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CONTENTS

The journal of
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Official Publication of Indian Prosthodontic Society
Kerala State Branch

Editorial

Second issue of JPID! IPS Kerala is moving forward in the right path. Editorial board of the JPID is really excited that we could publish quality articles in the initial issues of the journal itself. We are constantly looking forward to increase the quality of the journal further in the coming issues. Apart from creating new domains of research and publication in the field of Prosthodontics, the JPID should be one step ahead of other publications in its content and diversity. I am requesting the members of IPS Kerala to come up with suggestions in this regard. Please feel free to send your feedbacks to ispkeraeditor@gmail.com . We are trying our level best to obtain ISSN recognition and I am hopeful that we will achieve this objective within two months.

20th IPS PG Convention and 46th IPS conference are coming up and registrations are already started. Details of the 'Rebase' programme organized by Government Dental College, Kottayam is already uploaded in our website. I hope all the members and post graduate students will take part in these scientific deliberations.

Dr Prasanth Viswambharan

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Date 10.01.2018

Message

I am very happy to know that THE INDIAN PROSTHODONTIC SOCIETY Kerala state branch is coming up with a journal of their own. I wish all the very best and success for this endeavour and I hope this will be a state of the art journal which inculcates the urge to do valid and novel research among the young professionals.

K K Shailaja Teacher

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OSTEOTOME ASSISTED MAXILLARY RIDGE EXPANSION WITH IMPLANT PLACEMENT: A CASE REPORT

*Byju Paul Kurian, **Johnson, ***Sangeeta, ****Diana, ****Jiss

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Abstract:

Dental implants are the current treatment of choice for the replacement of missing teeth. However placement of implants in the alveolar bone remains a challenge for most of the clinicians because of the resorption of the residual ridge resulting in insufficient bone volume in one or more dimensions. This clinical report describes the use of "osteotome assisted bone expansion" technique for bone expansion of maxillary premolar area followed by implant placement. The bucco-lingual bone width available at the crest was 3 mm, an inadequate width for implant placement. Ridge expansion was accomplished with hand osteotomes followed by delayed loading after 6 months.

Key words:
Ridge expansion, Osteotome, Dental implant

Introduction

In the recent decades, Implant dentistry has become a desirable option for replacement of missing teeth. Sufficient width and height of bone must be present at the recipient site for long-term functional and esthetic results. Alveolar ridge resorption following tooth loss is unpredictable and irreversible process, often occurring as early as 6 months[1]. To facilitate osseointegration and avoid bone resorption, narrow, edentulous alveolar bony ridges less than 5-mm wide require bone augmentation prior to implant placement[2]. Important criteria considered during the implant placement are the presence of atleast 1 mm of bone around the implant[3]. Horizontal augmentation using the principle of guided bone regeneration (GBR), onlay bone block grafts, and alveolar distraction osteogenesis are among the techniques used to enhance the bone volume in case of a narrow alveolar ridge. The drawbacks of these techniques include donor site morbidity, unexpected bone resorption and infection.

Another treatment modality for treating a narrow bone ridge is the bone-splitting/ridge expansion technique introduced by Simion and coworkers in 1992. Narrow alveolar ridge is crestally opened and subsequently split with special osteotomes. The implant is then inserted into the expanded space between the medial and buccal bone walls and allowed to heal in a submerged position. The bone ridge expansion procedure presents the advantage of simultaneous implant placement and avoiding bone graft harvesting from secondary donor sites. After four months of healing the implant is uncovered and loading can be performed[4].

One disadvantage of the bone-splitting/ ridge expansion technique, is the risk of bone resorption due to malnutrition of the laterally out displaced buccal bone wall[4]. The most common anatomic area in which ridge expansion is performed is in the narrow anterior maxilla. When 3mm or more bone is present ridge expansion by means of osteotomes can be done. Osteotomes can offer numerous significant advantages – 1) Allows immediate placement of implants in narrow ridges at the time of expansion 2) Osteotomes compress the bone creating a denser bony interface with

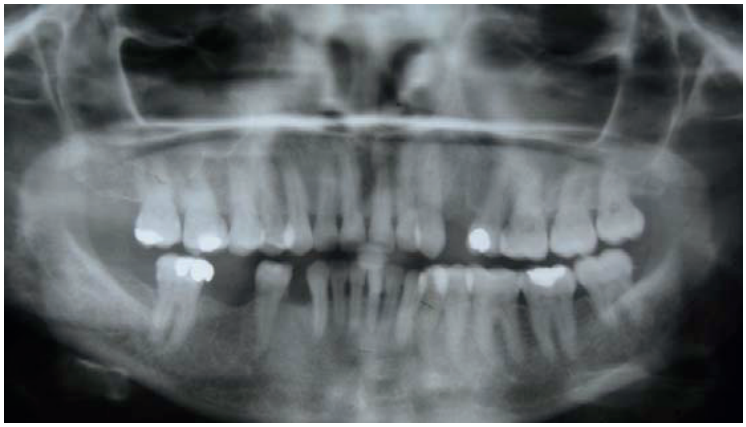

Fig 1: Pre operative Panoramic view

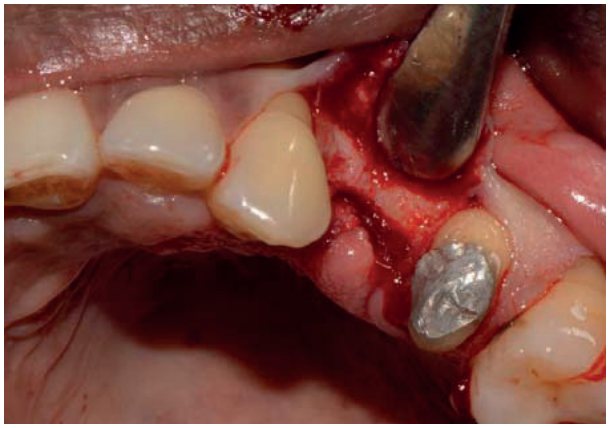

Fig 2: Intra oral view showing narrow ridge

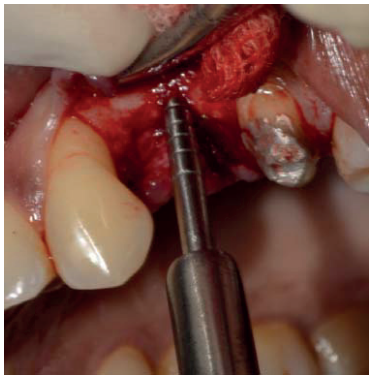

Fig 3: Osteotome assisted ridge expansion

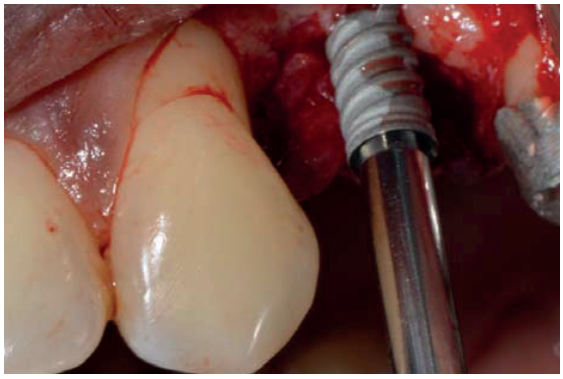

Fig 4: Implant placement

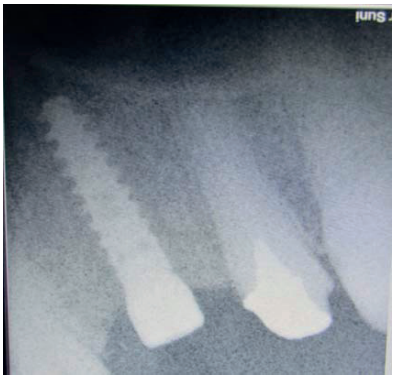

Fig 5: post implant placement after 4 months

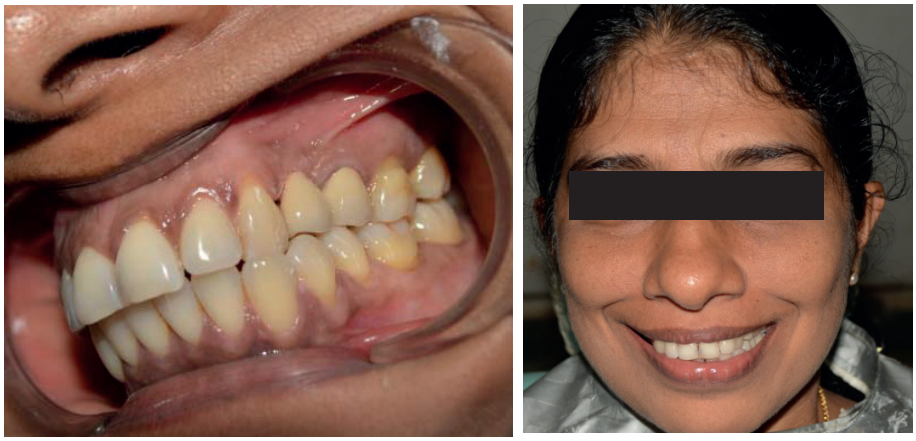

Fig 6: Screw retained metal ceramic crown on 24.

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PROSTHETIC AND IMPLANT DENTISTRY
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Kerala State Branch

increased bone to implant contact and therefore good initial stabilization of the dental implant, 3) Provides a greater tactile sensitivity, 4) It is minimally invasive and cost effective.

This clinical report describes the use of osteotome assisted bone expansion of resorbed anterior maxillary ridge in a patient with missing left maxillary first premolar followed by implant placement and subsequent rehabilitation with implant supported fixed prosthesis.

Case report

A 45 year old female patient reported to the department of Prosthodontics complaining of missing upper left first premolar teeth which was removed due to caries 5 years ago. Intraoral examination revealed missing 44 and 24 , implant on 46, root canal treated 25. Diagnostic impressions were made using irreversible hydrocolloid (Alginate) and study models were obtained in the first appointment. Intraoral peri-apical radiograph of the site 24 and panoramic radiograph were taken. Bone mapping was done which showed a bone width of 3 mm. After discussing the treatment plan with the patient it was decided to proceed with osteotome assisted immediate implant placement on 24 using GDC osteotome kit.

Full thickness mucoperiosteal flaps were raised on the buccal and palatal aspects of cortical plates under local anesthesia. To get a plane surface for the twist drill crestotomy was done with crest remover. An initial osteotomy cut was made horizontally in mesio-distal direction on the crest of the alveolar ridge extending from maxillary left canine to maxillary left second premolar using a fissurotomy bur. An osteotome was placed into the initial osteotomy cut. Using osteotome the bone was slowly expanded by gently tapping it with the hand mallet until the resistance was felt. The osteotome was held in that postion for about one to two minutes, then it was removed and re-inserted and tapping was done again till the resistance was felt. The procedure was repeated until the preferred width for the placement of 2.8 mm implant drill was achieved. Following the desired expansion, the osteotomy hole was extended to a depth of 10mm. Subsequently, an implant of 3.3x10mm dimension was placed in position. The implant was tightened with a torque wrench using a force of 30 N and healing screws were placed followed by placement of sterile Bioresorbable Demineralized Bone Matrix (DMBM) Xenograft Material. The mucoperiosteal flap was scrupulously sutured using 3-0 non-resorbable silk. Analgesics, Antibiotics and 0.2% Chlorhexidine mouth wash was prescribed. Patient was recalled after 7 days for removal of sutures and satisfactory healing of the wound was observed.

Following 6 months of periodic evaluation the second stage surgery was planned and gingival former of 5 mm height was placed. After 2 weeks gingival former was removed and impressions made using the open tray technique followed by jig trial. Cement retained metal ceramic crown was fabricated. For maintaining precise contact and contours, the crowns for implant (maxillary left 1st premolar) and endodontically treated maxillary second premolar were fabricated simultaneously.

Discussion

Dental implants commonly known as the third dentition have now revolutionarized various treatment modalities. The first requirement for a successful implant therapy is the availability of adequate amount of bone in terms of vertical as well as horizontal dimension. Reduced ridge width is a serious challenge for the successful placement of endosseous implants. It is well established that alveolar ridge less than 5 mm requires augmentation procedure in order to receive endosseous implant[5]. A single-step technique for bone expansion using osteotomes with gradually increasing diameters and subsequent placement of implants has been well documented[6]. Bone is a viscoelastic material that can be compressed and manipulated. Osteotomes are distinct from drills in that they do not excise bone during osteotomy

preparation rather they exert lateral compression, which increases bone density. The lower bone density and thinner cortical buccal plate in maxilla suits a successful ridge expansion[7, 8, 9].

The bony expansion using osteotomes is a reliable and relatively non-invasive way of widening narrow ridges which do not require harvesting of bone. The major advantages are reduced operating time, postoperative morbidity, short rehabilitation time, and less risk of exposure of the membrane or bone graft that could lead to infection.[10, 11].

Conclusion

The alveolar bone which has regenerative as well as viscoelastic properties, has shown a better survival rate following ridge expansion. Special consideration should be paid to the risk of labial/ buccal bone plate fracture and the restraint of implant placement along ridge expansion axis. This novel technique of bone expansion with osteotome offers the possibility of placing implants in cases of bone atrophy without the need for other more complex treatments.

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CUSTOMIZED POST SURGICAL VENTED EXTERNAL AUDITORY CANAL STENT FOR TREATING ACQUIRED ATRESIA- AN INNOVATIVE TECHNIQUE

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Abstract:

Acquired stenosis or atresia is an uncommon disorder of the external auditory canal. Its incidence has been estimated at 0.6 cases per 100,000. It has different names in literature such as post-inflammatory medial meatal fibrosis, post-inflammatory medial canal fibrosis, post acquired stenosis or atresia is an uncommon disorder of the external auditory canal. Conventional stenting materials like sponges or gauze can be used effectively to prevent stenosis of the external auditory canal, but these materials need to be firmly packed inside the canal which will result in occlusion of the canal with poor drainage and ventilation leading to partial hearing loss. This case report describes a novel technique for the fabrication of an acrylic stent with a vent in the centre of the prosthesis. The customized ear mold stent effectively prevented stenosis, while the vent not only provided ventilation but also improved hearing during the stenting period.

Introduction

Acquired external auditory canal (EAC) stenosis or fibrosis is a narrowing of the EAC caused by a variety of factors. It can occur at the meatus (opening) or along the cartilaginous or bony segment of the EAC. It is an uncommon occurrence, developing in a reported 0.6 cases per 100,000 people[1]. The most common causes include tumor, infection, trauma, and surgery. All these factors induce an inflammatory response, resulting in the formation of acute granulation tissue (soft, fleshy reactionary tissue). If left untreated, granulation tissue can epithelize (skin from the edges of the injury grows over the granulation tissue) into a soft membranous stenosis. Eventually, this soft membrane will remodel and mature into firm, fibrotic scar tissue or stenosis[2]. Immature stenoses, which are still soft and have not developed into firm dense scar tissue, can be treated with nonsurgical methods such as frequent aural cleansing, ototopical antibiotic/steroid drops, serial local steroid injections, and prolonged stenting.

Mature stenoses are resistant to these conservative measures and require surgical excision. Once the stenotic region is surgically removed, canalplasty, meatoplasty, and split-thickness skin grafting are commonly performed[3]. These surgical procedures are used to widen the EAC, open the EAC meatus, and cover the resected area with skin to prevent restenosis. Incomplete excision of the fibrotic scar tissue results in higher restenosis rates[4].

The journal of
PROSTHETIC AND IMPLANT DENTISTRY
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Kerala State Branch

Postoperative EAC stents are almost always used. Common/traditional stenting materials include plain and coated gauze such as Iodoform or Xeroform, expandable ear wicks, and absorbable gelatin sponges (Gelfoam). Silicone dental-impression compounds (Optosil and Reprosil) have also been used on occasion as short-term stents, with conversion to custom acrylic stents for long-term use[5]. The long term use of stents made from these materials have the drawback of reduced hearing and ventilation due to lack of venting. Hence EAC stents in Poly Methyl Methacrylate (PMMA) with stenting was suggested as a valuable alternative.

