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REVIEW ARTICLE

Current Trends in Fixed Prosthodontics

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Abstract

Prosthodontics has evolved largely in response to the changing needs of esthetics, function, comfort, and health of the patients and it is doubtless that this change will continue to occur in future. The best way to forecast the future is to try understanding the present. Hence, the knowledge about the emerging materials and latest technologies in the field of prosthodontics aids the prosthodontists to take their practice to higher levels. There are no previous articles in the literature describing the recent and ongoing researches in fixed prosthodontics. Hence, this article aims to give an overview of the recent advancements in the field of fixed prosthodontics and also provides an outlook on how it might influence the emergence of prosthodontics in future.

Introduction

Prosthodontics, one of the pioneer specialties of dentistry, was officially declared as separate dental specialty in the year 1947.[1] From then, it had evolved drastically and significantly, and now, it ensures to meet all the expectations not only of geriatric population but also the younger age groups by resolving the problems in occlusion, mastication, deglutition, and esthetics.

In the past two decades, the focus on oral rehabilitation has changed from removable to fixed prosthodontics. Furthermore, the treatment options in fixed prosthodontics have changed considerably in the past few years, mainly due to advancements in the adhesive system along with the restorative materials, which have translucent properties comparable to those of natural teeth and digital technologies such as computer-aided design and computer-aided manufacturing (CAD/CAM), robotics, laser, and 3D printing.

Prosthodontists should be aware of all current trends and use them judicially in their everyday practice to meet today's patients needs and thereby improve their clinical practice. This article is an attempt to describe few of the cardinal trends in the field of fixed prosthodontics and to provide a contemporary perspective on how this changing trend will shape the future of prosthodontics.

Evolution of Fixed Prosthodontics

The emergence of fixed prosthodontics dates back to 1746 when Claude Mouton used a gold crown and post, which was retained in the root canal.[2] In 1825, production of commercial porcelain crowns started in Philadelphia.[3] Later, Winder introduced screw joint retention between the pontic and abutment, which made a shift of fixed prosthodontics from single crowns to multiunit restorations.[4]

Evolution of fixed prosthodontics in the 20th century is exponential.[4] In 1903, Dr. Charles H Land introduced porcelain jacket crown.[4] In 1907, the description of lost wax technique was given by William H. Taggart which revolutionized the prosthetic dentistry.[5] In 1926, Ante's law was postulated which is the standard principle for abutment selection till date.[6] In 1957, a major breakthrough was made in dentistry when John Borden introduced high-speed air turbine hand piece which operates up to 300,000 rotations/minute.[7] In 1962, porcelain fused metal crowns were introduced based on the formulations given by Weinstein *et al.*[4] In 1973, Rochette bridge was introduced, which lead to an idea of minimal tooth reduction.[8] In 1985, introduction of CAD/CAM transformed the practice of dentistry for both patients and practitioners.[9]

Advancements in Ceramics

There have been immense advances in the composition, mechanical properties, and the processing techniques of ceramics in the past few years.[10] Most recent advances in dental ceramics includes (1) monolithic zirconia, (2) multilayered zirconia, (3) polymer infiltrated ceramics, and (4) processing techniques.

Monolithic zirconia

Zirconia, the toughest and strongest material among all dental ceramics, was in use in dentistry since the early 1990s. However, because of their insufficient translucency, zirconia cores always required porcelain veneering to achieve acceptable esthetics.[11] This often resulted in chipping or cracking of the veneered ceramic.[12] Rates of chipping were reported to be about 3–36% after 1–5 years for fixed partial dentures.[13] To overcome this, monolithic zirconia restorations without porcelain veneering have been introduced more recently.[12]

Microstructural modifications and altered processing techniques have led to better translucency of this novel material.[10] These restorations, exclusively manufactured by CAD/CAM, can be used in areas of limited interocclusal space because of its ability to withstand forces with occlusal thickness of just 0.5 mm.[12]

Multilayered zirconia

Multilayered zirconia system was introduced in 2015, aiming for superior esthetic properties. They showed gradation chroma and translucency, imitating the shade gradient of natural teeth: Gradual increase in translucency from incisal area of the crown to the gingival region.[14]

Polymer infiltrated ceramics

Recently, a new material called "polymer-infiltrated ceramic-network" (PICN) was introduced by combining the properties of ceramics and resin composites.[15] The structure of PICN consists of 86 weight % of ceramic matrix infiltrated with 14 weight % of polymer matrix. These materials have elastic modulus similar to resin composites along with long-term esthetic stability similar to ceramics.[16]

Processing techniques

Two recent ceramic processing techniques that come under the spotlight include stereolithography and selective laser sintering. Ceramic stereolithography is a process in which photopolymerizable suspension of ceramic powders is converted into solid resin under ultraviolet polymerization system. In laser sintering, powder granules are directly fused into single coping with the use of high-energy laser beam.[10]

Advancements in Luting Cements

Long-term success of any indirect restorations relays greatly on the meticulous selection of luting cement and proper execution of the cementation procedure.[17] Although a wide variety of cements are in use, most recent trends include self-adhesive resin cements and Ceramir material.[17,18]

Self-adhesive resin cements

These cements were developed in 2002 with the aim to combine the favorable properties of different luting cements into single product. This material was introduced to deliver the property of simple application similar to zinc phosphate and polycarboxylate cements; pH range, moisture tolerance, and fluoride release comparable to glass ionomer cement (GIC) along with optimal mechanical properties and good esthetics of resin cements.[17]

