diastolic blood pressure (DBP)] and heart rate (HR) were measured before anesthesia, 3 minutes after anesthesia, and after tooth extraction. After the treatment, the patient's pain level, compliance, tolerance, and anxiety level were assessed using the following criteria: (1) Pain Level: Pain was evaluated using the Visual Analog Scale (VAS),[11] which is scored from 0–10, with a higher score indicating greater pain. Scores of 0–2 were considered excellent, indicating no pain; 3–5 were considered good, indicating mild pain; 6–8 were considered fair, indicating moderate to severe pain; 9–10 were considered poor, indicating extreme pain. (2) Compliance: Compliance was assessed using the Frankl Scale,[12] where the physician scores the patient's cooperation: refusal or distress 1 point; uncooperative or unwilling 2 points; cooperative but indifferent 3 points; actively cooperative and enjoying 4 points. Patients scoring 1–2 points were defined as non-compliant, and patients scoring 3–4 points were defined as compliant. (3) Tolerance: Tolerance was assessed using the Houpt Behavioral Scale,[13] where the physician evaluated the patient's tolerance: treatment cannot be performed or failed 1 point; treatment interrupted or partially completed 2 points; treatment interrupted but completed 3 points; treatment completed without interruption but with some difficulty 4 points; treatment completed with only slight resistance 5 points; treatment performed smoothly 6 points. Patients scoring 1–2 points were defined as poor tolerance, 3–4 points as good tolerance, and 4–5 points as excellent tolerance. (4) Anxiety Level: The Modified Dental Anxiety Scale (MDAS)[14] was used to measure anxiety after tooth extraction. This scale is scored from 4–20, with higher scores indicating higher anxiety. Patients with MDAS scores greater than 11 were considered to have dental anxiety.

Statistical Methods

GraphPad Prism 8 software was used for graphing, and SPSS 22.0 software was used for data processing. Count data are presented as n(%), and the χ^2-test was used for comparison. Measurement data are presented as ($\bar{x} \pm s$), with comparisons between groups made using independent samples *t*-test and within-group comparisons made using paired *t*-test. A P-value of <0.05 was considered statistically significant.

Results

Comparison of Clinical Data

There were no significant differences in gender, age, body mass index (BMI), surgical side, comorbidities, or educational level between the two groups (P>0.05), indicating comparability. The data is shown in Table 2.

Comparison of Tooth Extraction Bleeding, Duration of Local Anesthesia, and Range of Anesthesia Infiltration

There were no significant differences in the amount of bleeding during tooth extraction, duration of local anesthesia, or range of anesthesia infiltration between the two groups (P>0.05). The data is shown in Table 3.

Table 2 Comparison of Clinical Data ($\bar{x} \pm s$, n[%])

	Traditional (n=65)	STA (n=65)	*t/x²*	*P*
Gender	–	–	0.277	0.598
Male	30 (46.15)	33 (50.77)	–	–
Female	35 (53.85)	32 (49.23)	–	–
Age (years)	27.94±4.38	28.62±5.01	0.823	0.411
BMI (kg/m²)	21.79±2.42	21.53±2.56	0.595	0.552
Surgical Side	–	–	0.492	0.482
Left	34 (52.31)	30 (46.15)	–	–
Right	31 (47.69)	35 (53.85)	–	–
Comorbidities	–	–	–	–
Diabetes	5 (7.69)	3 (4.62)	0.133	0.715
Hypertension	7 (10.77)	4 (6.15)	0.893	0.344
Education Level	–	–	0.538	0.463
High school or below	40 (61.54)	44 (67.69)	–	–
High school or above	25 (38.46)	21 (32.31)	–	–

Notes: There were no statistically significant differences between the two groups (P > 0.05).

Table 3 Comparison of Tooth Extraction Bleeding, Duration of Local Anesthesia, and Range of Anesthesia Infiltration ($\bar{x} \pm s$)

	Traditional (n=65)	STA (n=65)	*t*	*P*
Bleeding Volume (mL)	5.07±1.05	4.95±0.97	0.676	0.499
Duration of Local Anesthesia (min)	52.74±0.98	52.91±0.84	1.061	0.290
Range of Anesthesia Infiltration (cm²)	17.43±3.79	17.86±3.92	0.635	0.526

Note: No significant differences were found between the groups (P > 0.05).