This article presents a case where stenting was accomplished through the use of a custom canal acrylic ear stent with a vent.

Case report

A 76-year-old female patient reported to the Department of prosthodontics for fabrication of an ear stent (Figure 1). She was treated surgically for removal of epidermoid cyst in the left external auditory canal followed by reconstruction with split thickness skin graft. The treatment plan included placing EAC stent to prevent scar tissue formation and subsequent stenosis of the canal. She was using a coated gauze stent for 2 weeks after the surgery. It was decided to fabricate a heat cured PMMA vented stent with a wide bore to provide ventilation and improved hearing during the stenting period.

An impression of the external auditory canal along with the pinna of the affected ear was made in Putty

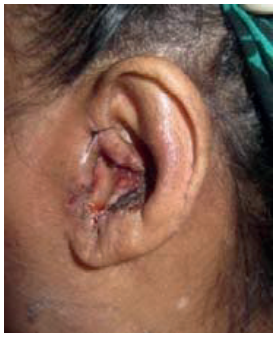
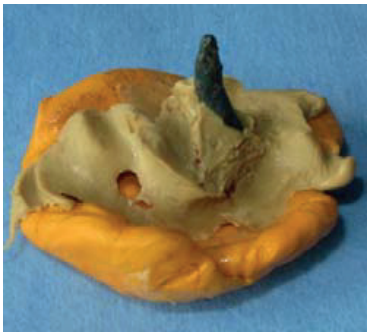


Figure 1 Preoperative view of the patient

Figure 2 & 3 Addition silicone Impression



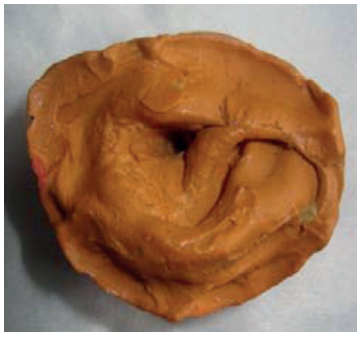


Figure 4 Stone model

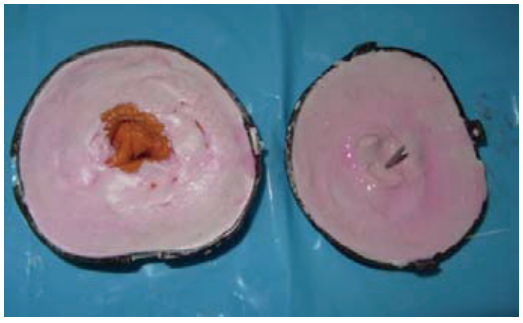


Figure 5 Mold

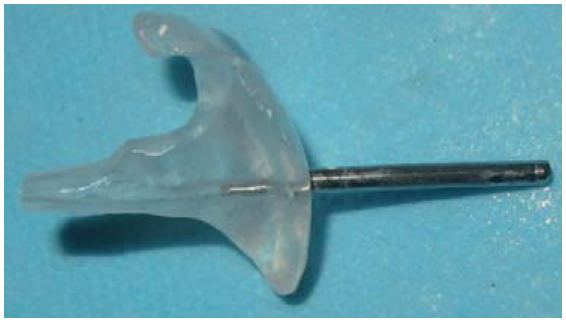


Figure 6 Processed acrylic stent with partially removed bur shank

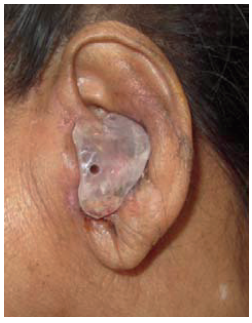


Figure 7 Processed PMMA ear stent in patient.

(ELITE HD+ Zhermack LOT 228679) and light body (FLEXCEED LOT 1405221) consistency of polyvinyl siloxane elastomeric impression material. Inner part of the canal was recorded with tempered low fusing impression compound. Light body material was injected into the folds of the auricle with the molded impression compound in the canal and the whole impression was again picked up using putty consistency Vinylpolysiloxane impression material (Figure 2&3). The impression was retrieved as a single unit, and a stone cast was made (Figure 4).

A wax pattern was fabricated including the folds of the auricle so as to obtain maximum retention for the prosthesis. A smooth and cylindrical shaped shank of an acrylic trimming bur was cut and placed in the wax pattern extending in to the canal, the removal of which will create a bore in the final processed prosthesis. The wax pattern was flasked and dewaxed in a conventional way .Vaseline was applied around the bur shank to allow easy removal after processing of the prosthesis (Figure 5). After dewaxing, the mould was packed in heat cured PMMA acrylic in dough stage and cured (Figure 6). After retrieval of the prosthesis from the flask, the shank of the acrylic bur was removed by pulling it with an orthodontic plier in order to create the bore of the stent. Acrylic stent was trimmed according to the anatomy of the auricle and finishing, and polishing was carried out (Figure 7). Stent was then kept in water for 24 before insertion to further reduce the monomer content. Instructions were given to remove and reinsert the stent by the patient for cleaning at home. The patient was recalled once in every 2 weeks for the first 2 months and later once in every 1 month for 18 months. No signs of stenosis were found during the recall visits.

Discussion

The epidermoid cyst is a common benign disease of the skin caused by inflammation of hair cortex follicles and proliferation of epidermal cells within the dermis or superficial subcutaneous tissue[7]. It is rarely seen in the EAC. Patients are mostly asymptomatic. They can get infected and later rupture. Epidermal inclusion cyst may mimic an early stage canal cholesteatoma which consists of, hyper proliferative epithelium, keratin debris, an intact basement membrane, and accumulation of inflammatory cells. Surgery is the treatment in asymptomatic cases.[8]

Conventional stenting materials like sponges or gauze can be used effectively to prevent stenosis of the EAC, but these materials need to be firmly packed inside the canal for adequate maintenance of the width of the canal. This will result in occlusion of the canal with poor drainage and ventilation leading to partial hearing loss of the affected ear[9].

Customized, hard acrylic stents with a central hole provide a non traditional alternative for EAC stenting to successfully prevent stenoses. During the prolonged EAC stenting period, a customized earmold provides a safe, comfortable, and effective alternative to traditional stenting materials. Venting the earmold subjectively reduces the conductive hearing loss encountered with traditional gauze stents[6].

Conclusion

This clinical report describes the management of post surgical stenosis of external ear canal with the help of a custom made acrylic stent. A novel technique of using the shank of an acrylic trimming bur to create a bore in the centre of the prosthesis is explained here. The role of the prosthodontist is equally important as other members of the team in maintaining the patency of the canal and assisting the wound healing.

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MAXILLARY SINGLE COMPLETE DENTURE REINFORCED WITH METAL PALATAL MESH: A CASE REPORT

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Abstract:

Single complete dentures are a challenging task for prosthodontists. The single complete denture is a complex prosthesis that requires a complete understanding of the basics of prosthetic rehabilitation of lost natural dentition. Single complete denture may be opposed by natural teeth, fixed restorations, a removable partial denture or an existing complete denture. This case report deals with the oral rehabilitation of completely edentulous maxillary arch opposing a dentulous mandibular arch with full complement of natural dentition, by incorporating a metal mesh into denture base to combat the masticatory forces from natural dentition and improve the longevity of the prosthetic replacement.

Key words:
Single complete denture, metal mesh

Introduction

Complete dentures continue to have an important role in the treatment of edentulous patients. Many patients become edentulous in one arch while some or all of their natural teeth remain in the opposing arch. The single complete maxillary denture opposing all or some of the mandibular natural dentition is not an uncommon occurrence[1]. Several difficulties are encountered in providing a successful single complete denture treatment, the most common being repeated fracture of the prosthesis[2]. The occlusal problems and denture base fractures seen in single complete denture are result of one or all of the following reasons : occlusal stress on the maxillary denture and underlying edentulous tissue from the teeth and musculature of opposing natural teeth; the position of the mandibular teeth, which may not be properly aligned for the bilateral balance needed for stability or flexure of the denture base.[3]

An ideal solution is to strengthen the single complete denture base with metal reinforcement, which may reduce the flexure of denture base. Metal due to high malleability and higher strength can scaffold the acrylic material to withstand flexural fatigue and stress concentration there by reinforcing the denture. Metal can be added in form of wires, bars, mesh or plates. Metal strengthener had a beneficial effect on the fracture resistance of the polymethyl methacrylate[4].

This case report describes the clinical management and fabrication of single complete denture with metal mesh reinforcement.

Case Report

A 60-year-old male reported to the department of Prosthodontics (Government Dental College,

Thiruvananthapuram) with a chief complaint of completely edentulous maxillary arch and a dentulous mandibular arch. The maxillary teeth were extracted 3 years back for the treatment of carcinoma pharynx. Intraoral examination revealed severely resorbed maxillary alveolar ridge. The patient was suffering from oral submucous fibrosis and the saliva was of medium consistency. The patient was cooperative and philosophical according to House classification. Mandibular teeth were healthy and the occlusal plane was unaltered.(Class 1 Single complete denture)[5]. Treatment was planned to give a maxillary single complete denture with metal mesh reinforcement (Figure 1).

Procedure

- Impression of mandibular teeth was made with an irreversible hydrocolloid impression

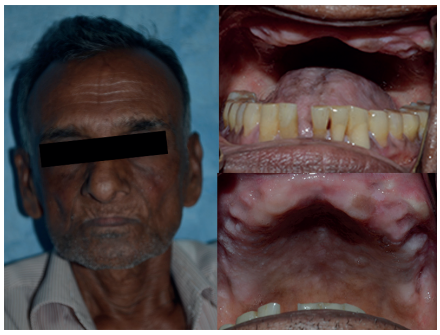

Figure 1:Preoperative

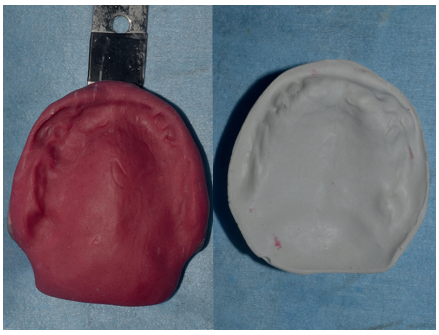

Figure 2: Preliminary Impression and Cast

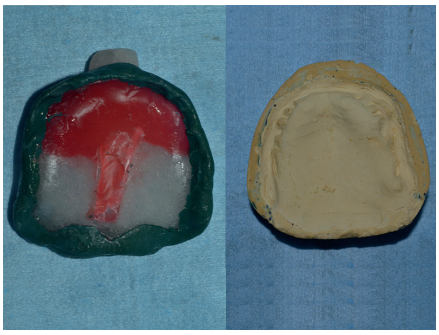

Figure 3: Peripheral Tracing and Master Cast

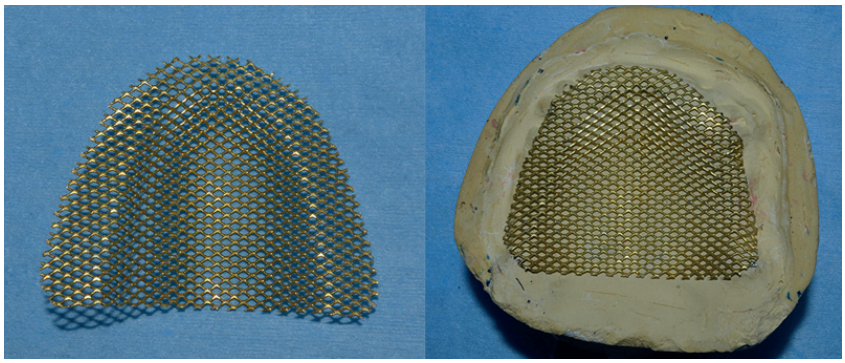

Figure 4: Adapting Metal Mesh

Figure 5: Jaw Relation

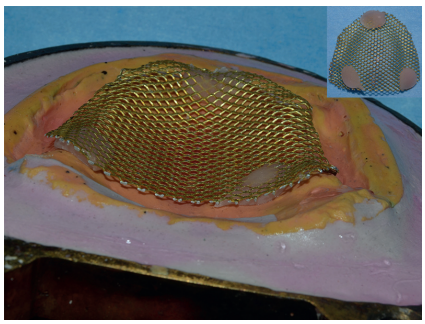

Figure 6: Positioning Metal Mesh

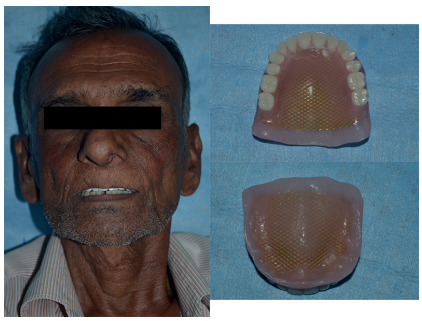

Figure 7: Postoperative

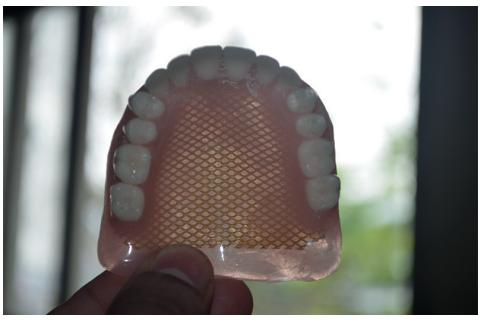

Figure 8: Single Complete Denture with Metal Mesh Reinforcement

material 1 (Zhermack Tropicalgin Alginate) and dental stone (Gypstone) diagnostic cast was poured.

- Preliminary impression of the edentulous maxilla was made with impression compound (Pyrax) and primary cast was made for the fabrication of a custom special tray (Figure 2).
- The peripheral tracing procedures was done with green stick impression compound (Hiflex) and the final impression was made with light body addition silicone elastomeric impression material (3M ESPE Imprint3) (since the patient was sensitive to conventional zinc oxide impression material).
- Master cast was made with dental stone (Gypstone) (Figure 3).
- A commercially available stainless steel metal mesh was adapted to the master cast and then adapted metal mesh was removed from the cast (Figure 4).
- Occlusal rim on the maxillary denture base was constructed and contoured for adequate lip support in the anterior region to stimulate the vertical and horizontal overlap of the anterior teeth and the vertical dimension and centric relation were recorded (Figure 5).
- Arrangement of the artificial teeth was carried out to reveal the necessary changes to be made on the lower teeth. Adjustments in the artificial teeth were incorporated in preference to making changes to the natural teeth.
- A trial of waxed up maxillary complete denture was done and it was invested in a denture flask.
- After dewaxing the preadapted metal mesh is tried on the master cast surface.
- The mesh was positioned in the cast such that there was uniform space beneath it with the help of widely separated three cold cure stoppers (Figure 6).
- Then cope of the flask is tried by closing the flask with a wax spacer, any indentation of the metal mesh on the wax spacer was checked and corrected by readapting the metal mesh.
- Two coat cold mould seal (DPI Cold Mould Seal) was applied to the dewaxed surfaces and packed with heat cured acrylic resin (DPI Heat Cure).
- After curing the denture was polished and inserted into the patient's mouth (Figure 7 and 8).
- Post insertion instructions were given to the patient regarding its maintenance and hygiene.

Discussion

One of the most common clinical situation involving a single complete denture is that of an edentulous maxillary arch with mandibular natural teeth. When a dentate arch opposes an edentulous arch, the edentulous arch is adversely affected because of the forces generated[5]. The natural teeth are firmly and rigidly retained in the bone and they can resist or deliver greater magnitude of the force without discomfort or displacement. The force has been recorded as high as 198 lb on single molar teeth. This is in sharp contrast with force with a complete denture, resting over the delicate mucosa of the ridge, which is established as a maximum static load of 26 lb[6]. There might be occlusal stress on the maxillary denture and the underlying edentulous tissue due to forces from teeth and musculature and opposing natural dentition. The midline fracture in a denture is often a result of flexural fatigue resulting from opposing natural dentition.

