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Research Article

Evaluation of Esthetic Principles in Prosthodontics: Review of literature

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Abstract:

The demand for cosmetic dental prosthetics has grown considerably during the last few years. Rush-to-market products, media-driven ideas, as well as dentists keen to please, have formed a challenge for the dentist to calculate benefits /risks ratio for every single treatment modality. The difference between Cosmetic and Esthetic prosthodontics is that Cosmetic prosthodontics implies treatment that is done strictly for visual appearance that may not be considered essential such as Veneers, Cosmetic crowns as well as teeth whitening .On the other hand, Esthetic prosthodontics uses an approach that helps to solve more complicated problems such as missing teeth or missing part of maxillary or mandibular jaws that both fixes the problem from a functional standpoint, but also helps the patient to look and feel better it also requires harmony and balance. In other words, esthetic prosthodontics is a more broad approach than cosmetic prosthodontics For this reason this literature review investigated the traditional and recent techniques and materials in different branches of prosthodontics that helps to give the patient the most aesthetically satisfying dental experience.

1. Introduction

Our everyday lives are full of esthetic experiences. Uncountable decisions depend on the esthetic appeal of the available options. The Oxford English Dictionary (OED) defines ‘esthetic’ as “concerned with beauty or the appreciation of beauty”, Dental esthetics is the application of the principles of esthetics to the natural or artificial teeth and restorations .Nowadays, owing to patients’ increasing esthetic demands and expectations, the natural appearance of the prosthesis has become an important outcome measure for defining the success of restoration therapy.

The difference between Cosmetic and Esthetic prosthodontics is that Cosmetic prosthodontics implies treatment that is done strictly for visual appearance that may not be considered essential such as Veneers, Cosmetic crowns as well as teeth whitening .On the other hand, Esthetic prosthodontics uses an approach that helps to solve more complicated problems such as missing teeth or missing part of maxillary or mandibular jaws that both fixes the problem from a functional standpoint, but also helps the patient to look and feel better it also requires harmony and balance. In other words, esthetic prosthodontics is a more broad approach than cosmetic prosthodontics.

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the dentist to calculate benefits /risks ratio for every single treatment modality. For this reason this literature review investigated the traditional and recent techniques and materials in different branches of prosthodontics that helps to give the patient the most aesthetically satisfying dental experience

2. Material and Methods

This narrative review aims to explore the multifaceted role of esthetics in prosthodontics, examining the interplay between biocompatibility, materials used, and the artistry involved in creating natural-looking prosthetic solutions. By analysing current literature and clinical practices, this review seeks to highlight the importance of esthetic considerations in enhancing patient satisfaction and overall quality of life, as well as to promote a deeper understanding of how esthetic principles can be seamlessly integrated into prosthodontic workflows.

2.1. Perception of esthetics

Designing the smile in the most natural esthetic manner is considered one of the main goals the dental treatment, the satisfaction with the results is dependent on the specific needs of the patient and the vision of the dentist [1]

Potentials to reach that aim have significantly changed and improved over the last decade through recent treatment modalities, improved dental materials, innovative techniques, and technologies. Among the most important advancements over the past decade are the founding of universal worldwide esthetic rubrics and guidelines based on studying the natural esthetic parameters, anatomy, and physiognomy ;example ; Face Symmetry, Golden Ratio, Gingival line, Gingival angle (GA), and Gingival zenith angle (GZA) [2,3].

The development of tooth whitening and advanced restorative materials as well as prosthetic materials and techniques, and the implementation of digital technologies in a 3-dimensional planning helped to imitate the natural beauty of the esthetic smiles.

2.2.Esthetics in removable prosthodontics

Esthetics in Complete Denture

In removable complete dentures, the dentist traditionally designs the smile, which is created by the technician, and then the patient is allowed to try them on in a mirror during the try-in stage.

Patients are becoming more esthetically demanding, seeking near-ideal tooth arrangement and color, in contrast to the dentist, who suggests teeth arrangement that follows anatomical averages or any accessible pre-extraction record, and selection of tooth color that harmonizes with the hair and skin.