Comparison of SBP, DBP, and HR Changes at Different Time Points

In the Traditional Group, SBP levels significantly increased after 3 minutes of anesthesia and after tooth extraction compared to before anesthesia (P<0.05). However, there were no significant changes in DBP and HR levels before anesthesia, 3 minutes after anesthesia, and after tooth extraction (P>0.05). In the STA Group, there were no significant changes in SBP, DBP, or HR levels at any time point (P>0.05). The data is shown in Figures 1–3.

Pain Level Comparison

In the Traditional Group (n=65), 26 patients had excellent pain relief, 29 had good pain relief, 9 had moderate pain, and 1 had poor pain relief. In the STA Group (n=65), 30 patients had excellent pain relief, 32 had good pain relief, 3 had moderate pain, and 0 had poor pain relief. The excellent and good pain relief rate in the STA Group (95.38%) was higher than that in the Traditional Group (84.62%) (P<0.05), as shown in Figure 4.

Compliance Comparison

In the Traditional Group (n=65), 12 patients were non-compliant, and 53 were compliant. In the STA Group (n=65), 4 patients were non-compliant, and 61 were compliant. The compliance rate in the STA Group (93.85%) was higher than that in the Traditional Group (81.54%) (P<0.05), as shown in Figure 5.

Tolerance Comparison

In the Traditional Group (n=65), 23 patients had excellent tolerance, 36 had good tolerance, and 6 had poor tolerance. In the STA Group (n=65), 31 patients had excellent tolerance, 34 had good tolerance, and 0 had poor tolerance. The excellent and good tolerance rate in the STA Group (100.00%) was higher than that in the Traditional Group (90.77%) (P<0.05), as shown in Figure 6.

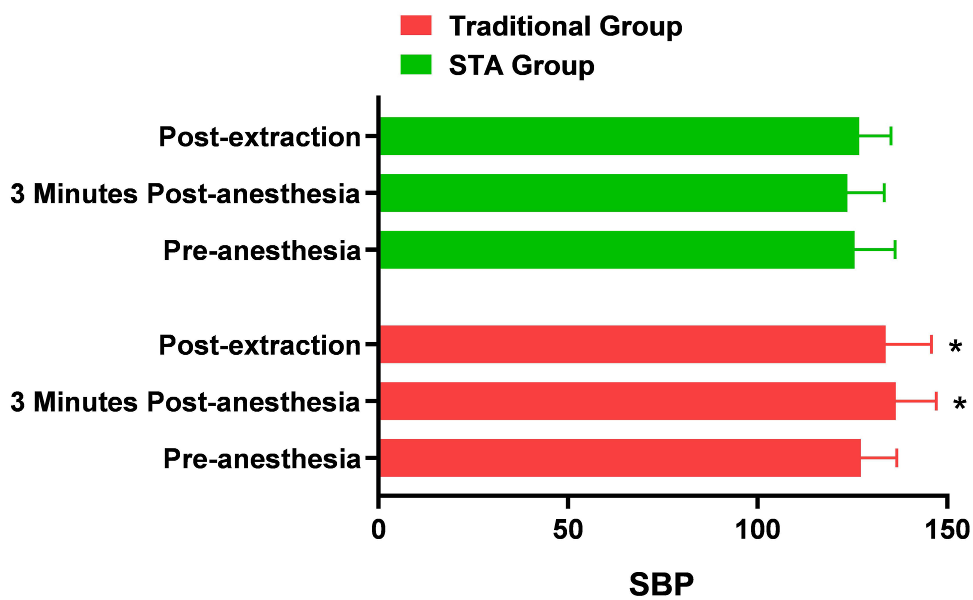

Figure 1 Comparison of SBP Changes at Different Time Points ($\bar{x} \pm s$, mmHg).
Note: Compared with the same group before anesthesia, *P<0.05.