There are several methods to increase the resistance of denture base to mechanical stress.

Acrylic resin base reinforced with several types of fibres like carbon, aramid, woven polyethylene and glass fibres have been introduced in past, but they all have certain disadvantages[7]. Carbon and aramid fibres strengthen PMMA but cause clinical problems like difficulty in polishing. Woven polyethylene fibres cause difficulty in processing as it requires etching, preparing and positioning layers of woven fibres which is impractical for dental office. With glass fibres, there is difficulty in achieving adequate impregnation of the fibres with PMMA. Reinforcement by incorporating butadiene styrene rubber has also been used (Rubber toughening). A metal reinforced denture base is usually preferred among all the reinforcement methods as it reduces the likelihood of denture fracture caused by extensive biting and impact force problems and do not cause much difficulty in processing. Metal framework reinforcement is used in complete dentures to improve the fracture resistance, dimensional stability, accuracy, weight and retention of a definite prosthesis[8].

Variety of metals can be used to fabricate the prosthesis including cobalt –chromium, nickel-chromium and titanium. These metal bases offer several advantages including high rigidity, fracture resistance, excellent strength to volume ratio, good adaptation to the supporting tissues, high thermal conductivity and no dimensional change in time. Metal denture bases have certain disadvantages including high cost, difficult refitting of the denture and increased time consumption in comparison to the acrylic resins. Several authors have described alternate economical techniques for suspending metal framework within denture bases before processing. Some authors advised the use of alginate edentulous impression tray as a method of reinforcing the denture base[9]. All forms of metal reinforcement significantly increased the impact strength and tensile strength of the denture base.

Summary and Conclusion

This article details a method for reinforcing single maxillary complete denture using a commercially available palatal mesh. Conventional metal base dentures are costly and required more patient appointments. In this article a simple and economical method of reinforcing denture with commercially available metal mesh was described.

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'REHABILITATING COMPLETE EDENTULOUS ARCH WITH MANDIBULAR FIXED PROSTHESIS: A CASE REPORT'

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Abstract:

An implant retained fixed denture is one that is fabricated over a metal framework and is cement retained into the implant abutments. The anterior part of a mandibular prosthesis is fixed on implants while the posterior part of the denture is extended and cantilevered from implants. This article presents the fabrication of a maxillary complete denture opposing mandibular implant retained fixed prosthesis.

Introduction

Osseointegrated implant treatment was originally designed by Dr, Per Ingvar Branemark for the edentulous patient. The term used by Branemark and others is 'Tissue–integrated Prosthesis'[1]. Many designs have evolved for treating patients with compromised bone or special needs[2]. These prosthetic designs may have an impact on biomechanics, maintenance, and implant success rates. Preoperative evaluation of the structure and quality of the edentulous residual ridge, the intermaxillary relationship, esthetics, phonetics, hygiene, and cost considerations will aid in differential treatment planning.

Implant-supported prostheses are a good option for edentulous patients who could not adapt to long-term use of conventional complete dentures. In fixed implant prosthesis, number of implants and AP spread determines the extent of cantilever. Unfavourable occlusal loading on cantilever extension leads to failures like loosening and breakage of screws and prosthetic posts, framework fracture, and implant loss. Cantilever load is primarily determined by the length of the lever arms and distal extensions[3]. It has been suggested that the extension from the midpoint of the most distal implant must not exceed 15 mm in the mandible[4].

Case report

A 60 -year-old woman was reported to PMS college of dental science and research with completely edentulous upper and lower arch having adequate interarch space [Figure 1]. Fabrication of cement retained prosthesis was planned for the mandibular arch and a new complete denture for maxillary arch. The unfavourable sinus anatomy in the posterior maxilla and patient's unwillingness for bone grafting to facilitate implant placement circumvent the placement of implants in the maxillary arch. The treatment options presented to the patient also included the fabrication of an implant-supported over-denture, but the patient's desire was to eliminate a removable prosthesis in the mandible.

Conventional procedure for fabrication of complete denture was carried out from primary impression till trial [Figure 2,3]. Mandibular trial denture was used to evaluate and determine the position of implant placement. Mark the position of teeth in mandibular master cast [Figure 4]. Radiographic stent fabricated for mandibular arch and assessed with OPG for bone height at the positions [Figure 5,6].

Stage I implant surgery

Surgical stent was fabricated with acrylic. With this stent mark the positions of implant on the

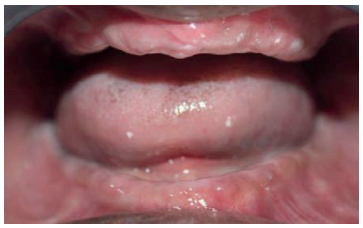
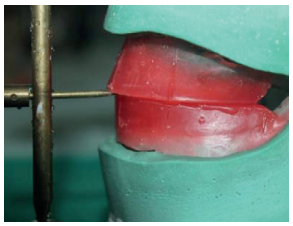


Figure1 pre op



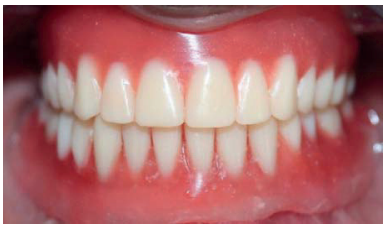


Figure 2,3 Jaw relation and trial insertion

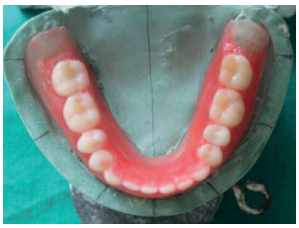


Figure 4 Mark the position of teeth in master cast

Figure 5 Radiographic stent

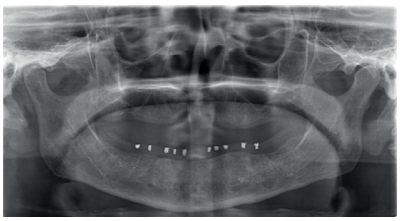


Figure 6 OPG with radiographic stent

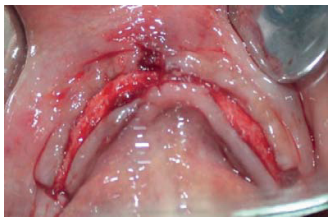


Figure 7 Full thickness mucoperiosteal flap elevated

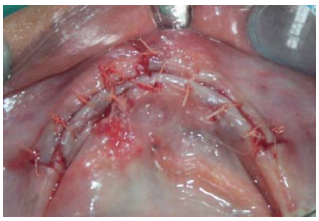


Figure 8 simple intermitent suture placed

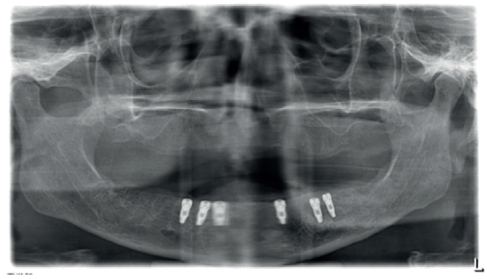


Figure 9 OPG

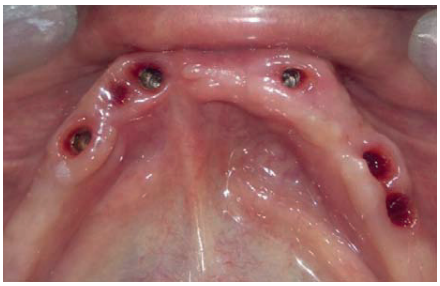


Figure 10 Healing screw removed

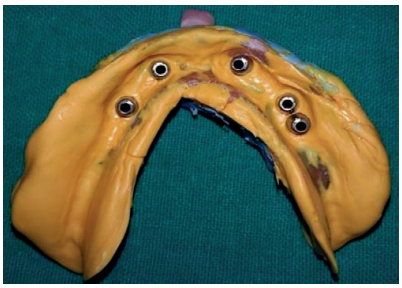


Figure 11 impression

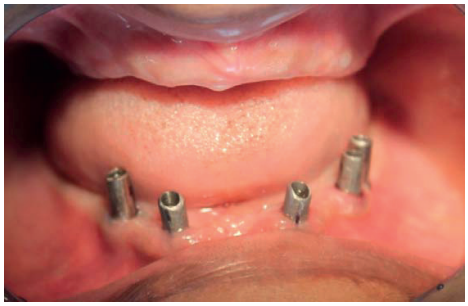


Figure 12 abutment screwed to fixture

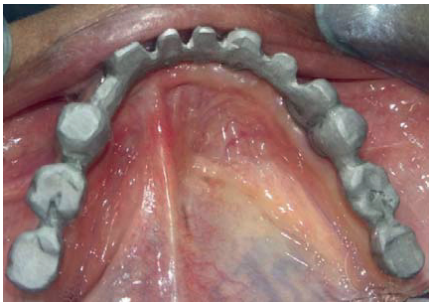


Figure 13 Metal frame work trial insertion

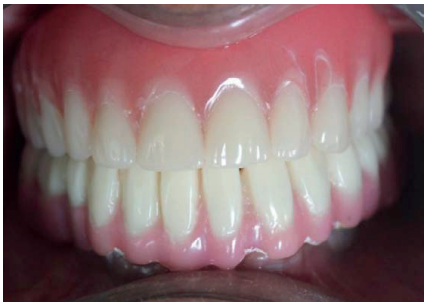


Figure 14 Finished prosthesis

mandibular arch with punch drill. A full thickness mucoperiosteal flap was raised in the mandibular arch from distal to mental foramen on one side to 1st molar on the other side. In the right quadrant, implants (GMI frontier implant) were placed in the 2nd premolar (3.75 mm × 10 mm), canine (3.75 mm × 10 mm), lateral incisor (3.75 mm × 10 mm) regions. In the left quadrant, implants were placed in 1st molar (3.75 mm × 10 mm), 2nd premolar (3.75 mm × 10 mm), lateral incisor (3.75 mm × 10 mm) and regions. A total of six implants were placed in the mandibular arch with a help of surgical stent. The flap was closed using simple sutures. After 1 week, the sutures were removed and soft tissue healing was satisfactory [Figure 7, 8]

Stage II implant surgery

After a waiting period of 4 months, an OPG and IOPA were obtained to evaluate the bone to implant contact percentage [Figure 9] and later stage II surgery was performed under local anesthesia cover screws were exposed .Crestal portion of implant placed at canine and lateral incisor in fourth quadrant get more closed due to error in angulations. So implant placed in canine region was made submerged and five healing abutments were placed and the flap sutured.

Prosthetic phase

After 2 week, the healing abutments were removed [Figure 10]. A well formed gingival collar noticed. A custom open tray was fabricated in acrylic resin for the mandibular arch. Impression copings were connected to the implants. These open tray impressions copings were stabilized with dental floss and pattern resin. The open tray was verified in the patient's mouth. The mandibular impression was made with polyvinyl siloxane impression material [figure11]. Jig trial was made on working cast and verified intraorally .Wax up for framework fabrication was carried out and casted. The metal framework was tried on straight abutments to evaluate and verify a passive fit intra-orally [Figure 12,13]. At this time an IOPA for each implant made to evaluate the fit between frameworks and implant interface. The maxillary complete denture acrylised, finished, polished and inserted. As the opposing denture is acrylic, mandibular implant prosthesis fabricated with acrylic over the metal frame work. Finished and polished prosthesis then cemented to the abutments. [Figure14]. Balanced occlusion verified. Post insertion instructions were given. Hygiene techniques were reviewed, and patient was scheduled for recall and maintenance.

Discussion

Functional stability and the preservation of remaining alveolar bone are primary, and often elusive, goals when restoring edentulous arch. But retention and stability in mandibular denture is compromised in many cases mainly due to interference of tongue. The incorporation of dental implants offers a practical adjunct in the fulfilment of these objectives. The degree of alveolar bone resorption determines whether teeth, or teeth and other tissues, must be replaced. With minimal resorption, a cement retained restoration is preferable to accommodate interarch space limitations.

According to Adell et al, the bridges were continuously stable in 89% of the maxillary and 100% of the mandibular cases. The mean value for marginal bone loss was 1.5 mm during healing and the first year after connection of the bridge. Thereafter only 0.1 mm was lost annually[2].

Regarding impression making Dr. Babita[5] systematically reviewed various impression materials and found polyvinyl siloxane and polyether both are the material of choice for making accurate impression. Wenz et al[6] reported that one stage impression using both putty and light body simultaneously is more accurate than the two stage impression. An open tray impression technique was used in this case with joining impression copings with pattern resin to get accurate impression. Heeje

Lee et al[7] found that for situations in which there were 4 or more implants, the pick-up technique more accurate than the transfer technique. Using a rigid material, connect all the impression copings together to prevent individual coping movement during the impression- making procedure[1]. Also studies reported more accuracy in implant impressions with the splint technique than with the nonsplint technique.[8]

The rehabilitation of edentulous patients with fixed dentures has been observed to achieve greater masticatory function and psychological satisfaction than with conventional over-dentures[9]. Many investigators have studied occlusal force measurements in patients with implant-supported prostheses opposing complete maxillary dentures, but their force measurements vary significantly[10]. Finger and Guerra stated that when implants are placed in one arch there is the possibility of rendering an opposing complete denture unstable. Zarb and Schmitt[11] suggested that the imbalance in stress resolution may lead to rapid resorption of the alveolar ridge in the maxillary arch. However, there is a little quantitative analysis on the distribution of occlusal loads and the stability of a maxillary denture opposed by a implant denture

Conclusion

Proper diagnosis and treatment plan are important. Every patient has unique treatment modalities. A thorough medical and dental history, clinical examination, dental radiographs, impressions, and jaw relation records are important steps leading to a successful oral rehabilitation. Careful execution and planning of treatment needed, enhances the final outcome. Dentists must consider the merits and demerits of implant prosthetic options and also to the patient's expectations. This article reports on the fabrication of a maxillary complete denture opposing mandibular implant fixed prosthesis. Occlusion and articulation were found to be good. Patient is satisfied with retention and stability.

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OCULAR PROSTHESIS FOR CONGENITALLY MISSING EYE - A CASE REPORT

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Abstract:

Loss of eye either due to trauma or congenital reason will have impact on person's social life or also inflicts psychological trauma . Rehabilitation of pediatric patients with custom made prosthesis have better adaptation to tissues stimulates muscle and provide better neuromuscular control for movement of the prosthesis. Rehabilitation of these patients with ocular prosthesis increases their confidence and gives courage to face the world. Various techniques are mentioned in literature for fabrication of custom made ocular prosthesis The combination of the iris of stock shell with custom made scleral part was used during fabrication of this prosthesis.

Key words:
congenital missing eye, ocular prosthesis

Introduction

Eyes are integral part of the oro-facial region. Various functions are performed by the eyes. Visualization of an object is possible because of sensory and motor nerve supply to the eyes. Eyes also have important role in esthetics of that person. Missing eye either due to trauma or congenital reason will have impact on person's social life or also give psychological trauma to that person. Rehabilitation of these patients with prosthetic eye increases their confidence and gives courage to face the world. Pare from Paris in their book described two types of ocular prosthesis—one fitted underneath the eyelids called 'hyplepharon' and the other fitted externally called 'eclepharon'[1]. Ocular prosthesis is classified into two type stock eye shell and custom made prosthesis. The various indications requiring prosthesis are divided into two broad categories namely congenital and acquired deformities. Anopthalmia and micropthalmia are most commonly occurring congenital defect where as phthisis bulbi, atrophic bulbi staphyloma, post chemical injury, post orbital exenteration are some common acquired reasons for loss of eye .

Custom built, hand painted prosthesis fabricated for individual patient from methyl methacrylate is universally accepted treatment modality.[2] This article gives a brief idea about custom made ocular prosthesis for pediatric patient with congenitally missing left eye

Case Report

A six years old female patient reported to department of prosthodontics, PMS College of dental science and research, Trivandrum with chief complain of missing eye since birth. On examination it was observed that left eyeball was missing from left eye with constricted fornix. Intraocular examination showed non irritated non inflammatory healthy tissue bed with average

tissue movements. Patient was not having any history of prosthetic eye. Right side eye was normal in size and function.

