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Perspective

Photobiomodulation in Contemporary Dental Practice: Expanding Clinical Applications for Tissue Repair and Patient Comfort

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DESCRIPTION

Photobiomodulation refers to the use of low-intensity light, commonly delivered through lasers or light-emitting diodes, to influence cellular activity without causing thermal damage. In dentistry, this approach has gained attention because of its ability to influence biological processes in oral tissues in a non-invasive manner. The interaction between light energy and cellular chromophores, particularly within mitochondria, leads to biochemical changes that can improve healing responses, reduce discomfort, and support recovery following various dental procedures. Its application spans multiple branches of dental care, including oral surgery, periodontics, endodontics, orthodontics, and management of oral mucosal conditions.

The biological basis of this light-based intervention lies in the absorption of specific wavelengths by intracellular components, especially cytochrome c oxidase. When exposed to appropriate wavelengths, typically in the red or near-infrared spectrum, cells experience enhanced adenosine triphosphate production. This increase in cellular energy availability influences processes such as protein synthesis, cell migration, and modulation of inflammatory mediators. As a result, tissues subjected to trauma or surgical intervention may recover more efficiently, with reduced inflammatory burden and improved microcirculation in the treated area.

In oral surgery, photobiomodulation has been explored as a supportive modality to improve post-operative outcomes. Procedures such as tooth extractions, implant placement, and minor oral surgical interventions often lead to inflammation, discomfort, and delayed tissue repair in some cases. Application of low-level light to surgical sites has been associated with reduced swelling and decreased perception of pain in many clinical observations. This is particularly relevant in patients who may be sensitive to conventional analgesic regimens or in situations where minimizing pharmacological intervention is preferred.

Periodontal care also benefits from this light-based approach. Chronic inflammatory conditions affecting the supporting structures of teeth often involve complex biological responses that can lead to tissue breakdown. Photobiomodulation has been studied for its potential to modulate inflammatory mediators such as cytokines while encouraging fibroblast activity and collagen formation. When used as an adjunct to scaling and root planning, it may support improved gingival healing and enhance patient comfort during the recovery phase. The ability to influence soft tissue responses without invasive manipulation makes it a useful adjunct in selected periodontal treatment plans.

Orthodontic treatment, which relies on controlled movement of teeth through alveolar bone remodeling, is often associated with discomfort during the initial phases and adjustment periods. Photobiomodulation has been investigated for its ability to reduce pain associated with orthodontic force application. It may influence nerve conduction and inflammatory mediator release in the periodontal ligament, leading to improved patient tolerance of orthodontic appliances. Additionally, some observations suggest a potential influence on the rate of tooth movement, although findings in this area vary and require further systematic evaluation.

The safety profile of photobiomodulation is generally considered favorable when appropriate parameters are used. Unlike high-intensity lasers that rely on thermal effects for tissue ablation, this approach operates within non-destructive energy ranges. Proper selection of wavelength, energy density, and exposure duration is essential to achieving desired biological responses without unintended tissue stress. Dental practitioners must be trained in parameter selection and device handling to ensure consistent outcomes across clinical applications.

CONCLUSION

Integration of photobiomodulation into dental practice reflects an expanding interest in biologically oriented treatment

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strategies that support natural healing processes. Its role is not intended to replace conventional dental procedures but to complement them by improving patient comfort and enhancing tissue response following intervention. As clinical understanding deepens and technological refinement continues, its applications are expected to become more clearly defined within evidence-based dental care.