Calcium aluminate GIC/Ceramir

This cement is a recent hybrid combination of calcium aluminate and GIC. It combines the pH, early strength, and adhesive property of glass ionomer with the long-term strength, better sealing, and biocompatibility of calcium aluminate cement.[18]

Advancements in Dental Handpieces

Handpieces with speed-sensing intelligence

These handpieces have inbuilt sensors that detect the frequency of vibrations of the bur and adjust the speed accordingly. When higher load is encountered by the bur, chips send signals to increase air pressure and maintain speed, thereby eliminating stalling. When bur is not under load, speed reduces automatically. The sensor monitors the speed several times per second.[19]

Microturbine head

Recently, handpieces that are lighter and smaller than the conventional ones were introduced to allow for greater accessibility and visibility. Turbine head of <9 mm and height of 10 mm provide better control and maneuverability, increasing the efficiency of practice and comfort of patient.[19]

Light-emitting handpieces

In recent decades, handpieces with integrated light sources that can directly illuminate the treatment area have been introduced. Such instrument was first marketed in 2007 with 25,000 lux light intensity. In 2013, at International Dental Show Cologne, multi-LED light turbine with 5x-LED ring was presented. This innovation is a breakthrough in dentistry that provides complete shadow-free illumination intraorally.[20]

Handpieces with multiple spray channels

In 2007, handpieces with five spray channels were launched to ensure guarantee sufficient cooling.[20]

Advancements in Tooth Preparation

Ultrasonic tooth preparation

Recently, a study done by Ellis *et al.* concluded that ultrasonic crown preparation can produce extremely precise margins with greater accuracy and closer adaptation of restorations.[21] It was found that the margins prepared with ultrasonic instruments were approximately twice as smooth as the ones prepared with regular rotary instruments.[22]

Laser tooth preparation

Lasers have been successfully tried for the hard tissue ablation in the past few years. Er-doped:YAG laser with the wavelength of 2.94 μm proves to be most promising with diminished heat distribution and improved efficacy for tooth preparation. "Laser application for wide area" is made possible by adding a scanner system to the existing dental laser units.[23]

Robotic tooth preparation

Shortcomings with manual tooth preparation are insufficient or excessive preparation and iatrogenic soft-tissue damage which are mainly attributed to insufficient vision and accessibility intraorally. Patient's and dentist's discomfort caused by high-pitched noises from the rotary instruments is another disadvantage.[24]

To overcome these drawbacks, in 2019, a robotic system with ultrashort pulse laser system was invented in China for tooth preparation. Study was conducted on 15 extracted human teeth and results concluded that the automated robotic tooth preparation showed better accuracy compared to manual preparation. However, a more in-depth research on safety, efficacy, and ablation range is needed.[24]

Advancements in Provisional Restorations

Luxatemp materials

It is a composite provisional material available as self-cure and light cure system. Recently, several modifications were made in this line: Luxatemp fluorescence which has superior esthetics and unique handling properties, Luxatemp Ultra with high flexural strength by incorporation of nanotechnology, and Luxatemp Solar which is a light-cured material. Light curing enables for flexibility in working time.[25]

Protemp crowns

These are the first prefabricated provisional crowns introduced. They are malleable, adjustable and with exceptional compressive strength of 395.6 MPa.[25] The complete kit consists of 42 crowns in nine preformed sizes to fit onto canines, premolars, and molars. Main advantage is its fast and simple fabrication process.[26]

Tuff-temp plus

This is a rubberized resin available in six shades and is either self-curable or light curable. Advanced rubberized urethane chemistry provides high impact resistance and dimensional stability.[25] This material does not undergo polymerization shrinkage and grips tightly to the teeth with perfect marginal adaptation.[26] Furthermore, margin refinement is very easy because the materials gets grinded without distortion or softening.[25]

The Structur

Structur 3 and Structur Premium are the recently developed materials in the Structur family of provisional materials. With the application of nanotechnology, Structur 3 was made highly fracture resistance and with greater compressive strength of about 500 MPa. This material is highly esthetic material with gloss and fluorescence similar to natural teeth.[25]

Structur Premium was developed to provide high fracture resistance making it ideal for long-term bridges along with excellent gloss, tooth- like fluorescence, and fast setting.[25]

CAD-CAM PMMA provisionals

CAD-CAM polymethyl methacrylate provisionals are the recent trends in provisional restorations that provide meticulous anatomic details. These restorations are milled out from dense block with much reduced porosity compared to traditional materials.[26]

Digitization in Fixed Prosthodontics

In the recent years, digitization has revolutionized the field of prosthodontics. In the current scenario, digital technology is a part of every procedure in prosthodontics starting from patient education and treatment planning to make impression, digital shade selection, digital facebow, and virtual articulations.[27]

Digital impressions

High precision impressions are possible now a days within few minutes with the use of optical oral scanners. iTero, Lava chair side scanners, and CEREC AS are the recently invented oral scanner systems. Instant visualization of preparation from all perspective is possible with the digital scanners.[28]

Shade matching

Digital shade matching eliminates the subjectivity in analysis of color thereby providing an exact color matching for the prosthesis and also reducing the chair side time. Various currently available devices such as Vita Easyshade, Shadescan, and Clear match system provide exact color matching with instant display of color.[29]

Conclusion

With the advancements in digital technologies and latest materials, clinicians have a wide range of treatment options in fixed prosthodontics that will meet the changing demands

of esthetics and function. Furthermore, with the latest developments, there is an obvious shift to less invasive dental treatments. Recent innovations such as robotics and lasers have revolutionized the fixed prosthodontics.

However, an in-depth clinical knowledge of these developments is crucial to take our specialty to next level.

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