Steps in fabrication of ocular prosthesis-

1- Considering patient age , comfort and co operation primary impression was made using elastomeric impression material by making patient reclined on dental chair. (figure- 1)

2- Light body impression material (3M ESPE) was injected into the eye socket and patient was asked to perform the various eye movements to record the tissue details.

3- The elastomeric impression material was supported with alginate impression material (Jeltrate) and reinforced using dental plaster before it is removed from the eye.

4- After the impression was set split cast was poured with dental stone (Gyprock), orientation notches were placed before pouring the second part for orienting split cast back in position.

5- Hard wax (MAARC) was used to form wax pattern. Molten wax was allowed to flow into the mould space obtained after pouring split cast. (Figure2)

6- Wax trial was done to check for the fullness and support of eye lids. (Figure 3)

7- Orientation of iris- The facial midline was marked. The distance from the midline to right iris was measured and marked with patient in upright position and straight gaze. The same measurement was taken to position the left iris. (Figure 4)

8- Shade selection of iris from stock eye shell was done and it is contoured to fit into the size of wax pattern.

9- Position is rechecked by placing into eye and final contouring done

10- Flasking and dewaxing procedures were

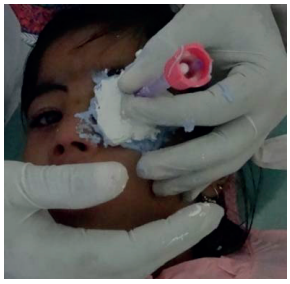

Figure 1.- Primary impression.

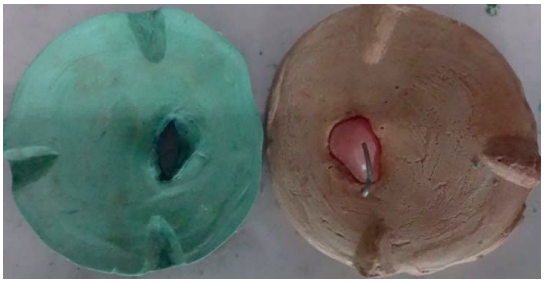

Figure 2.- Split cast with wax pattern

Figure 3 – Wax Trial

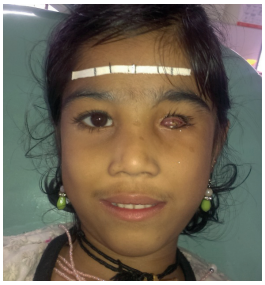

Figure 4 – Positioning of Iris

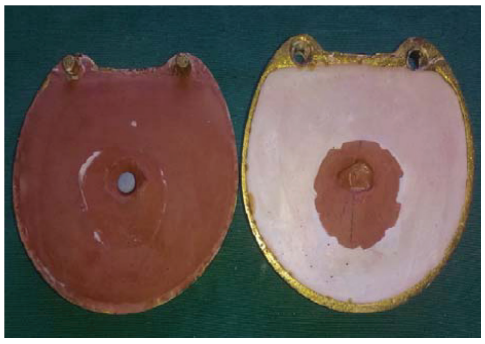

Figure 5- Acrylisation

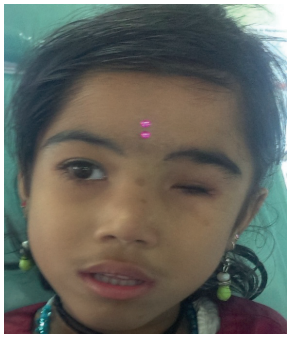

Figure 6- Preoperative

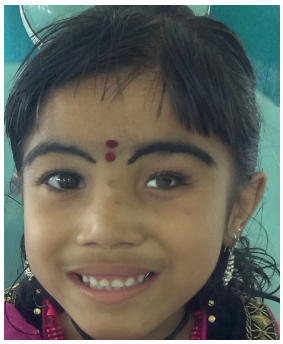

Figure 7 - Final prosthesis

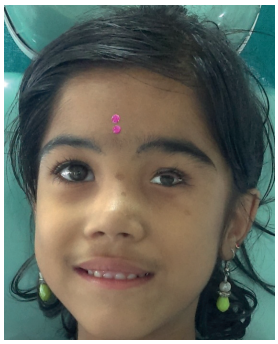

Figure 8 - Final prosthesis

followed by acrylisation. Scleral poly methyl methacrylate resin was used and long acrylisation cycle was followed to minimize residual monomer. (Figure 5)

11- Finishing and polishing was done and final insertion of customized eye shell was performed. (Figure-7,8)

12- Post insertion instructions were given

13- Patient was recalled after 24 hours for review

14- Various eye exercises were advised to increase mobility and aids in growth and development of socket as well as surrounding muscles.

Discussion

Pediatric patients with missing eye should be treated with custom made ocular prosthesis of larger size to facilitate the growth and development.[3] With increasing age, the ocular prosthesis requires replacement or modification for better fit and adaptation occurring due to growth. The indications for re-fabrication include prosthesis rotation within the socket, loose fit, decentration of the cornea, cosmetically significant ptosis, or discoloration of the prosthesis[4]. Soft tissue growth occurs up to twelve years of age, relining of prosthesis up to this age will help in increase in growth of fornix size[5]. Prosthetic rehabilitation with implant can significantly improve the appearance of the patient but implants are not indicated until the growth of the patient is complete[6].

Various techniques are mentioned in literature for fabrication of custom made ocular prosthesis.[7,8] The combination of the iris of stock shell with custom made scleral part was used during fabrication of this prosthesis. This technique is less time consuming and acceptable. Iris painting is an art which requires practice to characterize the iris to match the opposing iris and it can achieved only with repeated efforts. Custom made ocular prosthesis will have intimate tissue contacts , a stock acrylic shell lacks this intimate contact leading to accumulation of fluid between the prosthesis and tissue surfaces provides house for the bacterial growth and increased fluid pressure within the socket leads to tissue irritation and inflammation.[9] Ow and Amrit recommended the use of tissue conditioner for lining the custom made prosthesis for better tissue support and patient comfort[8].

Conclusion

Rehabilitation of pediatric patients with custom made prosthesis have better adaptation to tissues stimulates muscle and provide better neuromuscular control for movement of the prosthesis. Review appointments are integral part of the treatment and prosthesis have to relined or changed according to need of the patient and growth and development of socket.

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A SYSTEMATIC REVIEW OF ACCURACY OF CONVENTIONAL TECHNIQUE AND DIGITAL PHOTOGRAPHIC TECHNIQUE FOR TOOTH SHADE MATCHING.

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Abstract:

Shade matching of a restoration to the remaining natural teeth is of primary importance to all the patients .Various types of guides are present to facilitate the colour matching process. Digital photographic image makes it possible to evaluate several points which can aid in determining the true shade of a tooth. A comprehensive search was performed to identify related studies for inclusion in the review. All identified titles and abstracts were independently assessed for subject relevance. Full texts were then obtained and formally assessed for inclusion. This systematic review evaluated 29 studies that compared the efficacy of visual and instrumental shade matching methods.

Key words:
digital shade matching, conventional shade matching.

Introduction

The increasing aesthetic expectations in daily life directly affect techniques and treatment procedures in dentistry. Shade matching of a restoration to the remaining natural teeth is of primary importance to all the patients. The aesthetic demands of patient and dentists have elevated the importance of accurate shade matching.

Traditionally it has been performed visually with the aid of shade guide. Various types of guides are present to facilitate the colour matching process. However, irrespective of the type of shade guide system used, visual shade determination is associated with a high degree of sensitivity. Therefore a demand for methods that can analyze tooth shade objectively has emerged.

In this "information age" use of digital cameras and computers have become widespread in dentistry. Digital photographic image makes it possible to evaluate several points which can aid in determining the true shade of a tooth. The instrument is capable of recording digital data from an object and producing an image on computer screen, which can then be transmitted via internet. Images produced via a digital camera may be analyzed using appropriate imaging software.

Shade matching that is based on digital imaging is convenient and less expensive than the use of spectrophotometers and colorimeters.

So a systematic analysis was undertaken to review the matching performance of digital photographic shade analysis and conventional visual shade

TABLE-Characteristics of 29 studies included

Sl no.	Study	Study design	Setting	Method	Device	Sample			Assessment
						Type	no.	Area	
1	Raluca Draghici et al 2015	Cross sectional	In vivo	Visual Spectrophotometer	3D master shade Vita easy shade	Natural teeth	306	Middle third	Visual determination was reliable. Visual method assisted by spectrophotometer,use of dental photography would increase the predictability for esthetic dental restorations.
2	Teuta pustina-krasniqi et al 2015	Randomized control trial	In vivo	Visual spectrophotometer	3D master shade guide Vita easy shade guide	Natural teeth	1640		Combination of visual and digital shade analysis gives a precise predictability of shade
3	Foteini V. Et al 2007	Randomized clinical trial	In vivo	Visual spectrophotometer	Chromascop shade guide spectroshade	Natural teeth	3758	Middle-third	Spectrophotometric shade analysis seems to be more reproducible than visual shade determination
4	E. Klemetti et al 2006	Cohort study	In vitro	Visual colorimeter	Vita lumin Vita 3D Procera Shade eye	Natural teeth	4	Middle 3rd	Digital colorimeter may be in advantage over traditional method
5	P.B.Ozat et al 2013	Cohort study	In vivo	Visual	Vita 3D	Natural teeth	54	Labial surface	Dentists can match clinically acceptable shades in visual methods
6	Alvin G.wee et al 2006	Randomized control trial	In vitro	Digital camera	Nikon D100 Canon D60 Sigma SD9	Shade tab	65	Middle 3rd	Commercial SLR12 digital camera should be combined with appropriate calibration & can use in colour replication.
7	Karl martin lehmann et al 2011	Randomized control trial	In vivo	Spectrophotometer colorimeter	Easy shade Shade pilot Shade vision	Natural teeth	15	Cervical Body Incisal	Clinically acceptable intra device repeatability for all tooth regions when using same colour measuring device. But results obtained with different colour measuring devices was not acceptable.
8	Ahmed judeh et al 2009	Observational study	Model In vivo	Visual spectrophotometer	Vita C Vita easy shade	Shade tab Natural teeth	9 9	Middle 3rd	Spectrophotometer was more likely to match color than the visual method
9	Alma dozic et al 2007	Clinical trial	In vivo In vitro	Spectrophotometer colorimeter	Easy shade Shadescan Ikam Shade eye Identacolor II	Extracted natural teeth	25	Middle 3rd	Easyshade & ikam systems were most reliable

10	Q Li et al 2007	Cohort study		Visual Colorimeter	Vintage halo shade guide Shadeeye NCC colorimeter	Natural teeth	20	Middle 3rd	Shade eye NCC chromameter make better results
11	Lars shcropp et al 2008	Cohort study	Model	Visual Graphic computer software	Vita 3D Canon EOS	Shade tab	12	Labial surfaces	Better performance by graphic computer than by visual shade matching
12	Q. Li et al 2009	Randomized control trial	In vivo	Visual	Vita lumin Vitapan 3D Vintage halo Vintage halo NCC Chromascop	Natural teeth	60	Middle 3rd	visual shade selection could not achieve a clinically compatible shade-matching result, whatever shade guide system was used
13	Karl glockner et al 2015	Randomized control trial	In vivo	Visual spectrophotometer	Vita bad sackingen Easy shade	Natural teeth	1500		Both were similar in accuracy in shade determination
14	Dhruv anand et al 2016	Cohort study	In vitro	Digital camera spectrophotometer	Nikon D90 Vita easy shade	Extracted natural teeth	20		Digital camera can be used as an alternative to spectrophotometer as both values were similar
15	Samar Alsaleh et al 2012	Comparative study	In vivo	Visual spectrophotometer	Vita classical Vita easy shade	Natural teeth	50	Middle 3rd	Instrumental shade assessment had a better ability to select the closest shade compared to visual
16	Won suk oh et al 2010	Cohort study	In vitro In vivo	Digital photocolorimeter	Eye one match	Shade tabs Natural teeth	32 96	Middle 3rd	Shade matching using digital PCM was valid with the use of vitapan classical shade guide
17	Welson pimental et al 2014	Comparative study	In vivo	Visual spectrophotometer	Vita classical Spectroshade micro	Natural teeth	30	Middle 3rd	Instrumental method was more reliable compared to visual
18	DS Moodley et al	Randomized control trial	In vivo	Visual spectrophotometer	Vita classical Vita 3D Spectroshade	Natural teeth	25	Middle 3rd	Difference in Shade assessment using visual shade guides and spectrophotometer were within clinically acceptable limits.
19	K Yuan et al 2012	Cohort study	In vitro In vivo	Computer aided shade matching	Shade pilot Easyshade Shade eye NCC	Shade tabs Natural teeth	80 85	Central region	Shade pilot showed high accuracy and reliability
20	Burak yilmaz et al 2010	Cohort study		Visual Colorimeter	Vita classical Shade eye NCC	Shade tabs	25		Visual shade determination yielded better color replication of metal ceramic specimens than instrumental shade determination.
21	B. Yilmaz et al 2008	Cohort study	In vivo	Visual Colourimeter	Vitapan classical Shade eye N CC	Natural teeth	10	Middle 3rd	The intra-oral dental colourimeter produced acceptable repeatability from the readings of natural tooth.

22	Siegbert witkowski et al 2010	Cohort study	In vivo	Spectrophotometer	Crystal eye	Natural teeth	15		Spectrophotometer was accurate and reliable in shade selection
23	Ana Todorovic et al 2013	Cohort study	In vitro	Visual Spectrophotometer	Vita 3D Vita classical Vita easyshade	Shade tabs	20	Middle 3rd	Instrumental shade matching showed better results compared to visual
24	W.K. Tam et al 2012	Cohort study	In vitro	Digital camera	Canon EOS 1100 D	Shade tabs	26		Digital camera can be used as a tool for dental shade matching
25	Constanze olms et al 2013	Clinical study	In vivo	Spectrophotometer Visual	Vita easy shade Vitapan classical	Ceramic crown	25		Spectrophotometer was reliable in shade determination
26	Seungyee kim-pusatira et al 2009	Experimental study	In vitro	Spectrophotometer	Spectroshade Shade vision Vita easyshade Shadescan	Shade tabs	62	Middle 3rd	All the devices had good repeatability
27	W.D. Browning et al 2009	Comparative study	In vivo	Spectrophotometer Visual	Vita easy shade Vitapan 3D	Natural teeth	95	Middlle 3rd	Spectrophotometer showed better results
28	Salma A. Bahannan 2014	Cohort study		Visual Spectrophotometer	Vita 3D Vita easy shade	Shade tab	204		Spectrophotometer was better compared to conventional method
29	Alshiddi et al 2015	Comparative study	In vivo	Visual Spectrophotometer	Vita 3D Easy shade	Natural teeth	8	Middle 3rd	Shade matching using spectrophotometer is more accurate compared to traditional method

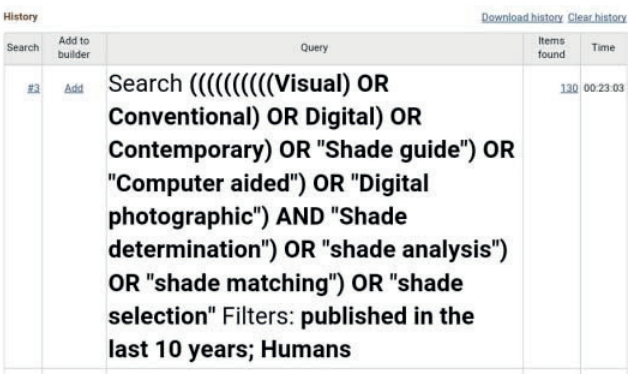

FIGURE 1. keywords for article search

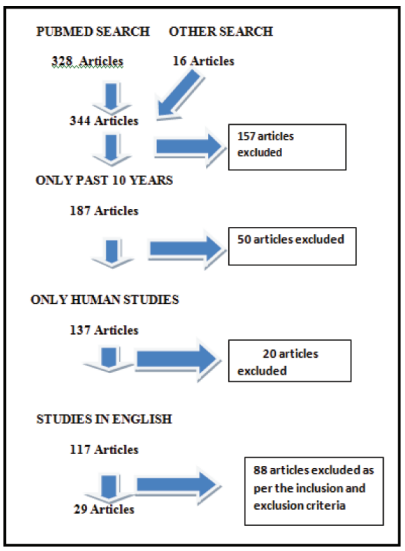

FIGURE 2. Search strategy

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matching.