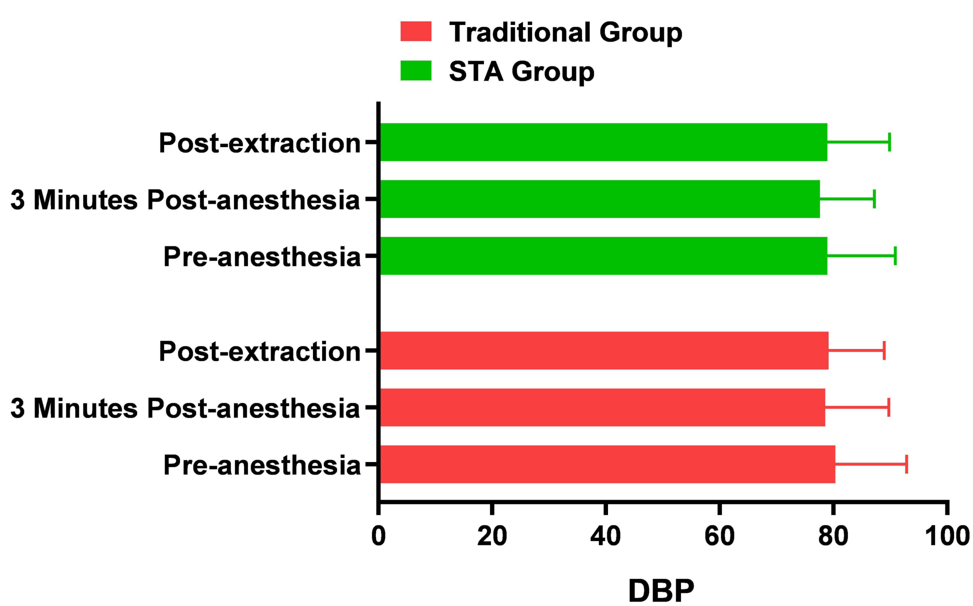

Figure 2 Comparison of DBP Changes at Different Time Points ($\bar{x} \pm s$, mmHg).

Anxiety Level Comparison

In the Traditional Group (n=65), 17 patients had dental anxiety, and 48 did not. In the STA Group (n=65), 6 patients had dental anxiety, and 59 did not. The proportion of dental anxiety in the STA Group (9.23%) was lower than that in the Traditional Group (26.15%) (P<0.05), as shown in Figure 7.

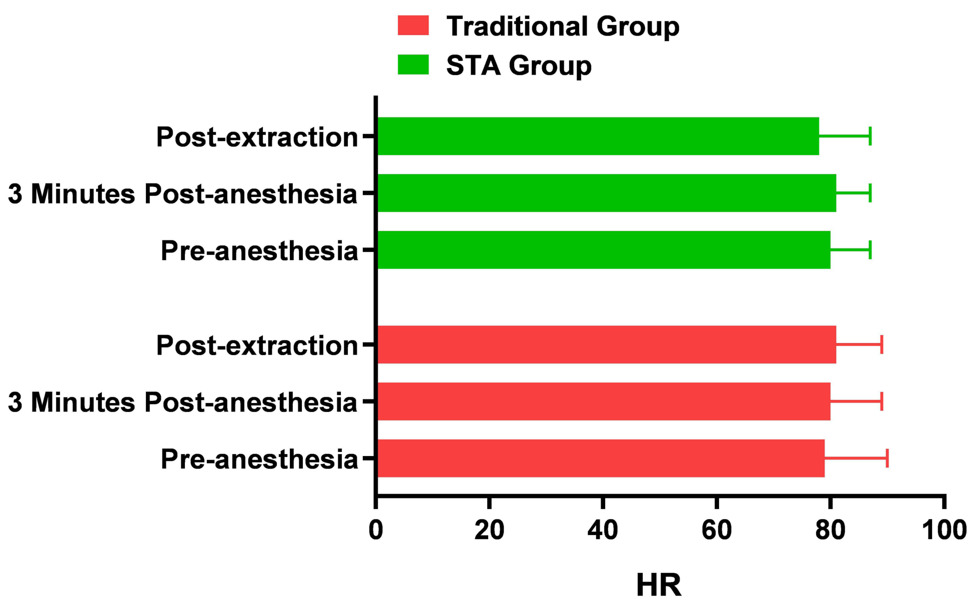

Figure 3 Comparison of HR Changes at Different Time Points ($\bar{x} \pm s$, beats/min).

