IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 25, Issue 9 Ser. 2 (September. 2026), PP 29-38
www.iosrjournals.org

Chronic Stress, Anxiety, and Endodontic Pain: An Integrative Review of Neurobiological Mechanisms and Clinical Implications

Patrícia Aparecida Frezarin[1], Ana Vitória De Oliveira Neves,[1]
Arnaldo Sant Anna Júnior [1]
[1](University Center North Of São Paulo (UNORTE), São José Do Rio Preto,SP, Brazil).

Abstract: *Endodontic pain is a multifactorial experience influenced by inflammatory, neural, procedural, and psychological factors. Chronic stress and anxiety may modify nociceptive processing, contributing to increased pain anticipation, perception, and persistence. This narrative review aimed to analyze current evidence regarding the influence of chronic stress and anxiety on endodontic pain and its clinical management. The findings indicate that pulpal and periapical inflammation activates trigeminal nociceptive pathways, while prolonged stress may alter pain modulation through dysregulation of the hypothalamic–pituitary–adrenal axis, cortisol signaling, neuroinflammation, and changes in descending pain control. Dental anxiety, negative expectations, previous painful experiences, and perceived lack of control may further intensify procedural and postoperative pain. However, the reported associations remain heterogeneous because of differences in clinical conditions, psychological instruments, and pain assessment methods. Current evidence supports the inclusion of anxiety assessment, patient-centered communication, and individualized pain control in endodontic care. Relaxation techniques, cognitive-behavioral strategies, appropriate procedural information, and nitrous oxide sedation may reduce anxiety and improve patient comfort in selected cases. In summary, chronic stress and anxiety are clinically relevant modulators of endodontic pain. Further prospective studies using standardized psychological, biological, and pain-related measures are required to clarify these relationships and support more individualized treatment strategies.*

Key Word*: Chronic stress; Dental anxiety; Endodontic pain; Pain perception; Root canal treatment..*

Date of Submission: 04-09-2026 Date of Acceptance: 14-09-2026

I. Introduction

Endodontic pain is a complex and multidimensional experience arising from the interaction between pulpal or periapical inflammation, nociceptive signaling, and individual factors that influence pain interpretation. Inflammatory processes within the dental pulp activate myelinated A-delta fibers and unmyelinated C fibers, producing pain that may vary from sharp and well localized to diffuse, spontaneous, or throbbing. Although root canal treatment is intended to eliminate infection, control inflammation, and preserve the affected tooth, pain may occur before, during, or after the procedure. Therefore, adequate endodontic pain management requires not only accurate diagnosis and technical intervention but also consideration of the individual characteristics that shape the patient's painful experience [1,2].

Among these characteristics, dental anxiety represents an important challenge in endodontic practice. It involves apprehension, tension, and negative expectations associated with the anticipation or performance of dental procedures. Root canal treatment is frequently perceived as one of the most anxiety-provoking dental interventions, particularly because it is commonly associated with pain, prolonged chair time, local anesthesia, and previous negative experiences. Dental anxiety may consequently reduce patient cooperation, increase emotional distress, and contribute to the postponement or avoidance of dental care, potentially allowing pulpal or periapical disease to progress [3,4].

The relationship between anxiety and pain appears to be bidirectional. Patients experiencing preoperative pain may develop greater anxiety about the procedure, while highly anxious individuals may anticipate more severe pain, display increased vigilance toward bodily sensations, and interpret nociceptive stimuli as more threatening. Evidence indicates that dental anxiety may be positively associated with pain before and during endodontic treatment, although the certainty of the available evidence remains limited because of the small number of studies and methodological heterogeneity. These findings suggest that endodontic pain cannot be fully understood through biological and clinical variables alone, as cognitive and emotional responses may influence both expected and experienced pain [3,4].

Chronic stress may further contribute to pain modulation through neuroendocrine, autonomic, and immune mechanisms. Prolonged exposure to psychological stress can disrupt the hypothalamic–pituitary–adrenal axis and alter cortisol regulation, inflammatory signaling, and central pain-processing pathways. Unlike

acute stress, which may temporarily suppress or intensify pain depending on the context, persistent stress may impair endogenous pain inhibition and favor hypervigilance, neuroinflammation, and increased pain sensitivity. Because anxiety and chronic stress often coexist, their combined effects may increase vulnerability to more intense or persistent painful experiences during endodontic disease and treatment [5,6].

Despite advances in endodontic techniques, anesthesia, pharmacological therapy, and infection control, pain management remains focused predominantly on local pathological and procedural factors. The psychological and neurobiological effects of chronic stress and anxiety are still insufficiently integrated into clinical assessment, particularly in patients presenting with acute pulpal or periapical pain. A better understanding of these relationships may support early identification of susceptible patients, improve professional–patient communication, guide individualized pain-control strategies, and reduce treatment avoidance. Therefore, this integrative review aims to examine the influence of chronic stress and anxiety on endodontic pain, with particular emphasis on the underlying neurobiological mechanisms and their implications for clinical practice [2,4].

II. Material And Methods

This study is a narrative literature review based on the selection and critical analysis of scientific publications addressing chronic stress, anxiety, and pain associated with endodontic conditions and procedures. The literature search was conducted in multiple electronic databases, including PubMed/MEDLINE, Scopus, Google Scholar, and Embase. The search strategy employed descriptors and related terms such as *chronic stress*, *psychological stress*, *anxiety*, *dental anxiety*, *endodontic pain*, *root canal treatment*, *postoperative pain*, *pain perception*, *nociception*, *cortisol*, *hypothalamic–pituitary–adrenal axis*, and *pain modulation*. These terms were combined using the Boolean operators "AND" and "OR" to identify studies relevant to the proposed topic.