Materials and methods

A comprehensive search in the following database was performed to identify related studies for inclusion in the review. MEDLINE (pubmed) and Google Scholar. Main keywords included Conventional, visual, shade determination, shade guide, digital photography. Reference lists of identified articles and relevant papers known to the authors were also searched. All identified titles and abstracts were independently assessed for subject relevance. Full texts were then obtained and formally assessed for inclusion.

Filters

Other inclusion criteria

a) Studies related to conventional shade matching.

b) Articles related to digital photographic shade matching.

c) Study design includes randomized control study, cohort study,clinical study, cross sectional studies.

d) Only past 10 years studies.

e) Only human studies.

f) Studies in English language.

Other exclusion criteria

a) Studies using restored teeth, non vital teeth.

b) Articles published in other languages

c) Full text articles that were not available on the database search.

DISCUSSION

This systematic review evaluated 29 studies that compared the efficiency of visual, spectrophotometer, colorimeter, digital cameras and computer-aided shade matching. In this analysis 18 studies compared between visual and instrumental, 5 studies included only instrumental out of which 2 was comparison between spectrophotometer and colorimeter. 2 study was conducted that involved only visual shade guide, 2 others included visual and computer aided shade matching and 2 more studies were conducted to compare digital camera and instrumental method in shade matching.

Visual shade guide

Out of 20 studies, 7864 samples were taken to conduct comparative studies between visual and instrumental shade matching methods and also among visual shade guides. 2 authors stated that spectrophotometer assisted by visual showed better results[1,2]. 12 studies inferred that instrumental using vita Easy shade, shade eye NCC and graphic computer shade matching had better results compared to vitapan 3D and vitapan classical[3,4,5,6,7,8,9,10,11,12,13,14]. Also spectrophotometer and visual were similar in accuracy in about 2 studies[15,16]. Another author conducted 2 different studies and concluded that repeatability was better in colorimeter, but better colour replication was in visual matching[17,18]. One author conducted a clinical study using vita 3D shade guide inferred that dentists can match clinically acceptable shades in visual methods[19].

The other study included 5 shade guides viz; Vita lumin,Vitapan 3D,Vintage halo,Vintage halo NCC & Chromascop concluded that visual shade selection could not achieve a clinically compatible shade-matching result[20].

Spectrophotometer

A total of 18 studies were conducted on a sample size of 7796, out of which 12 studies stated that spectrophotometer was better in repeatability and reliability[3,5,21,8,9,22,10,11,23,12,13,14]. Also in 3 other studies spectrophotometer was similar in accuracy with visual and digital camera shade selection[15,24,16].

2 authors concluded that combination of spectrophotometer and visual gave better results[1,2]. In another study intra-device repeatability was acceptable but inter-device did not give good results[25].

Colorimeter

A total of 6 studies were conducted on 99 samples out of which 2 studies stated that repeatability was good for colorimeter[17,25]. In 2 other studies colorimeter showed better results when compared with visual[4,6]. On comparison with spectrophotometer an author inferred that it was better than colorimeter[21]. Similarly in another comparative study visual showed better results[18].

Digital camera

A total of 3 studies were conducted on a sample size of 111 natural teeth and shade tabs. The authors concluded that digital SLR cameras can be used as an alternative to spectrophotometer[24] or as a separate tool for shade selection[26], also it gives a good colour replication[27].

Digital photocolorimeter

A study was conducted using "Eye one match" on a sample size of 128 and concluded that Shade matching using digital PCM was valid with the use of vitapan classical shade guide[28].

Computer software

This study used vita 3D and canon EOS for a sample of 12 shade tabs and inferred that better performance was given by graphic computer than by visual shade match[7].

Computer aided shade matching

In this study shade pilot, easyshade and shade eye NCC on a sample size of 165 was used and the inference was that all three varied in accuracy but shade pilot showed both high accuracy and reliability[29].

Summary

Visual shade matching with the help of shade tabs is the most commonly used method in shade determination since 1930's. But for the past few years with the emergence of new technologies there were newer instruments used in shade matching. So, the zest to check the efficiency and reliability of these instruments lead to many comparative studies between visual, spectrophotometer, colorimeter, digital cameras etc.

Out of 29 studies, 27 studies used instrumental methods on a sample size of 8271 and most of the authors stated that instrumental was better in accuracy than traditional method, also intra-device repeatability was acceptable but inter-device repeatability was not. 20 Visual studies were analysed on a total sample size of 7864 and they inferred that visual shade matching procedure using shade tabs were also reliable but visual assisted with instrumental would increase the predictability.

Though visual shade matching may sometimes be inconsistent, but it is definitely an inevitable part in dentistry. For cases where esthetics is a prime concern instrumental methods may be useful for better results. Therefore alterations in the usage of shade selection methods are acceptable depending on the cases.

Conclusion

This systematic review evaluated 29 studies that compared the efficacy of visual and instrumental shade matching methods. As per the limitations of this study design, it can be concluded that Inconsistency of visual method is not inferior to instrumental shade matching, similarly digital camera shade matching accuracy was comparable to instrumental methods. As a dental professional we have to decide which method to

be used for every individual cases depending upon their priorities.

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IMPLANT SURGICAL GUIDES ARE THEY USEFUL ?

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Abstract:

One of the most common errors causing implant failure or prosthetic failure is the improper positioning of the implants. The innovation of the implant surgical guide provides an extra step of safety to the surgery and also prosthetic planning before the placement of the implant helps in designing a more precise guide. The different types of surgical stents are briefly described in this manuscript.

Key words:
Implant surgery, surgical stents

Most of the current studies available show good survival rates for dental implants. However there are equal number of studies which show complications and errors too. One of the most common errors causing implant failure or prosthetic failure is the improper positioning of the implants. A secondary but equally as serious an error is impinging on anatomical structures like the inferior alveolar nerve or the maxillary sinus. Damaging for example the lingual artery can lead to a life threatening emergency.

How can the implant surgeon avoid such errors and be safe and keep the patients safe? Training and experience plays a big role in the expertise of the implant surgeon and the safety of the procedure.

The innovation of the implant surgical guide provides an extra step of safety to the surgery and also prosthetic planning before the placement of the implant helps in designing a more precise guide .This also allows in assessing the bone or soft tissue augmentation needs.

Historically there are three main types of surgical guide designs

1) Non-guided

2) Partially guided

3) Fully guided

The non guided design concept is rarely used nowadays due to the inherent inaccuracies involved in the fabrication and great potential for errors

Partially Guided

This concept means the initial pilot drill is guided using the surgical template and then the rest of the sequential drilling is done by the surgeon freehand following the pilot drill osteotomy .This has significantly better accuracy than the non guided concept but still the chances of error as the sequential drilling is done is still possible . The various techniques used is mentioned in the following tables (table 1-4)

The Fully Guided

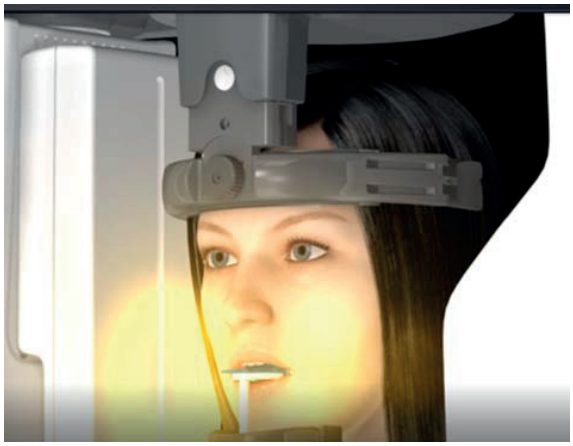
This concept means the full sequential drills

and the angulation of the drills are guided so theoretically the chances of error are low. However it should be made clear that improper design or lack of experience cannot be avoided by using a fully guided surgical template. The surgeon should have adequate training and ability to recognise errors in surgical guide design and be able to place the implant freehand based on knowledge of anatomical structures and not solely dependent on the surgical guide

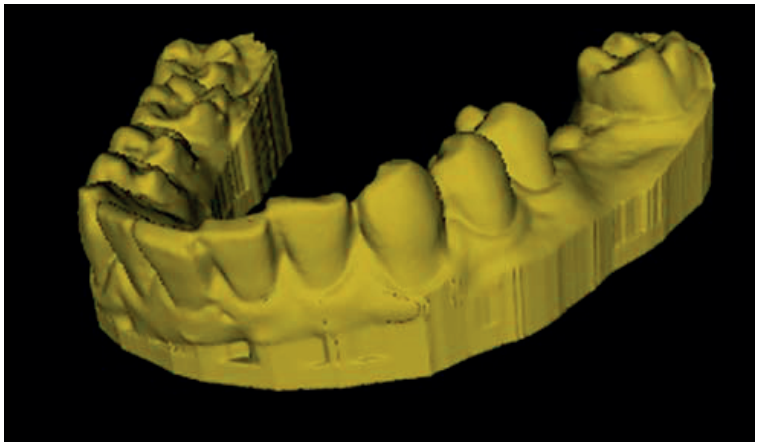
The fully guided concept can be broadly classified into 1) Cast based guide 2) CAD CAM/3D printed guides

The cast based guide was the ones made before CAD-CAM /3d printing became popular.This involved bone mapping and using periapical radiographs with grids and using digital software to superimpose the root structures onto the cast, the cast is then sectioned at the implant site and the bone mapping measurements are then transferred over to the cast. This is then utilised to aid in performing a cast osteotomy. A lab analog is placed in the cast osteotomy site and a suitable drill sleeve consistent with the implant site is then chosen and waxed up for the surgical template.

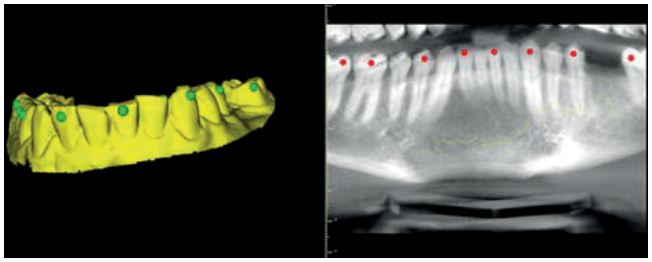
The CAD-CAM/3d print based surgical guide is constructed using data from a Computed Tomography or CT data in the early days and Cone Beam CT currently.The advantage of this technique is the CT data is converted into data that can be recognised by CT imaging and planning software. This also allows visual representation of



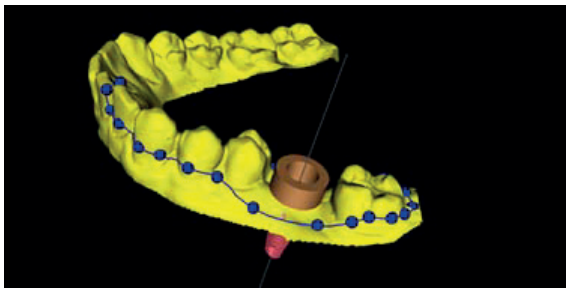
Step 1 – Scan Patient



Step 2 – generate STL model either by optical scan, impression inversion or CBCT scan of the impression or model



Step 3- stitch the model and the scan data of patient using common points



Step 4- outline the surgical guide extension

the anatomy, matching the diagnostic waxup and assessing the osseous and soft tissue requirements. This also helps the biomechanics and moment calculation of the proposed prosthesis.

However even the CAD-CAM guides are not infallible , some of the complications that has been observed were related to inaccurate planning, radiographic stent error, intrinsic errors during scanning, software planning, the rapid prototyping of the guide stent, and the transfer of information for the prosthetics 47. However, if the clinician recognizes these sources of inaccuracy, efforts can be made to minimize the error and optimize patient treatment.

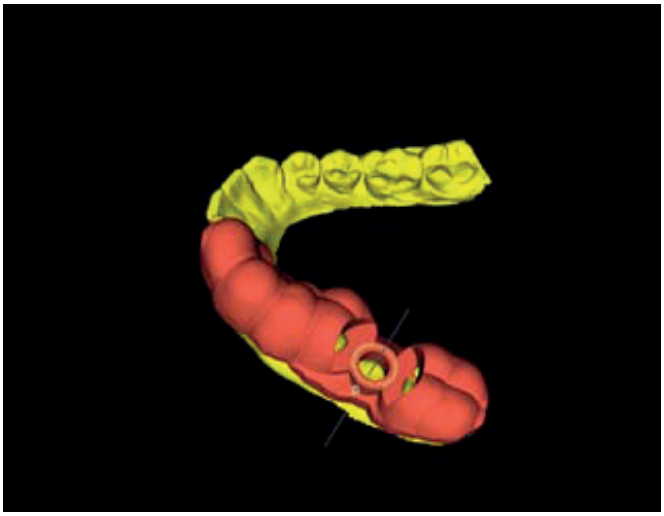
The classical protocol for fabricating the fully guided surgical template has four main steps, however there are now variations to each of these steps but it is not in the scope of this articles to go into detail on the variations.

The four main steps are

1) Fabrication of the radiographic stent.

2) The CBCT scan

3) Prosthetic and Implant planning using digital interactive software



Step 5- generate surgical guide

4) Fabrication of the stereolithographic guide

The radiographic stent is usually the diagnostic wax up constructed for accuracy of the future planned prosthetics. This template is then used to aid in the tomography and using a coordinate system is superimposed on the CBCT data of the patient. This is then used by the 3D interactive software to do the virtual surgery for placing the implants and then the data required for the surgical template is generated.

The surgical template data is then sent to the stereolithographic machines and either milled or printed based on the availability of a CAD-CAM milling machine or a stereolithographic printer where a laser will activate and cure liquid resin to form the surgical template. Suitable guide tubes are then placed into the printed or milled guide matching the sequential drills and the depth stops to prevent the over insertion of the drills are incorporated into the surgical guide.

One of the current software packages available which allows detailed planning but in very simple steps and not with a big learnign curve is BlueSky Plan (BlueSky Bio,USA) the following is a simplified workflow screen capture from the software.

Conclusion

There is no doubt that a well designed surgical guide can aid in the safe insertion of the dental implants.However it is not a substitute for adequate training and knowledge of anatomy.