Regarding the denture base material: To date, PMMA resin is the most commonly used material for a denture-base fabrication because it is easy to repair, has acceptable esthetics, and is at a reasonable price (Fig. 1). It has easy handling properties, polymerization begins by manipulating PMMA (polymer) and methylmethacrylate (monomer) yet ,one of the main disadvantages of this material is color instability .after the recent great acceptance of the CAD/CAM dentures some recent studies investigated the color changes of the 3D-Printed complete denture [4].

Berli et al. (2020) reported in their study that the 3D printed CDs showed better color stability than PMMA CDs, they exhibited some color changes due to their increased water sorption as revealed by other investigators that after heat cycling, the 3D-printed resin considerably enhanced water sorption, however this was within the permissible range of color change (Fig. 2) [5].

Figure 1: *PMMA denture base showing details of the gingival imitation*

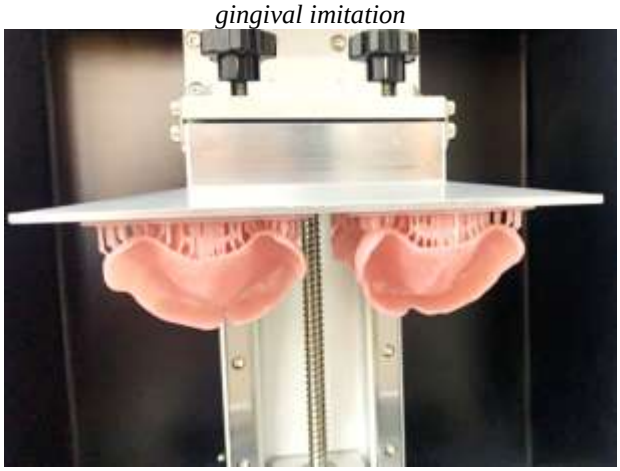

Figure 2: *3D printing of the CAD/CAM denture bases*

Regarding the artificial teeth ;Proper harmony and balance between a person`s smile and facial design includes tooth size,shape, and position .Nano-filled Hybrid denture teeth is a recent type of teeth can be used for removable complete dentures, because they demonstrate life-like translucency, high abrasion resistance, biocompatibility , color stability, plaque resistance and, strength. The Nano fillers in these denture teeth create a natural appearance in form of physical optical characteristics resulting in a natural depth of light dynamics.

El-Naggar et al. (2022) concluded in their study that Nano-hybrid resin composite denture teeth proved to have less deviation (higher precision) than the conventional acrylic denture teeth (Fig. 3) [6, 7].

Figure 3: *Nano-hybrid teeth*

Though the invasion of digital systems in the dental field generally, it is still very slow regarding the fabrication of the Removable complete dentures which may be due to the complexity of the fabrication steps and its higher cost. It seemed that most of the studies relied on digital scanning of the physical final impression and the Jaw relation records, only very few articles studied the preliminary digital impression which is obtained from direct scanning of the edentulous ridges intraorally ; one of them was (Takashi et al., 2016) who described in their study one of the digitizing systems which allow for obtaining digital preliminary impressions and digital jaw relation records as well, they suggested that the system has potential for clinical use in complete denture fabrication, although further improvement of the system is required [8-11].

Esthetics in Removable Partial dentures (RPD)

Removable partial denture is considered a basic treatment modality that we still must depend on for certain cases and is presenting a great challenge when it is concerned with esthetics due to the non-esthetic main components of the metallic framework, in addition it is more complicated when the missing teeth are in the anterior region.

Rashidi et al. (2019) in their study investigated the incidence of missing the anterior teeth, the study reported that Kennedy's Class IV n of partially edentulous cases was more common in the age group above 60 years old and most commonly seen in the mandibular arch [12]. The treatment of Kennedy class IV cases demands biomechanical harmony and esthetic perfection. The long-span state complicates the situation because of the absence of enough abutments to rely upon.