Eligible publications comprised full-text articles written in English and published in peer-reviewed scientific journals. Experimental studies, observational investigations, clinical trials, systematic and narrative reviews, and other studies relevant to the neurobiological, inflammatory, psychological, and clinical aspects of endodontic pain were considered. Publications were included when they examined the association between stress or anxiety and pain perception, nociceptive modulation, pulpal or periapical inflammation, pain during root canal treatment, postoperative endodontic pain, or strategies for managing anxiety and pain in dental practice. Studies whose content was unrelated to endodontic pain or that did not contribute to understanding the interactions among stress, anxiety, and pain modulation were excluded. The selection process involved a critical assessment of each publication based on its relevance to the review question, methodological characteristics, scientific consistency, and contribution to the proposed conceptual framework. Reference lists of the selected articles were also examined to identify additional pertinent publications.

The extracted information was organized into four thematic areas: pathophysiological mechanisms and factors associated with endodontic pain; neurobiological modulation of pain by chronic stress; psychological contributions to endodontic pain, particularly anxiety and pain anticipation; and clinical strategies for managing stress, anxiety, and pain during endodontic treatment. This approach supported the development of an integrated narrative concerning the biological, psychological, and clinical pathways through which chronic stress and anxiety may influence the endodontic pain experience.

III. Results and Discussion

Endodontic Pain: Pathophysiological Mechanisms and Associated Factors

Endodontic pain is a complex clinical phenomenon arising from inflammatory and neural changes in the dental pulp and periradicular tissues. Dental caries, trauma, restorative procedures, microbial invasion, and endodontic interventions can disrupt tissue homeostasis and initiate nociceptive signaling. However, the relationship between tissue damage and pain is not linear, because patients with apparently similar clinical conditions may report substantially different pain intensities. Clinical evidence indicates that pain is influenced by the biological condition of the tooth, the presence of previous symptoms, anatomical location, treatment-related factors, and individual patient characteristics [7,8].

Inflammation has a central role in the development of pulpal pain. Microbial components and tissue injury stimulate pulpal cells to produce cytokines, chemokines, prostaglandins, neuropeptides, and other mediators that coordinate immune-cell recruitment and vascular responses. In human pulp samples, tumour necrosis factor-α gene expression was significantly greater in teeth diagnosed with irreversible pulpitis than in healthy teeth or teeth with reversible pulpitis. This association between inflammatory mediator expression and symptom severity indicates that progression of pulpitis involves qualitative and quantitative changes in local inflammatory signaling [9].

Neurogenic mediators also contribute to the interaction between inflammation and nociception. Substance P, neurokinin A, and calcitonin gene-related peptide can be released from sensory nerve terminals and participate in vasodilation, plasma extravasation, immune-cell activation, and peripheral sensitization.

Human pulp tissue collected from painful teeth has demonstrated altered concentrations of these neuropeptides compared with healthy pulp, supporting the participation of pulpal nerves in both pain transmission and local inflammatory regulation. Consequently, pain associated with pulpitis reflects not only activation of sensory fibers by tissue injury but also reciprocal communication between neural and immune components [10].

The anatomical characteristics of the dental pulp may intensify the consequences of inflammation. Because the pulp is enclosed by rigid dentinal walls, inflammatory increases in vascular permeability and tissue fluid cannot be accommodated as readily as in more compliant connective tissues. Increased interstitial pressure, alterations in local blood flow, hypoxia, accumulation of inflammatory mediators, and progressive tissue injury may therefore accompany severe pulpitis. Nevertheless, pulpal inflammation is spatially heterogeneous, and clinical symptoms do not always accurately represent the histological condition of the entire pulp. Thus, pain intensity alone should not be interpreted as a precise measure of the extent or reversibility of pulpal damage [9,10].

Dental pulp is densely innervated by myelinated and unmyelinated primary sensory fibers. Experimental electrophysiological findings indicate that intradental A-fibers and C-fibers have distinct activation characteristics. A-fibers, particularly Aδ fibers located near the pulp–dentin border, are generally activated by dentinal stimulation and are associated with rapid, sharp, and relatively well-localized pain. C-fibers are distributed more deeply within the pulp, respond to intense stimulation and inflammatory mediators, and are associated with slower, diffuse, aching, or radiating pain. These functional differences help explain why brief sensitivity to external stimuli may evolve into spontaneous and persistent pain as pulpal inflammation progresses [11].

Histological and molecular evidence also demonstrates that the human dental pulp contains a considerable population of unmyelinated sensory fibers with specialized sodium-channel organization. These neuronal characteristics facilitate the generation and propagation of nociceptive impulses under inflammatory conditions. Inflammation can reduce activation thresholds and increase neuronal excitability, allowing previously innocuous or weak stimuli to produce pain. This process, known as peripheral sensitization, may contribute to spontaneous pain, thermal hyperalgesia, and prolonged discomfort in symptomatic pulpitis [10,12].

Stimuli applied to dentin may reach sensory neurons through more than one transduction mechanism. Fluid displacement within dentinal tubules can mechanically affect structures near the pulp–dentin interface, providing a physiological basis for the hydrodynamic explanation of dentinal sensitivity. Experimental findings also suggest an active sensory role for odontoblasts. Human odontoblast-like cells express mechanosensitive transient receptor potential channels, and stimulation of these channels can induce ATP release. Because ATP can activate purinergic receptors on adjacent trigeminal sensory endings, odontoblasts may participate in the conversion of mechanical or thermal changes into neuronal signals. These mechanisms are not necessarily mutually exclusive and may function together within the pulp–dentin complex [13].

Following root canal treatment, pain is usually associated with an acute inflammatory response in the periradicular tissues. Instrumentation, irrigation, intracanal medication, obturation, microbial persistence, and extrusion of debris or filling materials beyond the apical foramen may produce mechanical, chemical, or microbial irritation. These stimuli can activate resident immune cells and sensitize periapical nociceptive terminals, resulting in tenderness to percussion, pain during mastication, or spontaneous postoperative pain. Nevertheless, the presence of an operative event does not necessarily produce clinically relevant pain in every patient, indicating that postoperative symptoms emerge from the interaction of multiple factors [7,14].