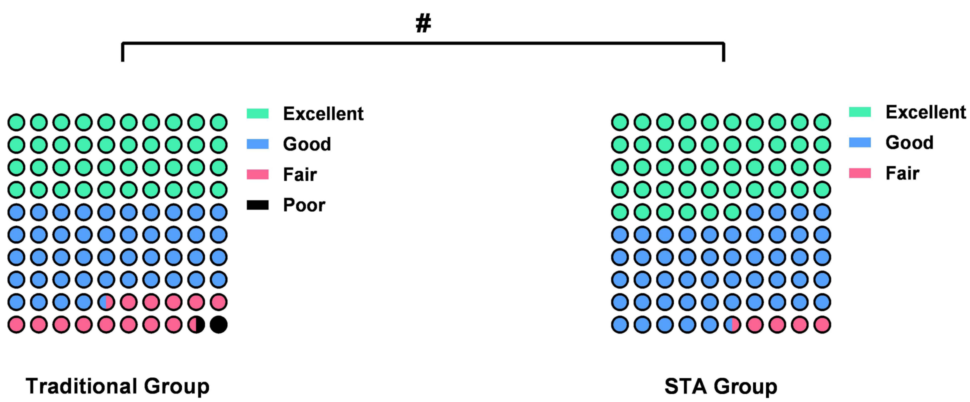

Figure 4 Comparison of Pain Levels [n(%)].
Note: Group comparison, #P<0.05.

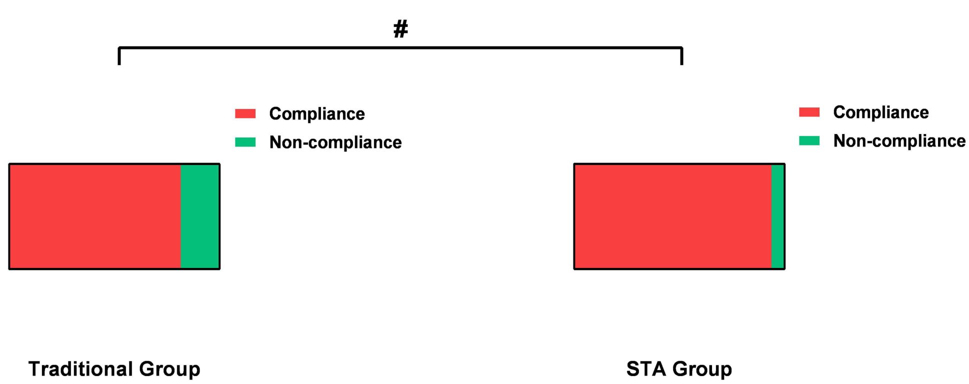

Figure 5 Comparison of Compliance [n(%)].
Note: Group comparison, #P<0.05.

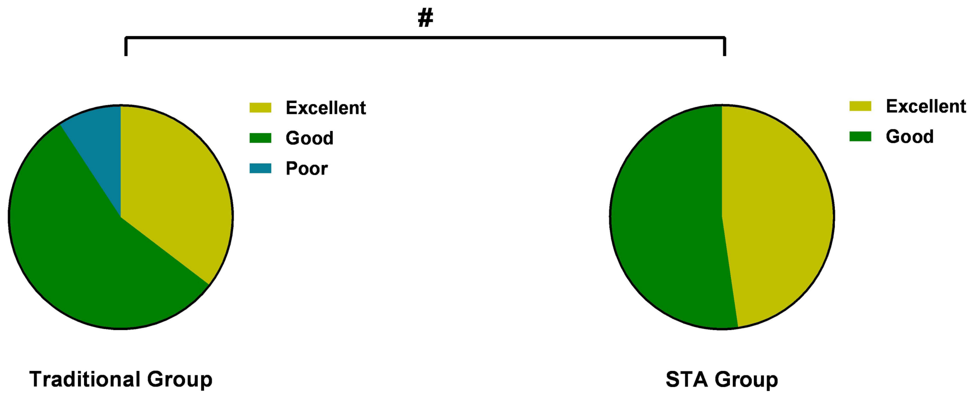

Figure 6 Comparison of Tolerance [n(%)].
Note: Group comparison, #P<0.05.

