Diagnostic Aids In Orthodontics – A Review

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Abstract

Accurate and precise diagnosis plays the first and the most important role in management of any orthodontic disharmony. Various methods of diagnosing craniofacial anomalies and malocclusion have been studied in the past. Historically, clinical examination was solely used as a diagnostic aid but over the last few decades, a sudden boom has occurred in the field of diagnosis due to advancements in technology. This article describes the various diagnostic aids over the past and also briefly describes the recent advancements that are made in the field of digital diagnosis.

Keywords: Diagnosis, Recent advancements, Orthodontics, Treatment planning.

Introduction: Diagnosis is the determination of the nature of the problem, disease, or condition by study and consideration of the patient's history, as well as symptoms and signs of their manifestations. It entails the creation of a thorough and accurate database of relevant details, sufficient to comprehend the patient's problem in addition to doubts about treatment that arise in the clinician's mind.[1]

Diagnosis (glossary of orthodontic terms): The determination of the nature of the problem, disease, or condition by study and consideration of the patient's history, as well as symptoms and signs of their manifestation.[2] Establishing a proper diagnosis is the first step to achieving treatment objectives in the management of any clinical entity. Over decades, a paradigm shift in the sector of diagnostic methods has occurred, resulting in a tremendous explosion of innovative ideas and information, resulting in rapid breakthroughs in the field. Technology is widening and becoming more inclusive towards various scientific fields, and orthodontics is no exception. Computers are used extensively by orthodontists for diagnosis, record keeping, practise management, individual patient analyzation, correspondence with peers, restoration fabrication, and a wide range of other tasks. Computers are now considered a necessity rather than a luxury.

Diagnostic aids can be broadly classified into[3]: (Figure 1)