Preoperative pain is one of the most consistent predictors of postoperative symptoms. In a prospective clinical study, patients presenting higher pain intensity before root canal treatment were more likely to report greater postoperative pain. Previous pain may indicate an established inflammatory response and peripheral sensitization before treatment begins, increasing the probability that mechanical or chemical stimulation during the procedure will maintain nociceptive activity. This association does not necessarily imply procedural failure, because early postoperative discomfort may represent a continuation or temporary exacerbation of the pre-existing inflammatory condition [8].

Tooth-related and procedural characteristics may also modify postoperative pain. A prospective study of 500 root canal treatments found that previous pain, molar location, mandibular teeth, emergency treatment, and occlusal contact were among the variables associated with different dimensions of post-endodontic pain. Another clinical investigation identified preoperative symptoms as a significant factor and suggested that reciprocating instrumentation combined with sealer extrusion could increase postoperative discomfort. Therefore, the effect of a specific instrument or technique should not be evaluated independently of diagnosis, preoperative symptoms, apical conditions, obturation quality, and other clinical variables [7,14].

Operator-related and technical factors may further contribute to variability in postoperative pain. In a prospective study using reciprocating instrumentation, postoperative symptoms were influenced by the clinical context in which treatment was performed, while patients with greater preoperative pain consistently presented more postoperative discomfort. Clinical prediction models have similarly incorporated patient characteristics,

inflammatory status, tooth location, pulp vitality, percussion sensitivity, and technical factors such as underfilling, overfilling, or missed canals. These findings reinforce that postoperative pain cannot be attributed to a single biological or procedural cause [15,16].

Overall, endodontic pain results from interactions among microbial injury, inflammatory mediators, neurogenic inflammation, peripheral sensitization, intradental sensory transduction, clinical diagnosis, and treatment-related irritation. Preoperative symptoms should receive particular attention because they repeatedly emerge as predictors of postoperative pain. A comprehensive assessment should therefore integrate pulpal and periapical diagnosis, pain history, tooth location, percussion sensitivity, technical findings, and patient-related variables. Such an approach is more consistent with the multifactorial nature of endodontic pain and may improve patient communication, procedural planning, and postoperative management [7,8,16].

Chronic Stress and Neurobiological Modulation of Pain

Stress is a coordinated physiological and behavioral response to actual or anticipated demands that challenge an individual's capacity to maintain internal stability. During acute stress, sympathetic activation and hypothalamic–pituitary–adrenal axis activity mobilize energy, increase cardiovascular output, and enhance vigilance. In controlled laboratory conditions, exposure to psychosocial stress produces measurable elevations in adrenocorticotropic hormone and cortisol, demonstrating the integration of psychological appraisal with neuroendocrine responses. Although this response is initially adaptive, its effects depend on the intensity, duration, predictability, and controllability of the stressor [17].

Activation of the hypothalamic–pituitary–adrenal axis involves hypothalamic secretion of corticotropin-releasing hormone, stimulation of adrenocorticotropic hormone release from the anterior pituitary gland, and subsequent glucocorticoid production by the adrenal cortex. Cortisol mobilizes metabolic substrates and regulates cardiovascular, immune, and neural processes. Its secretion is controlled by negative feedback and varies according to the time of day. However, repeated exposure does not produce identical responses in every individual. Experimental studies have identified subgroups with persistently high cortisol responses during repeated psychosocial stress, indicating that adaptation of the hypothalamic–pituitary–adrenal axis is influenced by individual response patterns [17,18].

Chronic or repeated activation of stress systems may modify pain through neuroendocrine, autonomic, and peripheral nociceptive mechanisms. In an experimental animal model, repeated sound stress enhanced inflammatory pain even after the termination of the stress exposure. This effect was associated with sympathoadrenal activation and increased sensitivity of peripheral nociceptive mechanisms. Therefore, stress-induced hyperalgesia does not necessarily require additional tissue injury at the painful site; persistent neuroendocrine alterations may amplify the nociceptive response to a pre-existing inflammatory stimulus [19].

The effect of stress on pain is not exclusively hyperalgesic. Acute stress may temporarily suppress nociceptive responses through stress-induced analgesia, an adaptive mechanism that allows an organism to respond to an immediate threat despite injury. In healthy individuals, experimentally induced stress increased heat-pain thresholds, particularly among participants who exhibited a measurable cortisol response. The magnitude of this hypoalgesic effect was predicted by cortisol reactivity and fear of pain, demonstrating that endocrine and psychological responses jointly influence acute pain modulation [20].

When stress is repetitive or uncontrollable, the direction of pain modulation may shift from analgesia toward facilitation. Animal experiments have shown that repeated restraint stress can produce delayed and persistent hyperalgesia. Additional electrophysiological evidence indicates that stress-induced hyperalgesia involves increased activity of pain-facilitating neurons in the rostral ventromedial medulla. These findings demonstrate that stress can alter descending pain-control circuits and amplify nociceptive transmission at the spinal level rather than acting only through peripheral inflammatory mechanisms [21,22].

The rostral ventromedial medulla represents a major output region of the descending pain-modulatory system. Its neuronal populations can either inhibit or facilitate spinal nociceptive processing according to behavioral and physiological context. Experimental activation of descending facilitation from this region contributes to the maintenance of neuropathic pain, showing that pain modulation is not exclusively inhibitory. Persistent stress may therefore disturb the balance between descending inhibition and facilitation, creating conditions in which nociceptive signals receive greater central amplification [22,23].

Neuroimmune signaling provides an additional connection between repeated stress and pain sensitization. In mice exposed to repeated social-defeat stress, microglial activation and inflammatory signaling increased within the spinal cord and were accompanied by enhanced pain behavior. Interventions that reduced microglial activation attenuated stress-associated hypersensitivity, supporting a causal contribution of spinal neuroinflammation. These findings indicate that repeated psychosocial stress can alter nociceptive circuits through communication among immune cells, glial cells, and neurons [24].