(Campbell SD. et al, 2017) Concluded some tips and tricks to enhance esthetic appearance of the partial denture [13, 14] :

1. To get optimal esthetics the metallic components must be hidden or covered as possible by guaranteeing that the retentive arm is positioned in the gingival third of the crown.
2. The anterior teeth should be arranged to be in the most natural position possible.
3. In most of cases large undercuts are present adjacent to natural abutment teeth the anterior edentulous span. this eliminated or decreased in size by altering the tilt of the cast and choosing suitable path of insertion.
4. Reducing of the freni attached close to the ridge should be done (surgically or by the use of Laser beam) to control the depth of notches in the denture flange to improve retention and esthetics of the prostheses. So the prosthodontist should plan out all necessary mouth preparations before starting the definitive prosthesis steps.
5. Using esthetic substitutes to conventional metallic clasps to decrease display of unesthetic-metal. **For example: Equipoise clasp design, Twin clasp/Spring clasp:** which contains wire soldered into a casted channel in the major connector, **Saddle lock clasp** or Hidden clasp. It uses the more pronounced proximal concave surfaces of the abutment adjacent to the denture base. Also the **Metal-free clasps** eg. Acetal resin, and flexible thermoplastic resins which proved acceptable flexibility and esthetic results.

2.3.Esthetics and cosmetics in fixed prosthodontics

All-Ceramic versus Metal-Ceramic crowns

The metal-ceramic FPDs are still considered as the typical modality for posterior tooth crowns. They provide the highest mechanical properties but they lack esthetic characteristics due to the metallic framework underneath and the opacity of the ceramic layer to conceal the metal, which may be challenging in areas with insufficient space [15, 16] .All-ceramic restorative materials proved the ability to offer an adequate substitute with better optical characteristics, which are more natural tooth mimicking in forms of color and high translucency. In the last decade, dental ceramics technology witnessed rapid advances. Several ceramics types and processing techniques were developed, in addition the implementation of CAD/CAM systems increased popularity of ceramics to a great extent [17, 18]. In a systematic review of (Ispas A. et al 2022), they evaluated the survival rate , technical and biological complications of All-Ceramic and Metal-Ceramic fixed partial dentures(FPD).

They found that, most of the studies showed comparable values regarding the success and survival rates of both types of FPDs in addition the

technical and biological complications also had very near results. However, in All-ceramic restorations some technical problems continued to appear for example ceramic chipping, which may result in fracture of the framework over time. Despite the mentioned technical complications, Zirconia and reinforced ceramics proved to be able to withstand for a long time without complaints [19].

To conclude; All-ceramic Systems, especially densely sintered zirconia and reinforced glass-ceramics, have a promising future because it was able to satisfy the prosthodontists and the patient.

Cosmetic Dental Veneers (Laminates)

Laminate veneers have become a very common cosmetic procedure for the anterior teeth (Fig. 4). However, due to the availability of different manufacturers in the dental market and differences of materials and preparation designs, the prosthodontist should have knowledge to select the suitable material type and preparation for each case. Generally any unpleasant change of the color or shape of anterior teeth may indicates use of laminates, however there are some specific indications for their use include: color change due to congenital factors for example: tetracycline staining and dental fluorosis, Aging and others, worn and fractured teeth, atypical tooth morphology, minor malposition also can be corrected, repairing of fractured or chipped crown and bridge facings intra-orally as well. Many studies described positive clinical results of the cosmetic veneers, with a 90 % survival rate in Twenty years [20].

Alothman et al. (2018) in their systematic review which searched through the different materials and designs for preparations they concluded that:

 Porcelain veneers proved to have excellent esthetic outcomes and predictable longevity, on the other hand, Composite veneers can be used as a good conservative solution, but it lacks durability [21].

 Regarding the geometry of design; Incisal coverage seems to have superior esthetic and more predictable outcomes, while making chamfer finish line on the palatal side proved to be unnecessary [22].

Cosmetic Lumineers (prep-less Veneers) and-Snap-On (Hollywood Smile)

Lumineers are brand of veneers that take less preparation and advanced dental work than traditional veneers. They're often called "Prep-less Veneers". Instead of porcelain, they're made of "ultra-thin" laminate which is typically the width of the average eye contact lens.their disadvantage that it cannot conceal the defects of the teeth completely [23]. In a study in Saudi Arabia reported from questionnaire survey comparing the preferences of patients on different cosmetic treatments included Composite buildups, Bleaching , Veneers and Prep-less Veneers (Lumineers) they noted that a majority of the surveyed people favored permanent treatment modalities rather than temporary treatment procedures [24].