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Author (y)	Material Used for Fabrication of the Template	Radiographic Marker Used	Imaging System Used	Conversion Process	Indication/ Advantages
Engelman et al[8]	Auto polymerizing acrylic resin	Metal bearings	Panoramic radiography	Remove lingual surface, leaving only facial surface of the teeth in the proposed implant site	Inexpensive, easy, improved visibility, external irrigation
Adrian et al[10]	Auto polymerizing acrylic resin	Lead foil over the maxillary and mandibular incisors, left mandibular occlusal plane, intaglio surface of mandibular trial denture	Lateral cephalography	Determine implant trajectory and location using radiopaque images; use cephalometric tracing paper, protractor, and surveyor to reproduce these data in a resin plane joining maxilla and mandible	Guides implant position and trajectory, serves as a bite-block, retracts the tongue and flap, allows sterile field, lessens chance of titanium contamination
Tarlow[11]	Acrylic resin duplicate denture; vacuum-formed thermoplastic matrix (0.02 inch) adapted over duplicate denture			Remove anterior lingual portion of matrix; remove anterior labial portion of duplicate denture	Indicated in anterior edentulous mandible; matrix dictates implant location and angulation, with minimal interference to surgical access
Espinosa Marino et al[12]	Heat polymerizing acrylic resin	Dual-curing composite resin mixed with colored chalk	CT	Trim buccal side of the template	Indicated in partially edentulous patient
Stellino et al[13]	Acrylic resin provisional FPD	Gutta-percha	CT	Remove gutta-percha from channels in the pontics	Alternative for removable radiologic template where a provisional FPD bridges the implant site
Pesun and Gardner[14]	Vacuum-formed thermoplastic matrix; adapt over diagnostic cast and on the duplicate cast of diagnostic wax-up; fill orthodontic resin in the space between these 2 matrices	Gutta-percha	CT	Reduce vertical height of the guide; remove gutta-percha	Indicated in severely worn dentition
Takeshita et al[15]	Denture base: auto polymerizing acrylic resin; teeth: mix powder consisting of 4:1 ratio of resin polymer and barium sulfate with monomer	Stainless steel tubes	Panoramic radiography, CT	Remove tube sprues	Barium sulfate depicts outline of the predesigned superstructure; stainless steel tubes represent location and inclination of the intended implant placement

Author (y)	Material Used for Fabrication of the Template	Radiographic Marker Used	Imaging System Used	Conversion Process	Indication/ Advantages
Sicilia et al[16]	Orthodontic wires and auto polymerizing acrylic resin	Contrast blocks, gutta-percha blocks	CT	Using wire, create 2 profiles of the missing teeth – occlusal and gingival Join these to acrylic resin block to make template solid and add self-retaining feature	Profiles mark the vestibular and mesiodistal limit of the teeth; the profile replaces buccal surface of the template
Minoretti et al[17]	Vacuum-formed thermoplastic matrix or auto polymerizing acrylic resin	Guide sleeve		Insert Kirschner wires through mucosa/bone using dental handpiece; fit guidance cylinders fitting trephine drill (Ø = 3.5 mm, ITI Dental Implant system) to the guide wire	Indicated in completely edentulous patient or in augmented alveolar ridges where template position after flap reflection is difficult Improves precision of implant placement – improving guidance during drilling process
Ku and Shen[18]	Vacuum-formed thermoplastic matrix filled with auto polymerizing resin acrylic resin	Gutta-percha	CT	Remove marker with carbide bur	Single implant therapy or short-span implant-supported prostheses
Becker and Kaiser[19] (Figure 2)	Vacuum-formed thermoplastic matrix (0.020 inch) and orthodontic resin	$^{5}/_{32}$ and $^{3}/_{16}$ inch brass tubes		Attach $^{3}/_{16}$ inch tube to the template $^{5}/_{32}$ inch tube guides the pilot drill	Precise surgical guide resulting in a functional and esthetically pleasing restoration
Cehreli et al[20] (Figure 3)	Vacuum-formed thermoplastic matrix (2.0 × 125 mm)	Pins (1 mm diameter)	CT	Fabricate 2 acrylic templates covering only residual ridges with guide channels of 2 diameters Inner lamina: remove foil covering edentulous ridges, secure bur ends bilaterally – guides insertion of removable surgical acrylic resin template; outer lamina: remove palatal portion, prepare occlusal holes	Posterior maxillary region with poor bone density; outer lamina contains radiopaque markers for radiographic evaluation and verify alignment of implants; inner lamina accepts 2 removable surgical guides bilaterally
Almog et al[9] Vertical lead strip guide	Custom tray material/auto polymerizing resin with vacuum-formed thermoplastic matrix (0.02 inch)	Lead strip (2 mm) vertically on the lingual/palatal wall of the buccal access groove	CT	Remove lead strip	Surgical osteotomy but more error in the buccolingual placement

Author (y)	Material Used for Fabrication of the Template	Radiographic Marker Used	Imaging System Used	Conversion Process	Indication/ Advantages
Almog et al[9] Gutta-percha guide (Figure 4)	Custom tray material/auto polymerizing resin with vacuum-formed thermoplastic matrix (0.02 inch)	Gutta-percha	CT	Remove gutta-percha	Surgical osteotomy allowing for some surgical latitude in preparation of the osteotomy sites
Almog et al[9] Metal sleeve guide (Figure 5)	Custom tray material or auto polymerizing resin	Metal guide sleeves	CT		Precise surgical osteotomy guide
Cehreli et al[21]	Auto polymerizing acrylic resin	Pins (1 mm diameter)	CT	Attach internally stacked stainless steel guides	Place implants in low-density bone; dual-purpose guide incorporating 3 drill guides
Akça et al[22]	Auto polymerizing acrylic resin		Used when CT is not required for evaluation of buccolingual angulation of available bone	Construct 4-mm thick flat horizontal plane; construct perpendicular resin plane on lingual side of the flat plane; prepare guide channels; transfer mesiodistal reference axis to the perpendicular part	Indicated in posterior edentulous mandible; reference axis on the perpendicular plane guides mesiodistal implant angulation; retracts the mucoperiosteal flap lingually Improves site visualization
McArdle[23]	Vacuum-formed thermoplastic matrix, light cured restorative material			Restorative material forms guide core; prepare center guide channels	Single tooth implant-supported restorations; flexible material
Koyanagi[24] (Figure 6)	Auto polymerizing acrylic resin	Orthodontic wire, stainless steel ball, gutta-percha point	Conventional tomography	Laser weld orthodontic round tube to the front cap of a latch type contra-angle handpiece	Template guides the head of the contra-angle handpiece, preventing the drill from contacting the template; allows objective assessment and determination of implant location, inclination, and depth for individual treatment cases
Kopp et al[25] (Figure 7)	Auto polymerizing acrylic resin	Barium sulfate liquid coat, thin orthodontic wire (0.014–0.016 mm) glued to the buccal aspect	CT	Modify surveyor table using a protractor Secure 22-mm diameter milled cylinders in the template	Cylinders guide pilot drill Buccal guide wire guides all future drills in the buccolingual and mesiodistal direction
Tsuchida et al[26] (Figure 8)	Auto polymerizing acrylic resin	Silicone impression material	CT	Remove silicone markers; remove buccal/lingual portion of the surgical template	Silicone markers: clear radiopaque markers that do not create artifacts in CT scanning

Author (y)	Material Used for Fabrication of the Template	Radiographic Marker Used	Imaging System Used	Conversion Process	Indication/ Advantages
Windhorn[27] (Figure 9)	Light polymerizing custom tray material			Use wooden stick as reference for molding resin around handpiece head	Wooden stick simulate implant location and angulation 2-piece implant placement guide
Al-Harbi and Verrett[28] (Figure 10)	Auto polymerizing acrylic resin		CT of arch prior to extraction; treatment planning using SimPlant software	Transfer planning data to surgical guide using milling machine; trim occlusal surface and buccal flanges; maintain 5-mm coronal-apical thickness of resin	For immediate implant placement following complete arch odontectomy; stable guide following staged tooth extraction
Arfai and Kiat-Amnuay[29] (Figure 11)	Auto polymerizing acrylic resin	Brass rod ($^3/_{32}$ inch)	Periapical radiography	Remove the rods	Placement of multiple implants in adequate osseous structure; dental surveyor improves accuracy
Wat et al[30] (Figure 12)	Auto polymerizing acrylic resin mixed with barium sulfate (ratio of 4:1)	Barium sulfate cylindrical channels drilled at proposed implant sites in radiographic template	CT	Remove nonsalvageable teeth to modify guide; place guide on the mounted cast; connect to the record base fabricated on the opposing arch, using embedded stainless rods and tubes	Convenient, economical, less traumatic, stable for edentulous arch opposing a partially edentulous arch, compatible with all implant systems
Oh and Saglik[31]	Auto polymerizing acrylic resin (DRPD); attach vacuum-forming thermoplastic matrix (1 mm) to the DRPD using acrylic resin			Trim buccal and lingual denture base extensions; prepare guide channels in the middle of acrylic resin teeth with buccal windows	Thermoplastic sheet engages the remaining dentition, assists in an accurate orientation, and maintains the DRPD to serve as a surgical template; permits stable intraoral placement of denture for successful implant placement
Annibali et al[32]	Auto polymerizing acrylic resin	Stainless steel or titanium cylinders	Panoramic and periapical radiography, lateral cephalography, CT	Cylindrical marker guides the pilot drill	Uses silicone matrix that depicts the emergence profile and the ideal loading center of the proposed restoration

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LITHIUM DISILICATE CERAMIC – AN OVERVIEW

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Abstract:

All ceramic materials are now extensively used in fixed prosthodontics. Even though metal ceramic restorations are still considered as the gold standard, the popularity of all ceramic materials is increasing day by day. Lithium disilicate is a glass ceramic material with excellent esthetic qualities and improved mechanical properties. The material is extensively used for esthetic restoration of anterior teeth. the improved mechanical properties of this glass ceramic material have extended its clinical indications. The ability to fabricate the restoration using CAD/CAM technology makes it the material of the modern-day. However, a better knowledge of the material is necessary for its effective and successful clinical use.

Key words:
Lithium disilicate, heat pressable ceramic, CAD CAM Milling

Introduction

Metal ceramic restorations are the gold standard in the fixed dental prosthesis[1,2]. Metal-free ceramics or All ceramic materials were developed to meet the increased esthetic demands. In the initial period, many all-ceramic systems introduced were not able to give reliable long-lasting restorations. A lot of significant developments in all-ceramic materials resulted in the formulation of life-like restorations with successful long-term results. Among them, lithium disilicate can be considered as a paradigm of metal free ceramic material with esthetics and better clinical survival rate. Lithium disilicate is one of the most popularly used ceramic material in dentistry at present. The higher translucency of lithium disilicate glass ceramic makes it the choice of material for restoration of anterior teeth[3]. The esthetic quality of the material is unsurpassable in the present scenario. The review is intended to give a better understanding of the material for effective and successful clinical use of the material.

Evolution of the material

In 1965, W. Mclean and T.H. Hughes introduced the new version of porcelain jacket crown first introduced by Charles Land in1903[4]. The inner core of strong aluminous porcelain reinforced the crown structure and doubled the strength compared to the traditional porcelain jacket crown. With this new version of porcelain jacket crown, there occurred a resurgence of all ceramic systems.

In 1968, MacCulloch first proposed the use of glass-ceramics in dentistry. Dicor was the first commercially available castable ceramic material for dental use, developed by Corning Glass Works and marketed by Dentsply International. Subsequently, introduced the machinable version called Dicor MGC but both the materials are not used in dentistry now because of the poor survival rate.

In the late 1980s, glass infiltrated core ceramic Inceram alumina was introduced by Vita Zahnfabrik. Inceram spinell and Inceram zirconia were subsequently introduced. The porous core

ceramic coping or framework fabricated by partial sintering is then infiltrated with lanthanum glass in these types of ceramics.

In the same period, hot isostatistically pressed leucite based glass ceramic (IPS Empress) was introduced. In this technique, the heated ceramic ingot was pressed into the mould in a specially designed furnace .

In the early 1990s, yttrium oxide partially stabilized tetragonal zirconia polycrystal (Y-TZP) was introduced to dentistry as a core material for all-ceramic restorations and has been made available through the computer-aided design/computer-assisted manufacture (CAD/ CAM) technique[5].

In 1998, Lithium disilicate based glass ceramic (IPS empress II) was introduced by Ivoclar Vivadent (AG, Schaan, Liechtenstein). The material was then upgraded by the introduction of IPS e.max lithium disilicate in 2005 with improved mechanical and esthetic properties[6].

From the above chronology, one will get acquainted with different all ceramic materials but many of these materials are obsolete. A continuous search for a better material is evident from the above description. The driving force for this endless pursuit is increasing quality demands. It is one of the time-tested ceramic material in the current scenario with better mechanical and esthetic properties.

Table 1.

Manufacturer Recommended Clinical Indication and contraindications for IPS e.max (LS2)

Clinical Indications	Contraindications
1. Thin veneers (0.3 mm), Veneers	1. Very deep subgingival preparations
2. Occlusal veneers	2. Patients with severely reduced residual dentition
3. Inlays, onlays, partial crowns	3. Parafunctions, e.g. bruxism
4. Minimally invasive crowns (≥ 1 mm)	4. Provisional insertion/ trial wear period
5. Three-unit bridges (up to the second premolar as the terminal abutment)	
6. Hybrid abutments and hybrid abutment crown	

Composition and structure

It is the second generation of heat-pressed ceramics next to leucite based ceramics, containing lithium disilicate ($Li_2Si_2O_5$) as a major crystalline phase. The final microstructure consists of about 65% by volume of highly interlocking prismatic lithium disilicate crystals dispersed in a glassy matrix. The crystalline phase gives its strength while the glassy matrix makes it very translucent. The IPS e.max press lithium disilicate has been developed as a system composed of SiO_2-Li_2O-K_2O- ZnO-P_2O_5-Al_2O_3-ZrO_2. The firing process will result in precipitation of lithium disilicate crystals which are highly interlocked. The thermal expansion mismatch between the lithium disilicate crystals and glassy matrix increases the fracture strength due to the development of protective tangential compressive stresses. The crystal alignment during the heating process also improves the fracture strength.

Modes of fabrication

Lithium Disilicate restorations can be fabricated by hot isostatic pressing of an ingot or by milling from a block using CAD/CAM technology

Heat pressable lithium disilicate

Hot isostatic pressing of the ceramic ingots (Figure 1) is done in a special furnace at a temperature range of 890° to 920° C. The heat pressing technique is similar to the lost wax technique used for metal castings. But in heat pressing, the molten ceramic ingot material is pressed into the mould cavity, eliminating the centrifugal casting. The method can be used for fabricating a monolithic restoration or it can be used for making a coping, later veneered

with ceramics of matching thermal expansion to fabricate the restoration.

CAD CAM Milled Lithium disilicate

Lithium disilicate glass ceramic blocks of an intermediate crystalline stage are used for CAD/CAM milling to fabricate the restoration (Figure2). It is easy to mill the blue blocks of the glass ceramic in the intermediate crystalline stage and thus avoiding excessive bur wear[7]. After milling the blocks, they are then crystallized in a special ceramic furnace. During the crystallization process, the lithium disilicate crystals grow, enhancing the strength of the material. After final crystallization, the restoration achieves better esthetic and mechanical properties[8].

CAD-ON technique

In this technique, a CAD/CAM designing of both framework and veneer structure is done on the scanned model of the preparation. The framework is fabricated by milling Zirconia blocks and the veneer structure is milled from lithium disilicate blocks (figure 3). The veneer and framework are then joined by a sintering process. The restoration fabricated using the technique has shown better mechanical stability[9]. The different lithium disilicate based products are listed in the Table 2.

Mechanical properties

The flexural strength of lithium disilicate ceramic material is in the range of 360-400Mpa. the heat pressable ceramic showed better flexural strength compared to the CAD/CAM form[10]. Monolithic restorations made of both pressable and cad cam milled type have higher fracture resistance compared to the veneered ones[11,12]. It has shown better mechanical performance when used for single crowns and anterior fixed partial dental prosthesis up to 2nd premolar[6,13,14]. Guess et al reported that monolithic lithium disilicate crowns exhibited higher fatigue resistance compared to hand layer veneered zirconia crowns based on an in-vitro study[15]. Most of the failures reported in the single crown occurred in the posterior region. An in vitro study by Dhima et al suggested that crown thickness should be 1.5mm or greater in the

Table 2.

Lithium disilicate based products and their details

Product Name	Specification	Company	In Market Since
IPS Empress II	Heat pressable	Ivoclar Vivadent	1998
IPS e.max Press	Heat pressable	Ivoclar Vivadent	2005
IPS e.max CAD	CAD CAM Milling	Ivoclar Vivadent	2006
IPS e.max Press impulse	Heat pressable with Value shade ingots	Ivoclar Vivadent	2010
IPS e.max CAD-on technique	Heat pressed on to zirconia framework	Ivoclar Vivadent	2010
Rosetta SP	Heat pressable	Hass Corporation	2012
Rosetta SM	CAD CAM Milling	Hass Corporation	2012
IPS e.max Press Multi	Heat pressable with multi shade ingot	Ivoclar Vivadent	2014
Vintage LD Press	Heat pressable	Shofu	2015
Amber Press	Heat pressable	Hass Corporation	2016
Amber LiSi-POZ	Pressed on to zirconia framework	Hass Corporation	2016
GC Initial LiSi Press	Heat pressable with High Density Micronization technology	GC America Inc.	2017

posterior region for fracture resistance[16]. However, in the case of lithium disilicate bridges the pontic width and connector dimensions are important factors which influence the fracture resistance of the restoration. According to manufacturer's recommendation, the maximum pontic width should be 11mm in the anterior region and 9mm in the premolar region (from canine to 2nd premolar). The pontic width is measured between the unprepared teeth. The connector should be 4mm in height and 4mm in width for posterior teeth and 4mm in height and 3mm in width for anterior teeth as recommended by the manufacturer. Lithium disilicate material is not indicated for more than three-unit fixed dental prosthesis and also for fabricating bridges beyond premolars. However there many clinical studies which have reported regarding the use of three-unit FDPs in the posterior region[17,18].