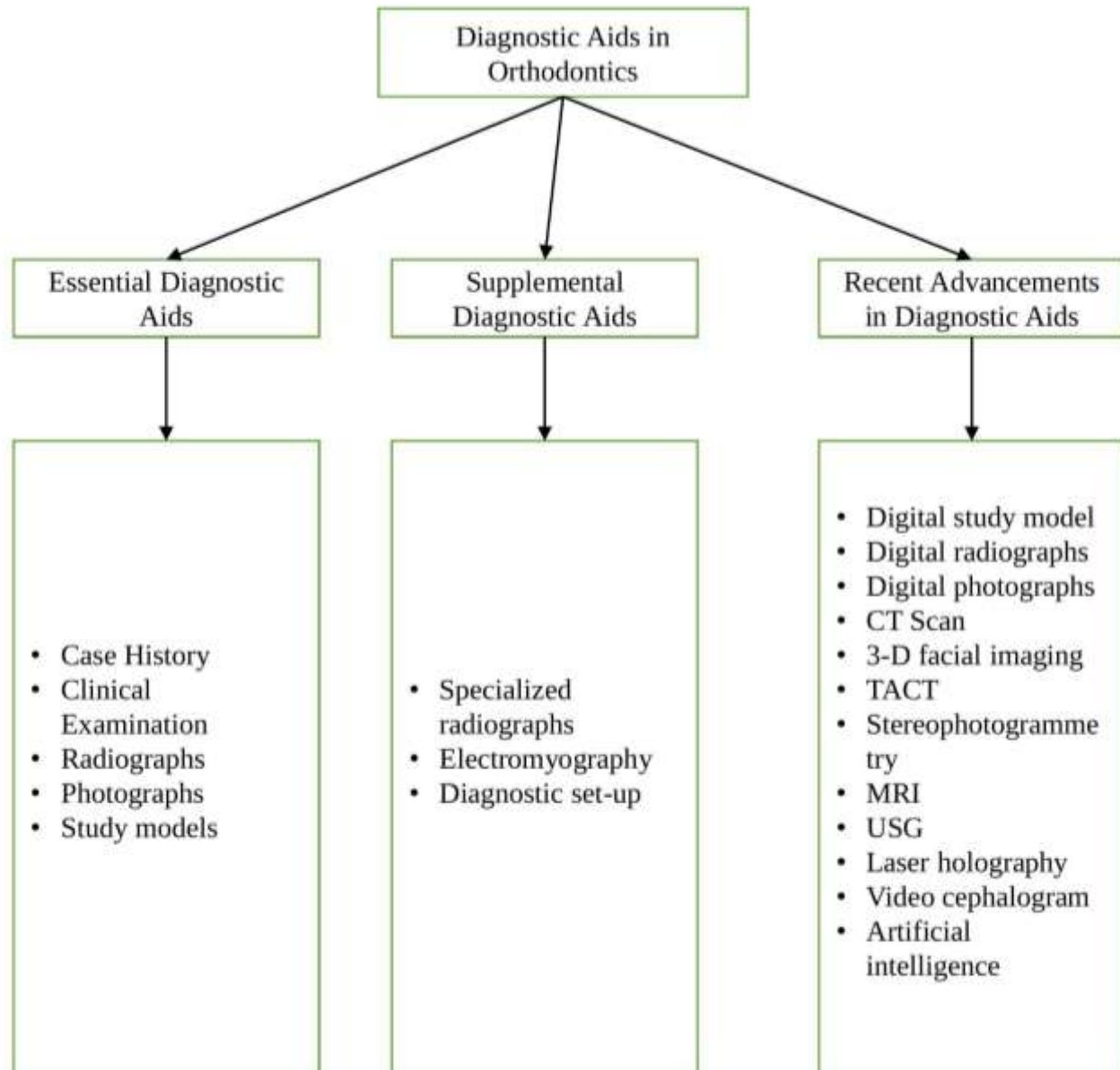1. Essential diagnostic aids

2. Supplemental diagnostic aids

Figure 1: Classification of diagnostic aids

1. ESSENTIAL DIAGNOSTIC AIDS

A. **Case history:** Most important and often the most neglected part of diagnosis is recording a detailed case history. A medical and dental history is an extremely important tool for assessing current health status and identifying medical disorders, medications, and other factors that might affect paradental tissue remodelling and, as a result, tooth movement.[3]

B. **Clinical Examination:** Clinical examination begins from the moment a patient enters into the clinic. Posture, built and gait can be assessed from just inspecting the patient. The oral health of the patient is assessed by looking at the patient's hard and soft tissues. General rule of thumb is to control all other oral pathologies before starting an orthodontic treatment.[1]

The developmental status of the patient is also assessed. It is particularly easy to fail to notice a missing or supernumerary tooth. Any active periodontal issue must also be addressed as the first line of treatment.

Jaw and occlusal function must also be thoroughly evaluated and recorded. Any discrepancy between centric relation and centric occlusion, neuromuscular disharmony, temporomandibular joint related issues have to be addressed and the patient has to be made aware of it before commencing with orthodontic treatment.[4]

Orthodontic patients very often report with problems of speech and mastication as well.[5] Also, smile analysis plays a major role in planning treatment objectives. A systematic examination of facial and dental appearance is to be made, starting with examination of facial proportions in all three planes of space which is called 'macro-esthetics', followed by evaluation of dentition in relation to face which is called 'mini-esthetics' and ultimately of teeth in relation to each other which is called 'micro-esthetics'.[6]

C. **Radiographs**[7]
    i. Cephalograms
        a) Cephalometric analysis is one of the most crucial aid in diagnosing an orthodontic patient. Over the years, using various anatomical landmarks, scientists have come up with multiple analyses to assess the growth pattern, need for extraction, need for surgery, amount of proclination/retroclination of teeth, etc using lateral cephalograms.[8] They are also used to assess skeletal maturity using cervical vertebrae.[9]
        b) Postero-anterior or frontal cephalograms are also used to assess facial asymmetry.[10]
    ii. Orthopantomograph
        OPG is used for pre and post-treatment evaluation, for determining the presence or absence of teeth, root length, axial inclinations, morphology and structure, TMJ assessment, and so on.[11]

D. **Photographs**: A photograph is a basic tool that allows a clinician to address relevant information about a patient. A series of photographs taken in this manner would indicate not only the treatment progress but would also be extremely useful when diagnosing a case. Assessment of visual treatment objective in case of myo-functional therapy is also a universally accepted standard protocol.[12]

E. **Study models:** Very integral part of orthodontic diagnosis, conventionally made of plaster or stone and help during model analysis or space analysis in forming a treatment plan for a patient and patient education regarding their malocclusion.[13]

2. SUPPLEMENTARY DIAGNOSTIC AIDS

A. **Specialized radiographs:** Hand-wrist radiographs to assess skeletal maturity,[14] occlusal radiographs to assess for to detect supernumeraries and odontomes and also to assess status of intermaxillary suture closure, intra-oral periapical radiographs to assess bone level periodically, etc can be used as an adjunct to lateral cephalogram and orthopantomogram.[1]

B. **Electromyography**: Electromyography (EMG) offers the most objective technique for assessing muscle function and performance by detecting electrical potentials in the muscles. Several studies have indicated that electromyography can detect muscle activity in both resting and working state.

