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Editorial

Biomarkers: A stepping stone for the future of endodontics

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Biological markers (biomarkers) have been defined by Hulka and colleagues as-cellular, biochemical or molecular alterations that are measurable in biological media such as human tissues, cells, or fluids.In endodontics biomarkers are useful tool for diagnosing, monitoring dental treatments progress and predicting outcomes.[1] Different types of the biomarkers can be easily isolated from various biological samples like saliva, blood, and dental tissues.

1. Inflammatory Biomarkers: In response to endodontic infection and tissue damage, numerous inflammatory biomarkers are released.
   (a) Cytokines:
      i. Interleukins (IL-1, IL-6, IL-8): These are small proteins released by immune cells that mediate and regulate inflammation. Elevated levels of these cytokines in dental tissues or fluids indicate an inflammatory response.[2]
      ii. Tumor Necrosis Factor-alpha (TNF-α): A cytokine involved in systemic inflammation. It can promote inflammation and is often found in higher concentrations in infected dental tissues.[3]
   (b) Prostaglandins: Like PGE2, A lipid compound that plays a role in the inflammation process, contributing to pain and swelling. It is often elevated in conditions like pulpitis and periapical periodontitis.
   (c) C-reactive protein (CRP): - An acute-phase protein produced by the liver in response to inflammation.[4]Elevated CRP levels in saliva or serum can indicate an ongoing inflammatory process in endodontic infections.
2. Tissue Destruction Markers: These biomarkers indicate the breakdown of tissue, which can occur in response to chronic inflammation or infection.
   (a) Matrix metalloproteinases (MMPs): MMP-8 and MMP-9: Enzymes that degrade extracellular matrix components, such as collagen. Their elevated levels suggest tissue destruction and can be associated with the progression of periapical lesions.[5]
   (b) Deoxypyridinoline (DPD): A marker of bone resorption, which can be detected in urine. Elevated DPD levels may indicate bone destruction around the teeth, common in severe periapical infections.
3. Microbial Biomarkers: These biomarkers are directly related to the presence of pathogenic microorganisms in endodontic infections.
   (a) Bacterial DNA/RNA: Identification of specific bacterial species, such as Porphyromonas gingivalis or Enterococcus faecalis, through

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DNA or RNA analysis helps in diagnosing and understanding the microbial profile of endodontic infections.

(b) Endotoxins: Components of the outer membrane of Gram-negative bacteria, like lipopolysaccharides (LPS), which trigger strong inflammatory responses. The presence of endotoxins in root canal infections is a marker of bacterial activity and infection severity.

4. Regenerative Biomarkers: These biomarkers are involved in tissue healing and regeneration, critical in endodontic treatments focused on tissue repair.

1. Growth Factors

1. Bone Morphogenetic Proteins (BMPs): These proteins stimulate bone formation and are crucial in healing and regeneration of periapical tissues.
2. Transforming Growth Factor-beta (TGF-β): Involved in tissue repair, this growth factor helps regulate cell proliferation, differentiation, and other functions essential for regenerating damaged dental tissues. [6]

2. Applications in Endodontics

1. Diagnosis: Biomarkers can significantly improve the accuracy of diagnosing various endodontic conditions [7]

   (a) Early Detection: Identifying elevated levels of specific inflammatory markers can help detect pulpitis and periapical periodontitis before they become symptomatic.

   (b) Differentiating Conditions: Using biomarkers like cytokines and prostaglandins, clinicians can distinguish between reversible and irreversible pulpitis, aiding in appropriate treatment decisions.

2. Prognosis: Biomarkers provide insights into the severity and likely outcomes of endodontic infections

   (a) Severity Assessment: Measuring tissue destruction markers like MMPs can help assess the extent of tissue damage and the severity of the infection.

   (b) Predicting Treatment Outcomes: Biomarker profiles can indicate the likelihood of success for treatments like root canal therapy, helping clinicians set realistic expectations and plan accordingly.

3. Treatment Monitoring: Monitoring changes in biomarker levels can help evaluate the effectiveness of endodontic treatments.

   (a) Effectiveness of Treatment: By tracking inflammatory and microbial biomarkers, clinicians can determine if the infection is resolving or if additional interventions are needed.

   (b) Regenerative Procedures: Measuring regenerative markers can help assess the progress of tissue healing in procedures like regenerative endodontic therapy.

4. Personalized Treatment: Biomarker analysis enables more personalized and targeted endodontic care

   (a) Tailored Treatments: Understanding a patient's unique biomarker profile allows for customized treatment plans, improving the chances of successful outcomes and minimizing unnecessary interventions.

   (b) Precision Medicine: Integrating biomarker data with other clinical information can lead to more precise and effective treatment strategies.

3. Challenges and Future Directions

1. Standardization: There is a need for standardized protocols for collecting, processing, and analysing biomarkers in endodontics to ensure consistency and reliability across different clinical settings and studies.
2. Validation: Further research and clinical trials are necessary to validate the clinical utility of various biomarkers. This involves proving that these biomarkers reliably predict clinical outcomes and are beneficial in guiding treatment decisions.
3. Technology: Advancements in molecular biology techniques and analytical technologies will enhance the identification, quantification, and application of biomarkers in endodontics. Techniques such as next-generation sequencing, proteomics, and metabolomics will play a crucial role.
4. Integration: Incorporating biomarker analysis into routine clinical practice requires integration with existing diagnostic tools and workflows. This involves developing user-friendly diagnostic kits and devices that can be easily used in dental clinics.

Incorporating biomarkers into endodontic practice holds the promise of transforming the field by enabling early and accurate diagnosis, personalized treatment, and improved patient outcomes. [8]

4. Conflict of Interest

None.

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