Figure4 *Porcelain Veneers*

Snap-on Smile

Snap-On Smile, or Removable Hollywood smile, is a quick-to-install smile, and it has reached the field of cosmetic dentistry to compensate for missing teeth and temporarily whiten teeth, and it is a quick solution in the form of flexible molds that are easy to install and remove from teeth, its disadvantages that the capability of being stained from the food and drinks especially hot drinks, and fragile as well. Due to true existence of Lumineers and Snap-on (Hollywood smile) in the dental market we still need reliable scientific studies about it [25].

(Al Anzy et al, 2020) concluded in their study on the Snap-on smile that it can offer an immediate change in the smile. It is also considered the most economical esthetic dental make-over of the smile as it has some advantages as it hides the missing teeth, stained and unfavorable shape(within limits) instantly without the need of adhesive ar preparations and may last from 2 to 5 years. However it has few drawbacks like it is less durable, gives more fake look (bulky appearance), with increased risk of decay and development of plaque [26].

2.4. Esthetics and cosmetics in maxillofacial prosthodontics (life-like appearance)

Maxillofacial prosthodontics is defined as the science and art of functional and cosmetic reconstruction of head and neck missing structures. Even with the advancement in reconstructive and plastic surgery, reconstruction of sophisticated facial structures still requires the cosmetic touch of the prosthodontist. Maxillofacial prostheses enable many patients with maxillofacial defects to resume their role in society.

Color matching is presenting a great challenge to the maxillofacial prosthodontist, Matching exact color of natural skin is an essential step in the fabrication of facial prostheses .Silicones and Acrylic resins are mainly used for facial prostheses, colorants are added to the to obtain the final natural color, sometimes some cosmetic dyes were added as well to adjust the final look. Several techniques have been used to complete an accurate skin-looking match, The manual techniques include chairside visual trial and error method throughout facial spraying prostheses following some tinting, artistic tattooing methods in addition to the commercial cosmetics [27].

Ranabhatt et al. (2017) compared i their systematic review the instrumental colorimetric or photometric techniques shade guides for facial skin and the chair-side visual trial-and-error method. Surprisingly the review reported that the most reliable and commonly used technique is trial and error method [28].

2.5. Esthetics in implant prosthodontics

The osseointegration of the implant was considered the final success of the procedure but nowadays, patients focus on an optimal esthetic look from their rehabilitation. These are the main reasons why implantology researchers have shifted the effort of their studies to esthetics [29].

One of the most challenging areas for implant installation has been the anterior maxilla which is commonly referred to as the ***"Esthetic Zone".***

Sadowsky et al. (2019) concluded the factors affecting the esthetic outcome of an implant-supported restoration into the following [30-34]:

(1) Implant placement: deep or shallow positioning of implants or Implants placed too close or too far together, violating the labial plate of bone or the labial soft tissues.

(2) Soft tissue condition: thin versus thick biotypes, Soft-tissue volume grafting following immediate implant placement in the presence of a thin biotype.

(3) Abutment shape: shoulder-less abutment, platform switching**.**

To obtain the best esthetic results, Sadowsky (2022) in their systematic review concluded the following:

1. Precise planning of the implant prosthesis through-out using the available radiographic and scanning modalities; cone-beam computed tomography (CBCT), Intraoral scanners (IOS) and CAD/CAM systems for 3D planning and fabrication of provisional restoration and surgical guides.
2. Tissue punch should be used especially in the esthetic zone to expose the sub-merged implant instead of the traditional surgical flab, this minimizes soft tissue inflammation and further bone resorption.
3. Initial implant site improvement represented in soft and hard tissue grafting. Modified palatal roll technique which includes rolling, palatal connective tissue pedicle from palatal side into a prepared labial area, It is suitable for adjustment of minor small-sized soft tissue defect around maxillary anterior implants.
4. A-traumatic tooth removal without flap elevation with intention of Immediate Placement of Implants into Anterior Post Extraction Sockets.
5. Papillary regeneration which may be done during second-stage surgery, it should be done carefully to avoid failure due to tension and ischemia.
6. Use of Custom Tooth Form Healing Abutments
7. Use of Gingiva-Colored Porcelain.
8. Platform Switching: This refers to the usage of a smaller-diameter abutment on a larger-diameter implant collar; this type of connection changes the perimeter of the implant abutment junction (IAJ) inward toward the middle of the implant.
9. Use of tooth colored implants such as zirconia implant may enhance esthetic to great extent.