C. **Diagnostic set-up:** It helps to examine the teeth on denture base in all dimensions and also determination of tooth discrepancies in treatment planning.[15]

3. RECENT ADVANCEMENTS IN DIAGNOSTIC AIDS

A. **Digital study model:** To overcome disadvantages of conventional study models, digital models came into existence. Although the cost of digital models is more, but the advantage of negligible storage space and storage cost makes it a better alternative to plaster or stone models. [16]

B. **Digital photography:** In photography, the introduction of digital media has simplified both the acquisition and management of still photographs. Extra-oral and intraoral photographs that can also be instantly transferred into the patient's record and viewed on a patient-visible display.[17]

C. **Digital radiography:** Using an electronic sensor and imaging system, the radiographs are taken instantaneously on a computer system. Digital radiography requires less x-radiation than conventional radiography. Reduces errors and saves time when compared to conventional radiography.[11,18]

D. **3-D facial imaging:** Helpful for diagnosis of craniofacial syndromes and anomalies.[19]It can also be used to visualize growth and to assess post-operative soft tissue changes following orthognathic surgery.

E.   **CT Scan:** For diagnosis of various craniofacial deformities and outcome of surgical procedures may be visualized using sophisticated CT techniques. Recently, with the advancements of 3-D printing, CT scans are also used for fabrication of customised surgical splints in cases of orthognathic surgery.[20]

F.   **CBCT:** CBCT has various implications in orthodontics[21]:

1. Assessment of anomalies like impacted teeth.
2. Assessment of interventions like maxillary expansion, cleft management, etc.
3. Assessment of bone levels mid treatment and post treatment.

G.   **Tuned Aperture Computed Tomography:** TACT and tom synthesis require the acquisition of several transmission radiographs of the target anatomy, each acquired from in unique point of view. A feature in a three-dimensional object is uniquely displaced on each result ant image, depending on its location relative to the imaging source and film.[22]

H.   **Stereophotogrammetry:** By combining X-ray with the principles of stereo photogrammetry, changes in bone density can be tracked.

I.   **MRI:** Magnetic Resonance Imaging is beneficial for the study of skeletal muscle physiology. This approach has been used to compare phosphate metabolism in muscles of bruxing subjects with non-bruxing controls. The use of these non-ionizing radiations also extends as a gold standard for diagnosis of temporomandibular joint disorders, specially involving soft tissues components.

A disadvantage is the difficulty in avoiding artifacts due to stainless steel orthodontic appliances. Some studies have used MRI to detect impacted teeth too.[23]

J.   **Ultrasonography:**

Sonography has found its way into orthodontics in a variety of ways[24]-

1. Assessment of swallow pattern.
2. Imaging of condylar position.
3. Zygomatic fracture diagnosis.
4. Muscle mass assessment.
5. Orthodontically induced root resorption.
6. Accelerating orthodontic tooth movement.

K.   **Laser holography:** Laser holography, a new method for measuring tooth movement, provides an accurate, non-invasive method for determining movement in three dimensions.[25] The stresses generated in the periodontium when the crown of a tooth is subjected to a force have important implications for the study of orthodontic tooth movement and periodontitis.[26]

L.   **Video cephalometry:** Video imaging has the potential to loach almost every aspect of the orthodontic practice: diagnosis and treatment planning, communications of consultations, database management, integration with practice management programs, communication with other offices, and many other areas that have not been fully realized yet.[27]

M.   **Artificial intelligence:** AI research is being done with the goal of achieving human-like generality. Because of the convenience with which the computer deals with patterns, AI has a broad range of applications in imaging diagnostics.[28] Another intriguing recent Intelligent system is extraction prediction in orthodontic planning.[29,30]

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