Marginal and internal fit

IPS e.max lithium disilicate restorations fabricated with the heat press technique have measurably smaller marginal gaps when compared with those fabricated with CAD/ CAM process. However, the marginal gaps observed for both pressable and CAD CAM restorations were in the clinically acceptable range[19]. Nam et al compared the internal discrepancy of porcelain fused to metal and CAD/CAM lithium disilicate crowns[20]. The internal discrepancy of the lithium disilicate crowns was higher but not statistically significant compared to porcelain fused to metal crown. A problem with computer-milled ceramic restorations is that the internal cutting bur may be larger in diameter than some parts of the tooth preparation, such as the incisal edge[21]. This would result in a larger internal gap compared to the heat pressing fabrication technique. To avoid this internal discrepancy, the incisal edge of the preparation should be at least 1.0 mm for optimal milling.

Luting of the restoration

Resin cement is recommended for cementation of lithium disilicate crowns. Lithium disilicate crown cemented with luting composite showed higher failure load compared with conventional cementation with glass-ionomer cement[22]. Resin-modified glass-ionomers exhibit an adhesive bond failure at the cement-ceramic interface, leading to fracture or loss of the prosthesis. Resin cement exhibit a 2% failure rate, whereas resin-modified glass-ionomers show a 15% failure rate. The manufacturer's recommended etching time for cementation of the IPS e.max Press glass ceramic restorations with a luting resin is about 20 s. Hydrofluoric acid etching of the ceramic restoration should not be done beyond the prescribed time as it can weaken the restoration[23,24]. Klosa et al reported that the method of cleaning the intaglio

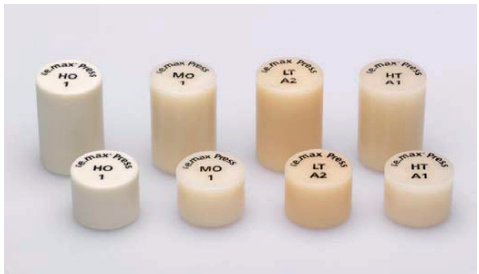

Figure 1: Lithium disilicate ingots for heat pressing (Photo: Ivoclar Vivadent)

Figure 2: lithium disilicate blocks for CAD CAM milling (Photo: Ivoclar Vivadent)

Figure 3: Zirconia framework(white) and lithium disilicate (bluish) veneer structure joined by process of sintering to form the final restoration. (Photo: Ivoclar Vivadent)

surface of the restoration after try in has significant effect on the resin bond strength and suggested that re-etching the ceramic with 5% hydrofluoric acid is most effective in removing contamination with saliva and/or a silicone disclosing medium for IPS e.max. press lithium disilicate[25]. The pressable form of lithium disilicate was seen to be more sensitive to the etchant compared to CAD CAM ceramics[26].

Abrasive wear of teeth

Silva et al carried out a randomized controlled trial for evaluating the abrasion compatibility and demonstrated that Lithium disilicate crowns were not only resistant to wear, but also were wear friendly to enamel antagonist surfaces[1].

For implant supported prosthesis

Lithium disilicate glass ceramic material is indicated for fabrication of hybrid abutments and crowns. Hybrid abutments or two-piece abutments have a titanium base which can be attached to the implant and a ceramic component bonded to the titanium base. While in hybrid abutment crown, the abutment and crown are fabricated in one piece that will be bonded to a titanium insert that can be screwed to the implant. Lithium disilicate hybrid abutment and hybrid abutment crown have the potential to withstand the physiological occlusal forces in the anterior region. According to an in vitro study polished surface of lithium disilicate promoted more cell adhesion and proliferation compared to the glazed surface[27]. This capability of polished lithium disilicate surface enhances soft tissue adhesion and is very significant when an implant-supported prosthesis is fabricated[28].

Survival rate

Lithium disilicate single crowns exhibit excellent clinical survival rate is 97.8 % for 5 years. However, the data for 5 to 10-year clinical survival rate is limited but according to a single study, it exhibits 10-year clinical survival rate of 96.7%. The two-year survival rate of three unit FPDs fabricated with IPS empress 2 was not satisfactory[29]. Solá-Ruiz et al also reported a poor survival rate of 71.4% for three unit FDPs fabricated with IPS empress 2[30]. The next upgraded form of lithium disilicate, IPS e.max (LS2) with improved mechanical properties have raised the clinical survival rate. Wolfart et al evaluated the clinical survival rate of three unit anterior and posterior fixed dental prosthesis fabricated with IPS e.max. lithium disilicate glass ceramic[17]. A cumulative survival rate of 93% after 8 years was reported based on the prospective clinical study. Esquivel-Upshaw et al reported a clinical survival rate of 93% for three-unit FDPs after two years[18]. The mechanical properties of lithium disilicate glass ceramic material, certainly upgrading the survival rate of the restorations.

Recent advances

A new manufacturing method called High Density Micronization (HDM) technology was used to develop the new enhanced lithium disilicate (Initial LiSi press by GC) with higher flexural strength compared to IPS e.max press[10].

Zirconia-reinforced lithium silicate is a new generation of glass ceramic material which combines the merits of both Zirconia oxide and glass ceramic material. The material contains 10% weight zirconia particle in a glassy matrix filled with fine crystals of lithium metasilicate and lithium silicate. The glass content of the material provides better esthetics for the restoration fabricated. Zirconia reinforced lithium silicate exhibited better fracture resistance and mechanical properties when compared to lithium disilicate glass ceramic material according to in vitro studies[31,32].

Conclusion

Lithium disilicate is a glass ceramic material with improved physical properties and unsurpassable esthetics. The clinical outcomes of the material

are very promising. A lot of research is going on to further improve the mechanical and esthetic properties of the material. A thorough understanding of the material is necessary for a clinician to successfully plan the restorative treatments utilizing the material.

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SURGICAL GINGIVAL SCULPTURING FOR IMPROVING ESTHETICS OF ANTERIOR FIXED PROSTHESIS: A CASE-REPORT

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Abstract:

The soft tissue management is very important in fixed prosthodontics. Pontic design in the anterior region should meet esthetic and functional demands. Most of the time, the convex shape of the residual ridge makes the pontic to be very unaesthetic. The lack of proper emergence profile of the pontic in an anterior fixed partial dental prosthesis can result in esthetic failure of the restoration. The surgical contouring of the soft tissue and the residual ridge has to be done in such situations for excellent aesthetic results. This article describes the use of a surgical technique for modifying the shape of residual ridge. A specially designed provisional fixed partial dental prosthesis is also used to preserve and shape the soft tissue during the healing period to achieve maximum esthetics.

Key words:
gingival shaping, soft tissue esthetics, ovate pontic, pontic design

Introduction

Esthetics associated with the health of adjacent tissues in anterior fixed prosthesis is often a challenging issue in a dental treatment plan. The success of fixed prosthodontic restoration is dependent on the health and stability of the surrounding soft tissue[1]. Pontic should be designed and fabricated to meet the functional demand, promote access, ensure esthetics along with the health of surrounding tissues[2]. The ovate pontic design, with a convex tissue surface, creates an illusion of the tooth growing out of the gum, creating an accurate duplication of 'emergence profile' thus meeting the esthetic demands[3]. It also helps to create and maintain interdental papilla thus eliminating 'black triangle' spaces[4]. However, the convex shape of the residual alveolar ridge can pose difficulty in fabricating pontic satisfactorily. Contouring the shape of the residual ridge by surgical intervention or gradual positive pressure is a management strategy to improve tissue contours[5].

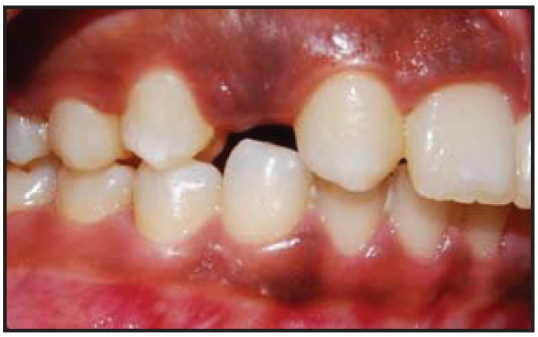
Even though it was believed that pressure over residual ridge resulted in the inflammatory process, studies by Tripodakis and Constantinides showed that a well-controlled hyper pressure applied with a convex and highly polished pontic associated with rigid plaque control resulted only in thinning of epithelium and shortening of rete pegs, without inflammation[6]. Thus, the procedure can improve esthetics without degrading the health of the adjacent tissue.

The development of the recipient sites involved surgical sculpturing of the tissue and subsequent use of a long-term provisional restoration. The

gingivoplasty can be conducted by either the use of high-speed rotary instruments, laser or electrosurgery. The timing of the gingivoplasty can also vary. It can be prior to impression taking or immediately prior to the fitting of the definitive restoration. Before the procedure the site should be anaesthetized so that the depth and visco-elastic nature of the mucosa can be assessed by bone sounding with a periodontal probe[4]. This article is a case report of surgically contouring the soft tissue over the residual ridge and improving gingival profile with a provisional restoration.

Case report

A female patient aged 26, was referred to the Department of Prosthodontics for prosthetic rehabilitation of missing right upper front tooth from the Department of Orthodontics. The maxillary right lateral incisor of the patient was congenitally missing. The maxillary right canine was transposed into the lateral incisor's position creating an edentulous space between the canine and first premolar. Intraoral examination revealed an inadequate inter-arch space of 2mm due to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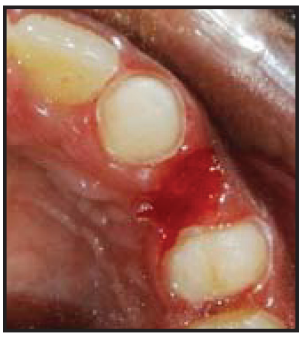
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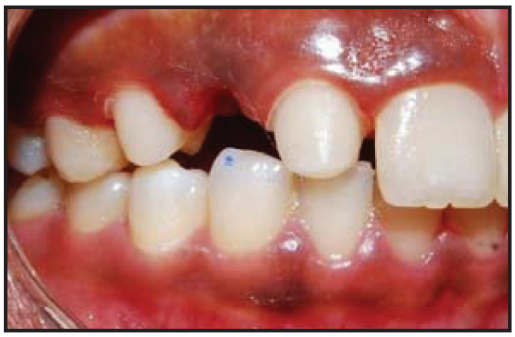
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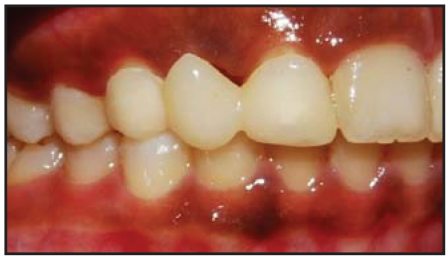
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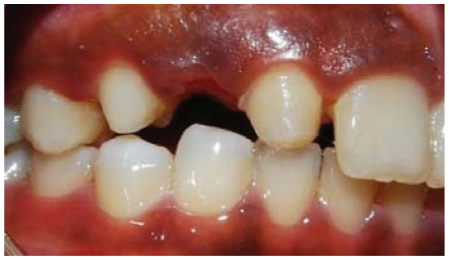
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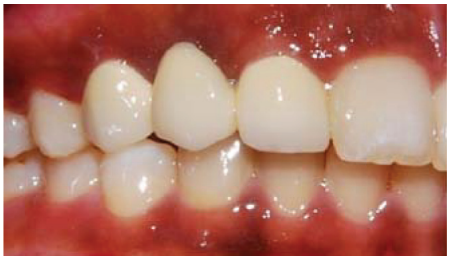
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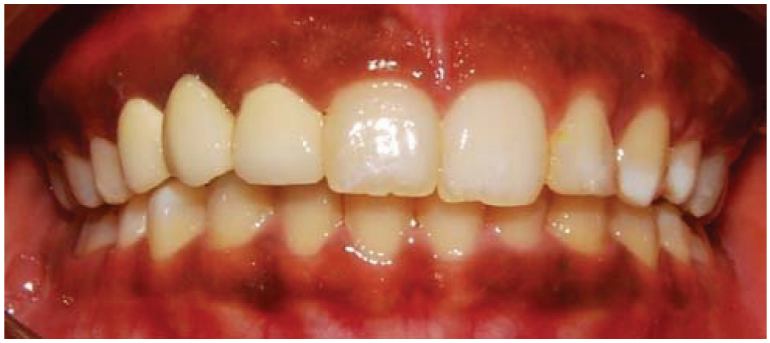
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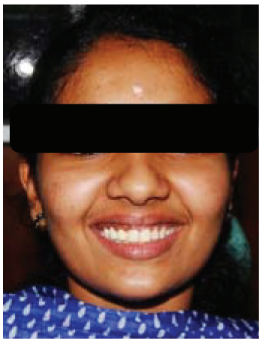
Figure 8

supra-erupted mandibular right canine. (Figure 1) However, bone sounding with periodontal probe showed 4mm of soft tissue over the ridge crest.

Treatment options such as implant and fixed bridgework were evaluated. Since the inter-ar ch clearance was minimal, implant treatment was not feasible. As the patient was extremely concerned about the aesthetics of the restoration, prosthetic rehabilitation was planned with fixed bridgework with ovate pontic design after contouring the soft tissue, thus simulating the lost tooth in form, function as well as aesthetics.

Procedure

The diagnostic cast was used for the fabrication of the wax up model. Facebow transfer was done and the casts were mounted on a semi-adjustable articulator. Protrusive and lateral records were used to program the articulator and anterior guidance was established in the wax up pattern, which was later verified in the patient's mouth. The occlusal scheme established was canine guided occlusion. Tooth preparation of 13 and 14 was done, after which polyvinyl siloxane impression of the arch was made. The recipient site for ovate pontic was surgically contoured using scalpel no.15 (Figure 2, 3) and coronoplasty of 43 was done. Thus, an inter arch clearance of 4mm was achieved.

On the cast, 3mm from the pontic site was scored and smoothened with a scalpel and a provisional prosthesis was fabricated using wax-up model. Once the slight bleeding from the prepared site has reduced, the provisional prosthesis was inserted with pressure. Initially, the gingiva in the contoured area becomes depressed and blanching is evident. After approximately 5 min, the gingiva returned to a normal light pink color. Then the provisional bridge with ovate pontic was temporarily cemented. (Figure 4)

The patient was reviewed every two weeks for twelve weeks and was given instruction on proper oral hygiene. The first week of temporization, the patient was instructed not to clean the area under the temporary ovate pontic because such cleaning will possibly interfere with wound healing under the pontic.

After twelve weeks, the provisional prosthesis was removed and the pontic site was inspected. The pontic site was adequately contoured to achieve proper emergence profile. (Figure 5). Proper retraction of the prepared teeth was done and final impression was made with polyvinyl siloxane impression material. After the final prosthesis with ovate pontic was made, it was tried in the patient's mouth. The prosthesis was checked for marginal integrity, proximal contact, occlusion, and the patient was asked about satisfaction with the color and appearance of the teeth. Once all the prerequisites had been completely checked and any corrections made, the final bridge was cemented. (Figure 6,7,8) Following cementation of the bridge, dental appointment was scheduled for review after two weeks to check the occlusion and gingival condition.