Clinical neuroimaging evidence also supports an interaction among persistent pain, cortisol regulation, and corticolimbic structures. Patients with chronic back pain demonstrated higher basal cortisol concentrations

than pain-free controls. Within the chronic-pain group, higher cortisol was associated with smaller hippocampal volume and stronger pain-related activation in the hippocampal and parahippocampal regions. These findings do not establish a simple unidirectional causal pathway, but they demonstrate that persistent pain and altered stress physiology are associated with structural and functional differences in brain regions involved in memory, contextual processing, and hypothalamic–pituitary–adrenal feedback [25].

The transition from acute stress-induced analgesia to stress-induced hyperalgesia has also been observed in clinical populations. When exposed to a cognitive stressor, pain-free individuals demonstrated an elevation in pain threshold, consistent with stress-induced analgesia. In contrast, patients with chronic musculoskeletal pain failed to exhibit this analgesic response and reported greater pain intensity after stress exposure. These results suggest that chronic pain may alter the normal relationship between stress and endogenous pain control, shifting pain modulation toward facilitation in susceptible individuals [26].

The relationship between chronic stress and pain should therefore be understood as bidirectional. Repeated stress can increase pain sensitivity through peripheral nociceptor sensitization, descending facilitation, neuroinflammatory signaling, and maladaptive cortisol responses. At the same time, persistent pain can act as a continuing stressor and sustain neuroendocrine and corticolimbic alterations. The direction and magnitude of this interaction vary among individuals, which helps explain why stress can produce analgesia in one context and hyperalgesia in another [19,25,26].

In Endodontics, these mechanisms provide a plausible framework for understanding why patients with similar pulpal or periapical conditions may report different pain intensities. Chronic stress may increase attention to threatening sensations, impair endogenous pain inhibition, and amplify the central processing of inflammatory nociceptive input from dental tissues. Nevertheless, the studies described above were predominantly conducted in experimental pain models or in patients with non-odontogenic chronic pain. Their findings should therefore not be interpreted as direct proof that chronic stress causes greater endodontic pain. Specific clinical studies combining validated stress measures, cortisol profiles, anxiety assessment, pulpal and periapical diagnoses, and longitudinal pain evaluation are required to establish this relationship in endodontic populations.

Dental Anxiety and Endodontic Pain Perception

Dental anxiety is a multidimensional response involving fear, apprehension, physiological arousal, and negative expectations related to dental care. Its development has been associated with previous painful experiences, limited knowledge about treatment, perceived lack of control, fear of injections and instruments, and the anticipation of procedural pain. In patients with irreversible pulpitis, higher anxiety has also been associated with previous painful dental experiences and a greater tendency to postpone appointments, potentially reinforcing a cycle in which avoidance contributes to worsening oral conditions and the subsequent need for more invasive interventions [27,28].

Root canal treatment is particularly affected by negative social beliefs concerning pain. Patients may approach the procedure expecting an experience considerably more painful than the pain subsequently reported. In a clinical investigation of anticipated and experienced endodontic pain, a substantial proportion of patients expected high levels of pain, whereas fewer patients actually reported severe pain during treatment. Similarly, anxiety levels have been positively associated with expected pain intensity, suggesting that anxiety may influence pain appraisal even before nociceptive stimulation begins [29,30].

The association between anxiety and pain is also evident during endodontic procedures. Among adults with irreversible pulpitis, greater dental anxiety was associated with pain reported before and during treatment. In another clinical study involving 180 patients, anxiety was positively correlated with intraoperative pain, and patients with higher anxiety presented a substantially greater probability of experiencing moderate or severe pain during root canal treatment. These findings indicate that preoperative anxiety may function as a clinically relevant predictor of procedural pain rather than merely representing an emotional consequence of existing dental symptoms [28,31].

Anticipated pain may influence the patient's experience by increasing attention to threatening sensations and strengthening avoidance behavior. Patients who expect intense pain may monitor the procedure more closely, interpret ambiguous sensations as threatening, and experience greater difficulty tolerating discomfort. In a study of 101 patients undergoing endodontic therapy, anticipated pain predicted pain reported during and after treatment and showed an even stronger relationship with treatment avoidance. Pain anticipation was significantly greater than the pain effectively experienced, demonstrating that expectations established before treatment can shape both sensory reports and behavioral responses [32].

The same study examined self-efficacy, defined as the patient's perceived ability to cope successfully with a challenging situation. Self-efficacy did not directly predict pain intensity but moderated the association between anticipated pain and avoidance during treatment. One possible interpretation is that patients with a strong need for personal control may experience greater discomfort when required to transfer control of the

situation to the dental professional. Nevertheless, this result requires caution because evidence concerning patient self-efficacy in endodontics remains limited, and the direction of its relationship with avoidance may depend on contextual characteristics and the quality of the patient–clinician relationship [32].

Psychological factors may continue to influence pain after completion of the procedure. In patients receiving single-visit root canal treatment for asymptomatic necrotic mandibular molars, dental anxiety and dental fear exerted direct effects on postoperative pain, while previous negative dental experiences influenced pain indirectly through these psychological variables. These findings indicate that postoperative pain cannot be explained exclusively by diagnosis, instrumentation, irrigation, or tissue inflammation, because patients' previous experiences and emotional responses also contribute to its variability [33].

More recent prospective evidence supports this relationship in symptomatic teeth. Among 132 patients treated for vital symptomatic mandibular molars, individuals with high preoperative anxiety reported greater pain during the early postoperative period and consumed more analgesics. After adjustment for age, sex, preoperative pain, and analgesic intake, high anxiety remained significantly associated with pain on the first postoperative day. Differences between anxiety groups were mainly observed during the first three days and subsequently diminished, suggesting that psychological factors may have their strongest influence during the initial stage of postoperative recovery [34].

The relationship between psychological status and dental pain may involve subjective and central processes rather than being fully explained by peripheral tissue injury or changes in cardiovascular parameters. Dental fear has been associated with increased pressure-pain sensitivity, while pain anxiety, mental pain, and dental anxiety have been related to differences in the perception of dental pain. These findings support the view that attentional focus, emotional appraisal, previous learning, and individual sensitivity can modify the processing and reporting of nociceptive information. However, these associations should not be interpreted as evidence that pain is imaginary; instead, they demonstrate that pain represents an authentic experience produced through interaction between biological and psychological mechanisms [35,36].