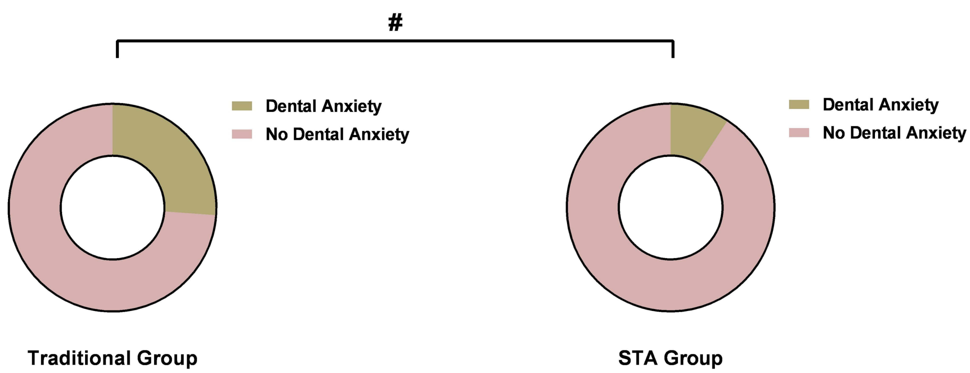

Figure 7 Comparison of Anxiety Levels [n(%)].
Note: Group comparison, #P<0.05.

Discussion

Currently, amide local anesthetics such as mepivacaine are widely used in clinical oral extraction anesthesia due to their minimal toxic side effects and prolonged anesthetic effects.[15,16] These anesthetics provide pain-free oral extraction treatments, offering patients a more comfortable treatment experience. However, although traditional local anesthesia methods can alleviate pain during oral extraction, they cannot avoid the pain experienced during pre-extraction local anesthesia. The preoperative anesthesia pain not only increases the patient's fear and anxiety but may also lead to a decrease in the patient's trust in oral treatment, thereby affecting cooperation during the procedure and the efficacy of anesthesia.[17–19] Therefore, how to alleviate preoperative suffering and improve the intraoperative experience through innovative anesthesia techniques has become an urgent issue in the field of oral anesthesia. Traditional local anesthesia methods usually use hand-operated injectors with metal cartridges, which are often accompanied by sharp sensations and discomfort. The main reasons for this are the mechanical injury caused by the needle and the rapid injection of the anesthetic, where the high-speed flow of the liquid and the acidic nature of the drug often irritate the oral mucosa, causing significant pain.[20,21] In contrast, STA anesthesia technology, as a new local anesthesia infusion device, employs a computer-controlled system and dynamic pressure sensing technology, allowing for pre-injection anesthetic preparation. This avoids the rapid drug release process seen in traditional anesthesia, effectively reducing the patient's pain during injection.[22] Recent studies, including Al-Ahmari et al (2024), have shown that CCLAD systems like STA not only provide better pain control during injection but also improve patients' psychological comfort and reduce overall treatment-related anxiety compared to conventional syringes.[23] By precisely controlling the flow rate and pressure of the anesthetic, STA technology not only prevents common pain issues during local anesthesia but also reduces the possibility of hematomas and other adverse reactions caused by the injection process.[24] Therefore, STA anesthesia technology has significant advantages in improving the patient's anesthesia experience. The results of this study showed that there were no significant differences between the traditional group and the STA group in terms of tooth extraction bleeding volume, duration of local anesthesia effect, or local anesthesia infiltration area (P>0.05), consistent with previous related studies.[25] This further confirms that STA anesthesia technology is comparable to traditional anesthesia methods in terms of local anesthesia effectiveness and drug efficacy duration. It is noteworthy that, in terms of blood pressure and heart rate changes, patients in the traditional group showed significant increases in SBP after 3 minutes of anesthesia and after tooth extraction compared to pre-anesthesia levels (P<0.05). In contrast, in the STA group, there were no significant fluctuations in SBP, DBP, or HR at any of the measured time points (P>0.05). This finding suggests that the STA group had more stable blood pressure, with no common blood pressure fluctuations or increases that are often observed with traditional anesthesia methods. This may be closely related to the low-flow, slow-injection characteristics of STA anesthesia, which avoids stress responses caused by rapid drug injection during anesthesia.