2.6. Perfecting the smile (the digital era)

Traditionally the treatment plan was finalized after discussion with the patient on viewing the diagnostic set-up on the articulator. But nowadays, in the digital dentistry era, virtual smile planning has become an increasingly essential component of the dental procedure. Today, virtual smile designing is used as the basis for creating the treatment plan. The virtual setup is used in addition to planning the other treatment steps in a multi-disciplinary team approach, and viewing the expected result to the patient [35]. For this reason, Digital Smile Design (DSD) software is a beneficial innovation in the modern era as it allows for patient smile enhancement by producing a visible treatment plan. This software undergoes exceptional communication between the prosthodontist and the patient while serving the prosthodontist with advanced communicative abilities with the laboratory technician by performing an accurate treatment plan through algorithms.

DSD enables a systematic workflow mimicking a patient's analysis by basically beginning with properly calibrated images. The frontal and profile facial assessments were commonly investigated using reference lines, from which standardized parameters have been assembled. The inter-pupillary and intercommissural lines, which bring a total logic of agreement and horizontal standpoint to an esthetically attractive face. The essential

shortcoming of this type of therapeutic approach is related to the numerous anatomical sides involved in rehabilitation. The different anatomical parts involved in the treatments, such as the teeth, gingiva, mucosa, lip, skin, and soon, which rely on symmetry, shape, and golden proportions, are associated with the treatment for giving patients an 'esthetic smile [6].

Digital imaging and designing aids patients to visualize the expected final treatment before the beginning the procedures which improve the predictability of the treatment. The prosthodontist can formulate patients` concerns and expectations by digital viewing the outcome [36, 37].

In our opinion, the DSD systems facilitated the communication between the patient and the prosthodontist and between the prosthodontist and technician from the other side, these all lead to best esthetic results.

2.7. Effect of social media on esthetics and cosmetics in prosthodontics: benefits and dangers

Rush-to-market products, media-driven patients` expectations, as well as dentists eager to satisfy, have made disquieting trials with little attention for the risk/benefit calculus of cosmetic dental treatment.Nobody can deny that Social media have a great impact on the manner people transfer ideas and information [38].

The connection nature of social media between individuals, facilitated finding health-related information while also contributing to a networked process of content development and circulation. Former studies viewed that individuals use social media as a way to share their sickness experiences, complaints and participate in health- related discussions with both the general public and within scientific communities [39].

Several studies reported that social media platforms including YouTube, Facebook and Twitter, and Blogs have a major effect on awareness, attitudes, perception and practice of both patients and healthcare personnel in various medical and dental fields. Social media platforms are now used in advertisement, marketing and in education as well [40].

In an cross-sectional study concerned with the dentistry-related communications especially cosmetic treatment by investigating different messages and states posted via micro-blogging services (Reels): they found that Whitening and Cosmetic Veneers possessed the highest results than the true medical advice or instructions and as expected females tended to share mainly the in Cosmetic-related topics than males [41].

All of these factors sometimes represent a great challenge to the prosthodontist to reveal the trueness of what is shown on social media to the patients and explain benefits versus risks.

2.8. Perception of importance of esthetics in arab community

Management of patients' esthetic complaints and demands depends on the assessment of the esthetic perception of the patients .Perception of smile esthetics depends on social and cultural awareness, gender, age and previous experiences of the observer. In this field females tend to be more unsatisfied with their teeth` shape and color more than males generally. Even with the great concern with esthetics appeared lately all-over the world, few studies in the literature have investigated the perception of smile esthetics among dental professionals and laypeople [42].