Individual characteristics may further modify this relationship. Some investigations have found higher anxiety or pain expectations among women, although differences in the pain effectively experienced are not always significant. This inconsistency indicates that sex should not be treated as an isolated determinant of endodontic pain. Its influence may interact with anxiety, previous experiences, coping strategies, clinical diagnosis, and expectations regarding treatment. Therefore, psychological assessment should focus on the individual patient rather than relying exclusively on demographic characteristics to estimate the risk of procedural or postoperative pain [29,31].

From a clinical perspective, assessment of dental anxiety and anticipated pain before endodontic treatment may enable more individualized care. Validated instruments such as the Modified Dental Anxiety Scale can assist in identifying patients who may benefit from detailed procedural explanations, greater participation in treatment decisions, behavioral coping strategies, supplemental anesthetic planning, or closer postoperative monitoring. Nevertheless, differences among anxiety scales, pain measures, and assessment time points remain important methodological limitations. Future studies should combine standardized psychological instruments with repeated evaluations of pain before, during, and after treatment to clarify the temporal and potentially bidirectional relationship between anxiety and endodontic pain [33,34,37].

Clinical Implications and Strategies for Managing Stress, Anxiety, and Endodontic Pain

The clinical management of endodontic pain should extend beyond the control of local inflammation and nociceptive input. Anxiety, negative expectations, previous painful experiences, perceived loss of control, and chronic psychological stress may influence how patients anticipate, interpret, and report pain. Therefore, psychological assessment should be incorporated into the preoperative evaluation, particularly in patients reporting intense pain, previous traumatic dental experiences, treatment avoidance, or disproportionate concern about the procedure. Brief validated instruments, such as the Modified Dental Anxiety Scale, can help identify patients who may require additional behavioral or pharmacological support. Nevertheless, anxiety scores should complement rather than replace a comprehensive clinical interview and pulpal and periapical diagnosis [38,39].

Communication is one of the first components of anxiety-sensitive endodontic care. Patients should receive clear and realistic information about the diagnosis, procedural steps, anesthesia, expected sensations, treatment duration, and postoperative course. Explanations should avoid reinforcing catastrophic expectations or guaranteeing a completely painless procedure. Instead, clinicians may establish a sense of predictability and control by agreeing on a stop signal, allowing brief pauses, checking discomfort throughout treatment, and explaining sensations before they occur. Experimental evidence indicates that mentally rehearsing the sequence of a dental consultation may reduce anticipatory anxiety, while recent endodontic evidence suggests that video-based pretreatment information can decrease self-reported anxiety and electrodermal activity. However, the amount and format of information should be individualized because highly detailed descriptions may increase distress in some patients [40,41].

Nonpharmacological strategies may be introduced before or during treatment according to the patient's anxiety level and preferences. Slow breathing, progressive muscle relaxation, guided imagery, distraction, and brief meditation are low-cost approaches that can reduce physiological arousal and redirect attention away from threatening stimuli. In a randomized clinical trial involving patients undergoing root canal treatment, a single session combining controlled breathing and guided meditation produced a greater reduction in anxiety than alprazolam or placebo. Nevertheless, this study had a small sample and an open-label design for the relaxation intervention, and its results should therefore be interpreted cautiously. In a separate randomized trial involving anxious periodontal patients, progressive muscle relaxation reduced anxiety and was accompanied by favorable changes in blood pressure, pulse rate, and salivary cortisol. Although this second study was not conducted in Endodontics, it supports the potential application of structured relaxation in dental settings [42,43].

Patients with persistent moderate or severe dental anxiety may require more structured psychological interventions. Cognitive-behavioral approaches seek to identify catastrophic beliefs, modify maladaptive interpretations, increase perceived control, and gradually reduce avoidance through controlled exposure to feared dental stimuli. In a randomized clinical trial, a brief cognitive-behavioral intervention delivered in a private dental clinic reduced dental fear and enabled several participants to undergo dental treatment. These methods may be particularly relevant for individuals with repeated appointment cancellations, dental phobia, or anxiety that cannot be adequately controlled through communication and brief relaxation alone. When anxiety is severe, associated with trauma, or accompanied by a broader psychiatric condition, referral to a psychologist or psychiatrist should be considered as part of interdisciplinary care [44].

Effective local anesthesia is another essential component of psychological management because inadequate anesthesia may reinforce fear, hypervigilance, and negative expectations regarding future treatment. This is especially important in mandibular teeth with symptomatic irreversible pulpitis, in which conventional inferior alveolar nerve block has limited and variable success. Profound lip numbness does not necessarily indicate complete pulpal anesthesia; therefore, anesthesia should be confirmed before access preparation, and supplemental techniques should be available when pain persists. Clinicians should also avoid interpreting pain during treatment as merely psychological, since anxiety may amplify pain but does not exclude an inflammatory or anesthetic cause. Anxiety management and adequate local anesthesia should consequently be regarded as complementary aspects of patient-centered pain control [45,46].

Nitrous oxide–oxygen inhalation sedation may be considered for highly anxious patients who remain cooperative but require additional anxiolysis during endodontic treatment. In a randomized clinical trial involving highly anxious patients with irreversible pulpitis, the administration of 30%–50% nitrous oxide reduced anxiety and pain during local anesthetic injection and endodontic access compared with local anesthesia alone. Another randomized study found that nitrous oxide increased the success of inferior alveolar nerve block in mandibular posterior teeth with symptomatic irreversible pulpitis from 28% in the placebo group to 50% in the intervention group. These results indicate that nitrous oxide may provide both anxiolytic and analgesic benefits, but the remaining anesthetic failures demonstrate that it should be used as an adjunct rather than as a replacement for profound local anesthesia or supplemental injection techniques [45,47].