Pain is one of the most concerning factors for patients undergoing oral treatments, and pain control during tooth extraction directly affects postoperative recovery and psychological state.[26] This study found that pain control in the STA group was significantly better than in the traditional group (P<0.05), indicating that STA technology exhibited superior efficacy in alleviating intraoperative and postoperative pain. Traditional anesthesia methods often cause discomfort during drug injection, such as piercing pain and a burning sensation at the injection site. This discomfort can exacerbate patients' anxiety, thereby affecting anesthesia efficacy. STA anesthesia technology, through precise control of drug flow rate and pressure, releases the drug slowly and steadily, avoiding the sharp diffusion of drugs,[27] which significantly reduces intraoperative discomfort and effectively alleviates pain. Especially postoperatively, STA anesthesia technology can reduce postoperative inflammation by minimizing local tissue damage and the irritating effects of the injection,[28] thereby further reducing the patient's pain perception. Meanwhile, anxiety during oral treatment is another important factor that influences the patient's treatment experience. Many patients, when receiving traditional local anesthesia, experience significant anxiety due to the pain and discomfort during the injection process, which affects treatment compliance.[29,30] The results of this study showed that the prevalence of dental anxiety in the STA group was significantly lower than in the traditional group (P<0.05), indicating that STA anesthesia not only alleviated pain physiologically but also effectively reduced patients' fear and anxiety psychologically. As STA anesthesia uses a slow and uniform drug release method, patients no longer experience sharp pain or injection fear during anesthesia, thereby lowering anxiety levels and enhancing their trust in treatment. Additionally, this study found that the STA group performed better in terms of treatment compliance and tolerance, with significantly higher compliance and tolerance scores compared to the traditional group (P<0.05). This result is consistent with previous related studies.[31,32] The reason for this may be closely related to the comfortable anesthesia experience provided by STA technology. Due to the fine control offered by STA, patients experience less pain throughout the treatment, and their psychological burden is also relatively reduced. Thus, treatment cooperation and intraoperative tolerance naturally improve. Higher compliance and tolerance not only ensure the smooth progress of treatment but also provide a good foundation for postoperative recovery, reducing the occurrence of complications and promoting faster recovery.

Although this study provides strong data support for the clinical application of STA anesthesia technology, it still has some limitations. First, this study is a single-center, retrospective analysis, and patients were not randomized into groups, which may lead to selection bias and reduce the external validity of the findings. Second, the lack of blinding in the anesthesia and evaluation processes might have introduced observer bias during data collection and subjective outcome assessments. Third, the anesthesia procedures were all performed by a single operator, which, although ensuring consistency, also limits the generalizability of the results. Fourth, this study did not conduct reproducibility testing, and thus the consistency of the anesthesia effects across different practitioners and settings remains to be verified. Additionally, the sample size was relatively small and focused only on a single surgical procedure—impacted tooth extraction. Future studies should consider adopting randomized, double-blinded controlled trial designs with multi-center participation and larger sample sizes, to enhance the robustness and generalizability of the results. Furthermore, it is recommended to evaluate the impact of various patient-related factors (eg, age, sex, baseline anxiety levels, comorbidities) on the efficacy of different anesthesia methods. In summary, STA anesthesia technology has shown significant advantages in oral outpatient tooth extraction surgeries, particularly in reducing pain and anxiety, and improving treatment compliance and tolerance. Given these advantages, STA anesthesia is a promising technique worth further clinical promotion, especially for anxious patients. With the optimization of its technology and the accumulation of clinical experience, STA anesthesia may be more widely applied in various oral surgical procedures, contributing to safer and more comfortable patient experiences.

Conclusion

This study demonstrates that the STA technique offers potential advantages over traditional local injection anesthesia in the outpatient extraction of mandibular impacted teeth. Compared to the traditional method, STA was associated with lower pain scores, reduced patient anxiety, improved compliance and tolerance, and more stable vital signs during the procedure. These findings suggest that STA is a feasible and effective anesthesia method in dental outpatient settings. However, as this study is a retrospective analysis, it carries a higher risk of bias. Therefore, the results should be interpreted with caution and should not be considered definitive evidence of treatment efficacy. Further large-scale, prospective, multi-center studies are warranted to validate these findings and to explore the broader applicability of STA in various clinical scenarios.

Disclosure

The authors report no conflicts of interest in this work.

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