Discussion

The most commonly used pontic design for the functionally visible region in the mouth is the modified ridge lap design. In the present case, the inter arch space was not adequate for a pontic and thus surgical sculpturing of the residual ridge soft tissue was necessary for prosthetic rehabilitation using a fixed partial dental prosthesis. Ovate pontic design was considered best in this scenario as it can give excellent esthetics and better strength. Emergence of the ovate pontic from the ridge mimics the natural tooth and the broad convex geometry makes it stronger than the modified ridge lap[7]. The surgical modification of the residual ridge soft tissue increased the inter arch space which helped in achieving adequate connector height and establishing the canine guided occlusion. The ovate pontic contacts a larger surface area

of the soft tissue but applies only minimal or light pressure on to the tissues[8]. The pontic design prevents any food impaction and its convex surface makes cleaning easy. Nevertheless, careful oral hygiene measures are essential to avoid any tissue inflammation[9]. An interim bridge with an ovate pontic was given to support the pseudo papillae and socket depression formed after the surgical sculpturing of the gingival tissue[7]. The convex surface of the pontic was glazed for achieving maximum biocompatibility and cleanability

Conclusion

The surgical gingival sculpting technique was used to achieve excellent aesthetics in the prosthetic rehabilitation of the congenitally missing tooth. The emergence of the pontic from the residual ridge exactly resembled the natural tooth making the patient very satisfied with the treatment.

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ZIRCONIA (ZrO_2) IN PROSTHODONTICS

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Abstract:

Abstract: Zirconia based ceramics are widely used in dentistry because of its excellent physical properties, biocompatibility and superior aesthetics. They are currently used for the manufacture of endosseous dental implants, crown and bridges, esthetic orthodontic brackets and dental posts. The tetragonal form of zirconia is stabilized at room temperature and is used in dentistry. This tetragonal stabilized zirconia exhibits high strength and fracture toughness due to phase changes which occurs within the material under stress. This article presents a brief history, mechanism of fracture toughness, types of zirconia ceramics, their properties, dental applications and processing of zirconia.

Key words:
Ceramics, zirconia, transformation toughening, Yttria-stabilized Tetragonal Zirconia Polycrystal (Y-TZP).

Introduction

Zirconia is an all-ceramic material that is increasingly used in dentistry because of its excellent physical properties, biocompatibility and superior aesthetics. Zirconia based ceramic alloys are the strongest and toughest oxide ceramics currently available. Its first application as a biomaterial was to manufacture ball heads for total hip replacements. In dentistry, it is used for fabricating endodontic posts, crown and bridge restorations, implant abutments, and aesthetic orthodontic brackets. Zirconium is a chemical element with the symbol Zr and atomic number 40. The sources for zirconium are two minerals, zircon (zirconium silicate, $ZrSiO_4$) and baddeleyite (zirconium oxide, ZrO_2).

Zirconia: Structure and properties

Zirconia is a polymorphic material exhibiting three crystal structures in the solid state depending on the temperature. The structure is monoclinic at room temperature and pressure. The structure is tetragonal between 1170 and 2370°C and cubic above 2370°C and up to the melting point. These phase transitions are reversible, with the crystal structure changing from cubic through tetragonal to monoclinic upon cooling. These reverse processes are associated with a volume expansion which is 0.5% in the case of cubic to tetragonal transition. The transition from the tetragonal to the monoclinic phase is accompanied by a large increase in volume (4%). This lattice expansion caused by the cubic to tetragonal to monoclinic transition induces severe stresses and causes pure zirconia to break into pieces upon cooling from high temperatures. This limited its use as a structural ceramic prior to 1975.

Addition of small amounts of calcium oxide to pure zirconia will prevent this cracking and stabilize the high temperature cubic phase at room temperature with tiny intergranular tetragonal precipitates formed between large cubic grains [partially stabilized zirconia (PSZ)]. Magnesium oxide (MgO), yttrium oxide ($Y2O_3$) and cerium oxide (Ce_2O_3) are also used to generate partially stabilized zirconia.[2]

Transformation toughening

Transformation toughening of zirconium was first reported by Garvie, Hannink, and Pascoe (1975) in Magnesia Partially-stabilized Zirconia (Mg-PSZ). Mg-PSZ contains both cubic and tetragonal grains in its microstructure. Under stress, the tetragonal grains transform into monoclinic form and subsequent cracking occur in zirconia ceramic during cooling. The volume expansion following the transformation of tetragonal to monoclinic produces compressive stresses around the crack preventing further propagation. Garvie et al termed this toughened zirconia "ceramic steel" because both steel and toughened zirconia exhibit martensitic transformation which enhances their strength and fracture toughness.[3,4]

Types of Zirconia ceramics used in dentistry

Even though there are so many different types of zirconia ceramic systems, only three are used to date in dentistry. They are (1) Magnesia Partially-stabilized Zirconia (Mg-PSZ) (2) Yttria-stabilized Tetragonal Zirconia Polycrystal (Y-TZP) and (3) Zirconia-Alumina composites[5]

Magnesia Partially-stabilized Zirconia (Mg-PSZ)

Magnesium oxide (8–10 mol. %) is added to pure zirconia to stabilize cubic and tetragonal phase at room temperature. The microstructure consists of tetragonal precipitates of 100 to 200 nm in diameter dispersed within a matrix of relatively large cubic grains of 30 to 60 μm diameter. Above 200 nm, they spontaneously transform to monoclinic structure thereby decreasing the mechanical properties of the ceramic product. Another factor affecting the properties of Mg-PSZ is the difficulty to obtain SiO_2 free Mg-PSZ powder. This results in the formation of magnesium silicate that lowers the Mg content in the grains. All these factors led to a decline in the use of Mg-PSZ as a biomaterial.

Yttria-stabilized Tetragonal Zirconia Polycrystal (Y-TZP)

Yttria stabilized tetragonal zirconia polycrystal (3Y-TZP) is the most frequently used form of zirconia for dental applications. Addition of 3 mol% yttrium oxide (Y_2O_3) stabilizes tetragonal phase at room temperature. Thus it is an apparently monophase ceramic material containing 100% small metastable tetragonal grains. They have the finest grain size (0.3–0.5 μm). These grades of Zirconia exhibit high strength and fracture toughness, excellent wear properties and thermal expansion coefficient close to that of iron and iron-based alloys. The high strength and toughness of TZP is due to the stress-induced martensitic transformation of the tetragonal phase to the stable monoclinic phase. Stresses generated during dental procedures such as grinding or sandblasting of ceramics lead to tetragonal to monoclinic transformation in the surface region. This is accompanied by a volume expansion that compresses the cracks and resists its further propagation. This increases the fracture toughness of Y-TZP compared with other dental ceramics.[6]

However, the tetragonal to monoclinic phase transformation can occur slowly on Y-TZP surfaces by contact with water. This is called low-temperature degradation (LTD) or ageing of Zirconia. This transformation takes place at fairly

low temperatures (65-300°C). The accompanying volume expansion leads to extensive microcracking. LTD results in surface roughening, reduction in strength, toughness and density. Attempts have been made to minimize LTD of 3Y-TZP systems by the addition of various other oxides such as ceria (CeO_2) or Al_2O_3 or TiO_2. However, only ceria additions below 6 mol% did not degrade the mechanical properties.[9]

Zirconia-Alumina composites

Alumina-Zirconia composites combine the advantageous properties of alumina and zirconia. They are called either Zirconia toughened Alumina (ZTA) when Alumina is the main component, or Alumina Toughened Zirconia (ATZ), when Zirconia is the main component. Alumina contributes to high hardness, high stiffness and hydrothermal stability of tetragonal zirconia phase against ageing.

Eg: Vita In-Ceram-Zirconia® system is a ZTA infiltration ceramic system.

Examples of ATZ ceramics are Ziraldent® and NANOZR® [10]

Zirconia: Processing

Computer-aided design and computer-aided manufacturing (CAD/CAM) has nowadays become somewhat synonymous with zirconia. Most of the commercially available CAD/CAM systems use zirconia based materials(Y-TZP) to fabricate restorations and implant abutments. CAD/CAM zirconia dental frameworks can be produced according to two different techniques: "soft machining/green machining" and "hard machining".

Soft Machining (Green Machining)

The die of the supporting abutments or wax pattern of the crown or FPD is scanned, an enlarged restoration is designed by computer software (CAD), and a presintered ceramic blank is milled by CAM. The restoration is later sintered at a high temperature. The size of the restoration is increased to 25-30 % higher than desired to compensate for the predictable firing shrinkage of zirconia that occurs during final sintering. There are several systems using soft machining of 3Y-TZP for dental restorations, including Cercon (Dentsply International) and Lava (3M ESPE).

Hard Machining

Hard machining involves milling the framework directly to the desired dimension out of fully sintered 3Y-TZP blanks prepared by hot isostatic pressing. Because of the high hardness and low machinability of fully sintered Y-TZP, the milling system has to be particularly robust. DCS-Precident and DC-Zirkon systems use fully sintered Y-TZP blanks to produce dental restorations. Unlike porcelain, zirconia is free of edge chipping when using any diamond grit size. Supporters of soft machining claim that hard machining may introduce microcracks in the framework during the milling process. In contrast, hard-machining supporters may claim a superior marginal fit because no shrinkage is involved in their manufacturing process.[11]

New process technology for Zirconia: powder injection molding (PIM)

Powder injection molding (ceramic injection molding) is an alternative to classical machining for preparing complex-shaped components like dental restorations from zirconia. It consists of four basic steps: feedstock preparation, injection molding, debinding process and sintering. The ceramic powder is mixed with a thermoplastic binder system in a special mixing device to form moderate viscosity feedstock. The binder is used for the artificial plasticization of the ceramic powders. The mix is then granulated and then formed into uniform pellets. The pellets are liquefied and then forced into a mold. The molded component is placed into a high temperature kiln to remove the

binder. The binder is removed by evaporation and exothermic reaction, leaving only a small fraction behind. It is then sintered by setting the kiln to a more intense heat where the parts densify and shrink by about 20%.[12]

Zirconia radioactivity

Concerns have been raised about the potential radioactivity risk associated with the use of zirconia, since the naturally occurring ores of zirconia, notably zircon, contain trace amounts of radioactive elements, such as Uranium (U^{238}), thorium (Th^{232}), and the nuclides of their decay chains.[13] The separation of these elements is difficult and costly. However, many scientific studies and publications confirm that levels of radioactivity of Zirconia are well below the limit set by ISO standard (0.2 Bq/g or 200 Bq/kg) and use of this material in the medical field may therefore be considered safe and biocompatible.

Zirconia: Mechanical properties

The fracture toughness of zirconia is 6-10 MPa $m^{1/2}$ which is very low compared to the fracture toughness of steel and ductile metals; but almost twice as high as that of aluminum oxide ceramics. This is due to transformation toughening, which induces compressive stress at the crack tip and preventing its propagation. The flexural strength of 3Y-TZP ranges from 900-1200 MPa. The hardness of 3Y-TZP is 12-14 GPa which is about one half of the hardness of dense alumina. This is a clear advantage over alumina which allows grinding of coronal parts for adaptation. Modulus of elasticity is 200 GPa while that of alumina is 380 GPa. This creates less stresses between dentin and the prosthesis.[14]

Zirconia has a high resistance to fatigue, with the tetragonal-monoclinic transformation contributing to the increased fatigue life. In the presence of favorable environment such as moist air, ceramics develop subcritical crack growth as water penetrates into the cracks and causes corrosion[15]. However, studies have shown that in spite of this susceptibility to subcritical crack growth, 3Y-TZP can withstand the severe cyclic loading and wet conditions of the mouth and is therefore an appropriate material for the fabrication of dental restorations.[16]

Optical properties

Zirconia is highly radiopaque, which would seem to contraindicate use in the esthetic zone. However, the increased opacity of zirconia is very useful in esthetically demanding clinical situations to mask darkened substrates such as blackened teeth, pins and metal cores. Because of its opacity, it must be covered with translucent ceramics to yield natural tooth-like appearance. Impurities, pores and dispersed alumina particles (used to prevent ageing) in zirconia scatter light thereby contributing to the radio opacity. The optical transmission of tetragonal zirconia is increased exponentially as the sintered grain size is reduced.[17] Newer highly translucent zirconia ceramics like Lava Plus High Translucency Zirconia [3M ESPE] enables translucency by high quality processing, which minimizes the effects of impurities and structural defects.

Biocompatibility

Biocompatibility of zirconia was evaluated in in vitro and in vivo studies with no reported local or systemic adverse reactions to the material. Ceramic is a very biocompatible restorative material for dental purpose; in particular zirconia appears to be well tolerated by periodontal tissues. In vitro tests using Ames test and carcinogenic or mutagenic tests for zirconia did not elicit any mutagenic effect in vitro, and it did not induce any tumors after long term implantation in rabbits. The direct apposition of bone to zirconia implants is confirmed by several authors.[18]

Prosthodontic applications of zirconia

Zirconia implants

Y-TZP is currently considered an attractive and advantageous endosseous dental implant material because it presents enhanced biocompatibility, improved mechanical properties, high radiopacity, and easy handling during abutment preparation[19]. From the available data, osseointegration of Y-TZP implants might be comparable with that of titanium implants. And many studies have shown enhanced implant osseointegration in titanium implant surfaces coated with zirconia.[20]

Zirconia-based Crown and Bridge

Y-TZP ceramic is used as a framework material for crowns and large FPDs in both the anterior and posterior areas of the mouth. They are produced using CAD-CAM technology by milling partially or densely sintered pre-fabricated blocks. Zirconia fixed partial dentures have been reported to have survival rates ranging from 73.9-100% at 2-13 years follow up periods.[21] The most frequent technical problem found in all studies of zirconia restorations was minor chipping or fracture of the veneering ceramic. Residual stresses within the veneer due to thermal mismatch between the zirconia infrastructure and the veneer porcelain, as well as rapid cooling protocols during fabrication when firing the veneering feldspathic porcelain onto the zirconia substructure are linked to the high prevalence of veneer chipping observed in clinical trials.[22]

Heintze and Rousson classified the chipping of porcelain-veneer by severity and the treatment required for repair as follows: Grade 1: Small surface chipping. Treatment: polishing the restoration surface. Grade 2: Moderate surface chipping. Treatment: use of a resin composite repair system. Grade 3: Severe veneer ceramic chipping exposing the zirconia core. Treatment: replacement of the damaged prosthesis.[23, 24] However Long-term evaluation will be needed to make a definite conclusion regarding the success and longevity of zirconia.

Full-contour zirconia ceramics: One ultimate solution for the chipping of veneering porcelain is to not use porcelain. Full Contoured Zirconia restoration is a recent advance in the field of ceramics which eliminates the need to use veneering porcelain. These are glazed zirconia units which give strength and esthetics of zirconia with minimal tooth reduction. Only internal coloration and stains remain to achieve adequate esthetics for the full contour zirconia ceramic. However, glazed zirconia is more abrasive than polished or as-sintered zirconia. This raises concerns about wear of the opposing enamel.[25]

Zirconia-Based Dental Posts

Non-metal posts possess superior esthetic qualities over metallic posts and preclude the possibility of corrosion and reduce the risk of toxicity. Nonmetallic prefabricated posts such as fiber reinforced resin posts and zirconia-based ceramic posts have been developed as alternative to metal posts. Zirconia posts have a high flexural strength, are biocompatible, and are highly corrosion resistant. However, if the post needs to be retrieved from the root canal in case of failure, it is nearly impossible in case of zirconia posts. Another disadvantage is the rigidity of zirconia posts which causes stress to be transferred to the less rigid dentin, thereby resulting in root fractures.[28]

Conclusion

Introduction of zirconia ceramics has opened a wide range of all-ceramic applications unthinkable 30 years ago. These new generations of all-ceramic materials present interesting options, both in terms of material selection and fabrication techniques. However, the greatest challenge in developing all-ceramic compositions or processing methods

suitable for dental applications is satisfying strength as well as esthetics, while ceramic materials for industrial applications generally do not need to meet esthetic requirements.

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