Pharmacological anxiety management should be individualized according to anxiety severity, medical history, treatment complexity, and the clinician's training. Oral benzodiazepines and conscious intravenous sedation may be appropriate in selected cases, but their potential effects on psychomotor and respiratory function, need for postoperative supervision, contraindications, and drug interactions must be considered [48.] Nitrous oxide has the clinical advantage of dose titration and relatively rapid onset and recovery, but its administration requires appropriate equipment, patient monitoring, professional training, and adherence to local sedation regulations [47,48]. Sedation should not be used solely to compensate for insufficient communication, inadequate local anesthesia, or unresolved procedural pain. Moreover, patients exposed to chronic stress should not automatically receive pharmacological sedation because chronic stress and procedural dental anxiety represent related but distinct constructs [5,6,27].

A stepped and individualized clinical approach is therefore preferable because no single anxiety-management strategy is universally effective. 48 Patients with mild anxiety may respond to empathetic communication, procedural information, enhanced control, and brief relaxation. Those with moderate anxiety may benefit from structured behavioral interventions, longer appointments, distraction, and, when appropriate, nitrous oxide sedation [40,42,43,47]. Patients presenting severe anxiety, dental phobia, substantial treatment avoidance, or complex psychological comorbidities may require cognitive-behavioral treatment, conscious sedation, or interdisciplinary referral [44,48]. Pain and anxiety should also be reassessed during and after treatment because painful experiences and negative memories may contribute to future anticipatory anxiety and avoidance [27,32]. Follow-up communication, clear analgesic instructions, and accessible professional support in the event of unexpected symptoms may reduce uncertainty and strengthen patient confidence in subsequent care.

Although these interventions are clinically promising, evidence specifically connecting the management of chronic stress with reduced endodontic pain remains limited. Most available endodontic studies have evaluated situational or procedural anxiety rather than prolonged stress exposure, and differences in populations, clinical diagnoses, psychological instruments, and pain-assessment time points limit comparisons among studies [28,31-34]. Some intervention trials have also included relatively small samples or short follow-up periods, reducing the certainty and generalizability of their findings [32,43,47]. Cortisol assessment presents additional limitations because cortisol secretion demonstrates circadian variation, substantial interindividual variability, and sensitivity to acute situational stress [5,17,18,20]. Consequently, routine cortisol testing cannot currently be recommended as a method for evaluating stress-related susceptibility to endodontic pain. Future clinical studies should combine validated measures of chronic stress, dental anxiety, pain expectation, neuroendocrine activity, anesthetic success, and postoperative pain. Until stronger evidence becomes available, psychological screening, effective communication, reliable anesthesia, behavioral interventions, and carefully selected sedation should be integrated into individualized endodontic care [38,40,42-48].

IV. Conclusion

Endodontic pain is a multidimensional experience resulting from interactions among pulpal and periapical inflammation, nociceptive signaling, clinical variables, and individual psychological characteristics. Chronic stress and anxiety may influence this experience by modifying pain expectation, attention to threatening sensations, neuroendocrine activity, inflammatory signaling, and endogenous pain modulation. Consequently, similar clinical conditions may produce different pain intensities among patients.

Current evidence indicates that dental anxiety and anticipated pain are associated with greater procedural and postoperative discomfort in some endodontic populations. However, direct evidence concerning the influence of chronic stress on endodontic pain remains limited, since most available studies have investigated acute or situational dental anxiety. Differences in psychological instruments, pain measures, clinical diagnoses, and assessment periods also prevent definitive conclusions regarding causality.

Endodontic care should therefore combine accurate diagnosis and effective local anesthesia with psychological screening, patient-centered communication, behavioral strategies, and appropriately selected sedation. Recognizing anxiety and chronic stress as potential pain-modulating factors may improve patient comfort, treatment adherence, and clinical decision-making. Further prospective studies using standardized assessments of chronic stress, dental anxiety, neuroendocrine activity, and endodontic pain are required to support more individualized and evidence-based management strategies.

References

[1]. Pak JG, White SN. Pain prevalence and severity before, during, and after root canal treatment: A systematic review. Journal of Endodontics. 2011;37(4):429–438. doi:10.1016/j.joen.2010.12.016.

[2]. Falatah AM, Almalki RS, Al-Qahtani AS, Aljumaah BO, Almihdar WK, Almutairi AS. Comprehensive strategies in endodontic pain management: An integrative narrative review. Cureus. 2023;15(12):e50371. doi:10.7759/cureus.50371.

[3]. Alroomy R, Kim D, Hochberg R, Chubak J, Rosenberg PA, Malek M. Factors influencing pain and anxiety before endodontic treatment: A cross-sectional study amongst American individuals. European Endodontic Journal. 2020;5(3):199–204. doi:10.14744/eej.2020.17363.

[4]. de Farias ZBBM, Campello CP, da Silveira MMF, Moraes SLD, Vasconcelos BCE, Pellizzer EP. The influence of anxiety on pain perception and its repercussion on endodontic treatment: A systematic review. Clinical Oral Investigations. 2023;27(10):5709–5718. doi:10.1007/s00784-023-05181-1.

[5]. Knezevic E, Nenic K, Milanovic V, Knezevic NN. The role of cortisol in chronic stress, neurodegenerative diseases, and psychological disorders. Cells. 2023;12(23):2726. doi:10.3390/cells12232726.

[6]. Bonanno M, Papa D, Cerasa A, Maggio MG, Calabrò RS. Psycho-neuroendocrinology in the rehabilitation field: Focus on the complex interplay between stress and pain. Medicina. 2024;60(2):285. doi:10.3390/medicina60020285.

[7]. Arias A, de la Macorra JC, Hidalgo JJ, Azabal M. Predictive models of pain following root canal treatment: A prospective clinical study. International Endodontic Journal. 2013;46(8):784–793. doi:10.1111/iej.12059.

[8]. Ali A, Olivieri JG, Duran-Sindreu F, Abella F, Roig M, García-Font M. Influence of preoperative pain intensity on postoperative pain after root canal treatment: A prospective clinical study. Journal of Dentistry. 2016;45:39–42. doi:10.1016/j.jdent.2015.12.002.