Nowadays, in Arab societies the awareness about esthetics and cosmetics have been increased due to the spread of advertisements. The ideal smile has predetermined parameters that should be considered while restoring smile. These components include the smile arc, lip position, facial upper and lower midlines, and lip curvature. The correlation between these parameters can be changed to achieve different smiles and appearance that's why different studies were done to discover different smile criteria in Arab communities. The prosthodontist should be familiar with the characteristics of a pleasant smile and the prevalence of each parameter.

For example in a study sample in Saudi Arabia (Alhussmi et al., 2017) there was no concern of Golden proportion with the variety of natural teeth proportions tested. Despite the great awareness of the effect Golden proportion in other societies, such as the Malaysian population [43, 44].

Efforts from Egyptian researchers were done to attain the best satisfying esthetic results it is vivid that the smile we create should be esthetically appealing and functionally sound too.

Al Khodary (2017) concluded in his study on complete denture esthetics that the facial midline and width of the nose helped right selection of the maxillary incisors` width. Patients` opinions regarding their teeth form and color should be taken into consideration carefully. The digital smile design (DSD) software offered a simple and reliable scheme to evaluate and build the complete denture smile [8].

Sharbasy et al. (2022) studied the esthetic CAD-CAM milled PEEK and PEKK frameworks and compared them with the conventional cast Cobalt-chromium frameworks ,They reported that Milled PEKK framework was approximately as preservative as PEEK framework for abutments`

periodontium and supporting bone while metallic framework is still the most preserving for the bone of residual ridge [45].

Regarding the implant supported prostheses; (El-Talawy et al., 2021) investigated the prosthetic complications and patient satisfaction with (PEEK) framework prosthesis veneered with acrylic versus composite resin for individuals restored by "All on four" modality. They found that both esthetic modalities can be used successfully for rehabilitation of patients with maxillary arch rehabilitation as they achieved favorable satisfaction outcomes. However, composite veneers showed better results regarding chewing and appearance while acrylic veneers was superior in terms of accessibility of cleaning[46]

Elbasty et al. (2022) evaluated the Fracture Resistance of laminate veneers made of two different ceramic materials (Zirconia reinforced lithium silicate glass ceramic (CeltaDUO) and Lithium disilicate glass ceramics (e.max CAD) at different load angulations .They found that fracture resistance of ceramic veneers under functional Loads was higher at 60° than at 125° angle for both ceramic materials,.Both Celtraduo and e. max CAD laminate veneers provide clinically acceptable fracture resistance values [47].

3. Conclusions

Esthetics perception sometimes is considered subjective opinion according to different cultures of communities however after reviewing the academic literature in the last ten or fifteen years some points were concluded to obtain the best esthetic results in the different dental prosthetic branches:

1. Regarding the Removable prostheses; the CAD/CAM complete dentures proved to have a promising esthetic results versus the conventional acrylic resin, for RPD concealing or using alternatives to the undesirable metallic framework and clasps can improve acceptance of the RPD by the patients.
2. Regarding the Fixed restorations the all-ceramics reported similar results of the survival and success rate when compared to the metal ceramics, However till now there are no strong academic evidences to rely on regarding the cosmetic Veneers, Lumineers(prep-less Veneers) and Hollywood smile (Snap-on) thought their availability in the Dental markets.
3. For Implant fixed restorations; paying great concern to the precise planning and the right positioning of the implant and the attention of the sot tissues health will give best esthetic results.
4. The Social Media has great effects on the patients` esthetic demands but the implementation of the DSD facilitated the communication between the triad (patient, technician and prosthodontist) and illuminated the esthetic expectations for each and helped to converge viewpoints.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** I hereby declare that I have no conflict of interest in the preparation and writing of this academic work. Throughout the duration of this research and writing process, I have remained impartial and have not been influenced by any external relationships, financial interests, or affiliations that could be perceived as affecting the objectivity or integrity of this manuscript. I have conducted this work with a commitment to transparency and honesty, ensuring that all findings and conclusions presented are based solely on the rigorous examination of the available evidence and current literature.
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