[9]. Kokkas AB, Goulas A, Varsamidis K, Mirtsou V, Tziafas D. Irreversible but not reversible pulpitis is associated with up-regulation of tumour necrosis factor-alpha gene expression in human pulp. International Endodontic Journal. 2007;40(3):198–203. doi:10.1111/j.1365-2591.2007.01215.x.

[10]. Awawdeh L, Lundy FT, Shaw C, Lamey PJ, Linden GJ, Kennedy JG. Quantitative analysis of substance P, neurokinin A and calcitonin gene-related peptide in pulp tissue from painful and healthy human teeth. International Endodontic Journal. 2002;35(1):30–36. doi:10.1046/j.1365-2591.2002.00451.x.

[11]. Ngassapa DN. Comparison of functional characteristics of intradental A- and C-nerve fibres in dental pain. East African Medical Journal. 1996;73(3):207–209.

[12]. Henry MA, Luo S, Levinson SR. Unmyelinated nerve fibers in the human dental pulp express markers for myelinated fibers and show sodium channel accumulations. BMC Neuroscience. 2012;13:29. doi:10.1186/1471-2202-13-29.

[13]. Egbuniwe O, Grover S, Duggal AK, Mavroudis A, Yazdi M, Renton T, Di Silvio L. TRPA1 and TRPV4 activation in human odontoblasts stimulates ATP release. Journal of Dental Research. 2014;93(9):911–917. doi:10.1177/0022034514544507.
[14]. de Oliveira Damasceno C, da Silveira Bueno CE, De Martin AS, Pelegrine RA, Villela AM, Ruivo LM, Shoji Kato A. Factors associated with post-endodontic treatment pain performed by students in an endodontic graduate program. Iranian Endodontic Journal. 2020;15(4):221–226. doi:10.22037/iej.v15i4.26214.
[15]. García-Font M, Duran-Sindreu F, Morelló S, Irazusta S, Abella F, Roig M, Olivieri JG. Postoperative pain after removal of gutta-percha from root canals in endodontic retreatment using rotary or reciprocating instruments: A prospective clinical study. Clinical Oral Investigations. 2018;22:2623–2631. doi:10.1007/s00784-018-2361-x.
[16]. Gao X, Xin X, Li Z, Zhang W. Predicting postoperative pain following root canal treatment by using artificial neural network evaluation. Scientific Reports. 2021;11:17243. doi:10.1038/s41598-021-96777-8.
[17]. Kirschbaum C, Pirke KM, Hellhammer DH. The Trier Social Stress Test: A tool for investigating psychobiological stress responses in a laboratory setting. Neuropsychobiology. 1993;28(1–2):76–81. doi:10.1159/000119004.
[18]. Kirschbaum C, Pruessner JC, Stone AA, Federenko I, Gaab J, Lintz D, Schommer N, Hellhammer DH. Persistent high cortisol responses to repeated psychological stress in a subpopulation of healthy men. Psychosomatic Medicine. 1995;57(5):468–474. doi:10.1097/00006842-199509000-00009.
[19]. Khasar SG, Green PG, Levine JD. Repeated sound stress enhances inflammatory pain in the rat. Pain. 2005;116(1–2):79–86. doi:10.1016/j.pain.2005.03.040.
[20]. Timmers I, Kaas AL, Quaedflieg CWEM, Biggs EE, Smeets T, de Jong JR. Fear of pain and cortisol reactivity predict the strength of stress-induced hypoalgesia. European Journal of Pain. 2018;22(7):1291–1303. doi:10.1002/ejp.1217.
[21]. da Silva Torres IL, Cucco SNS, Bassani M, Duarte MS, Silveira PP, Vasconcellos AP, Tabajara AS, Dantas G, Fontella FU, Dalmaz C. Long-lasting delayed hyperalgesia after chronic restraint stress in rats: Effect of morphine administration. Neuroscience Research. 2003;45(3):277–283. doi:10.1016/S0168-0102(02)00232-8.
[22]. Martenson ME, Cetas JS, Heinricher MM. A possible neural basis for stress-induced hyperalgesia. Pain. 2009;142(3):236–244. doi:10.1016/j.pain.2009.01.011.
[23]. Burgess SE, Gardell LR, Ossipov MH, Malan TP, Vanderah TW, Lai J, Porreca F. Time-dependent descending facilitation from the rostral ventromedial medulla maintains, but does not initiate, neuropathic pain. Journal of Neuroscience. 2002;22(12):5129–5136. doi:10.1523/JNEUROSCI.22-12-05129.2002.
[24]. Sawicki CM, Kim JK, Weber MD, Faw TD, McKim DB, Madalena KM, Lerch JK, Basso DM, Humeidan ML, Godbout JP, Sheridan JF. Microglia promote increased pain behavior through enhanced inflammation in the spinal cord during repeated social defeat stress. Journal of Neuroscience. 2019;39(7):1139–1149. doi:10.1523/JNEUROSCI.2785-18.2018.
[25]. Vachon-Presseau E, Roy M, Martel MO, Caron E, Marin MF, Chen J, Albouy G, Plante I, Sullivan MJL, Lupien SJ, Rainville P. The stress model of chronic pain: Evidence from basal cortisol and hippocampal structure and function in humans. Brain. 2013;136(3):815–827. doi:10.1093/brain/aws371.
[26]. Löffler M, Schneider P, Schuh-Hofer S, Kamping S, Usai K, Treede RD, Nees F, Flor H. Stress-induced hyperalgesia instead of analgesia in patients with chronic musculoskeletal pain. Neurobiology of Pain. 2023;13:100110. doi:10.1016/j.ynpai.2022.100110.
[27]. Tellez M, Kinner DG, Heimberg RG, Lim S, Ismail AI. Prevalence and correlates of dental anxiety in patients seeking dental care. Community Dentistry and Oral Epidemiology. 2015;43(2):135–142. doi:10.1111/cdoe.12132.
[28]. Dou L, Vanschaayk MM, Zhang Y, Fu X, Ji P, Yang D. The prevalence of dental anxiety and its association with pain and other variables among adult patients with irreversible pulpitis. BMC Oral Health. 2018;18:101. doi:10.1186/s12903-018-0563-x.
[29]. Watkins CA, Logan HL, Kirchner HL. Anticipated and experienced pain associated with endodontic therapy. Journal of the American Dental Association. 2002;133(1):45–54. doi:10.14219/jada.archive.2002.0020.
[30]. Perković I, Romić MK, Perić M, Jukić Krmek S. The level of anxiety and pain perception of endodontic patients. Acta Stomatologica Croatica. 2014;48(4):258–267. doi:10.15644/asc48/4/3.
[31]. Murillo-Benítez M, Martín-González J, Jiménez-Sánchez MC, Cabanillas-Balsera D, Velasco-Ortega E, Segura-Egea JJ. Association between dental anxiety and intraoperative pain during root canal treatment: A cross-sectional study. International Endodontic Journal. 2020;53(4):447–454. doi:10.1111/iej.13245.
[32]. Santos-Puerta N, Peñacoba-Puente C. Pain and avoidance during and after endodontic therapy: The role of pain anticipation and self-efficacy. International Journal of Environmental Research and Public Health. 2022;19(3):1399. doi:10.3390/ijerph19031399.
[33]. Vitali FC, Mafra G, Santos PS, da Fonseca Roberti Garcia L, da Silveira Teixeira C. Patient-related predictors of post-operative pain following root canal treatment: A structural model analysis. International Endodontic Journal. 2024;57(12):1758–1768. doi:10.1111/iej.14137.
[34]. Sağlam H, Arslan H. The association between anxiety levels and postoperative pain following endodontic treatment: A prospective observational study. BMC Oral Health. 2026;26:1445. doi:10.1186/s12903-026-08715-7.
[35]. Kankaanpää R, Auvinen J, Rantavuori K, Jokelainen J, Karppinen J, Lahti S. Pressure pain sensitivity is associated with dental fear in adults in middle age: Findings from the Northern Finland 1966 Birth Cohort Study. Community Dentistry and Oral Epidemiology. 2019;47(3):193–200. doi:10.1111/cdoe.12443.
[36]. Taheri AA, Parvizifard AA, Reisi S, Jafari M, Mohammadian Y, Heshmati K, et al. Associations between the perception of dental pain and pain anxiety, mental pain, and dental anxiety in an Iranian sample. International Journal of Psychiatry in Medicine. 2024;59(1):34–49. doi:10.1177/00912174231180855.
[37]. Humphris G, Crawford JR, Hill K, Gilbert A, Freeman R. UK population norms for the Modified Dental Anxiety Scale with percentile calculator: Adult Dental Health Survey 2009 results. BMC Oral Health. 2013;13:29. doi:10.1186/1472-6831-13-29.
[38]. Humphris GM, Morrison T, Lindsay SJE. The Modified Dental Anxiety Scale: Validation and United Kingdom norms. Community Dental Health. 1995;12(3):143–150.
[39]. Alghofaily M, Nair P, Alolayan AB, Al-Hadlaq SM. Levels of anxiety and fear related to non-surgical root canal treatment performed by endodontic residents and endodontists. Frontiers in Dental Medicine. 2022;3:851834. doi:10.3389/fdmed.2022.851834.

[40]. Armitage CJ, Reidy JG. Evidence that process simulations reduce anxiety in patients receiving dental treatment: Randomized exploratory trial. Anxiety, Stress & Coping. 2012;25(2):155–165. doi:10.1080/10615806.2011.604727.
[41]. Anatürk Ş, Dönmez Özkan H. Determining the effect of video information on the dental anxiety levels of endodontic patients: A randomised clinical trial. Journal of Oral Rehabilitation. 2025;52(11):1933–1944. doi:10.1111/joor.14054.
[42]. Park ES, Yim HW, Lee KS. Progressive muscle relaxation therapy to relieve dental anxiety: A randomized controlled trial. European Journal of Oral Sciences. 2019;127(1):45–51. doi:10.1111/eos.12585.
[43]. Verma MR, Rao RD, Langade D, Jain AK, Guha A, Mohan M. Assessment of yogic relaxation techniques for its anxiolytic effects in patients requiring endodontic treatment: A prospective, randomized controlled study. Journal of Conservative Dentistry. 2021;24(2):209–213. doi:10.4103/JCD.JCD_97_21.
[44]. Spindler H, Staugaard SR, Nicolaisen C, Poulsen R. A randomized controlled trial of the effect of a brief cognitive-behavioral intervention on dental fear. Journal of Public Health Dentistry. 2015;75(1):64–73. doi:10.1111/jphd.12074.
[45]. Stanley W, Drum M, Nusstein J, Reader A, Beck M. Effect of nitrous oxide on the efficacy of the inferior alveolar nerve block in patients with symptomatic irreversible pulpitis. Journal of Endodontics. 2012;38(5):565–569. doi:10.1016/j.joen.2012.02.010.
[46]. Drum M, Reader A, Nusstein J, Fowler S. Successful pulpal anesthesia for symptomatic irreversible pulpitis. Journal of the American Dental Association. 2017;148(4):267–271. doi:10.1016/j.adaj.2017.01.002.
[47]. Gupta PD, Mahajan P, Monga P, Thaman D, Khinda VIS, Gupta A. Evaluation of the efficacy of nitrous oxide inhalation sedation on anxiety and pain levels of patients undergoing endodontic treatment in a vital tooth: A prospective randomized controlled trial. Journal of Conservative Dentistry. 2019;22(4):356–361. doi:10.4103/JCD.JCD_332_18.
[48]. Hoffmann B, Erwood K, Ncomanzi S, Fischer V, O'Brien D, Lee A. Management strategies for adult patients with dental anxiety in the dental clinic: A systematic review. Australian Dental Journal. 2022;67(Suppl 1):S3–S13. doi:10.1111/adj.12926.