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Ortho-Prostho Management of Hypodontia Using Fibre-Reinforced Composite Resin Bridge: An Interdisciplinary Approach

[1*]Abdulgani Azzaldeen , [2]Abdulgani Mai , [3]Abu-Hussein Muhamad[*]
Al-Quds University, School Of Dentistry,Jerusalem, Palestine
Correspondence author::Abu-Hussein M

Abstract: *Hypodontia is the congenital absence of <6 teeth because of agenesis. The absence of teeth may be unilateral or bilateral. Several treatment options are indicated to treat hypodontia, including the maintenance of primary teeth or space redistribution for restorative treatment with partial adhesive bridges, tooth transplantation, and implants. However, an interdisciplinary approach is the most important requirement for the ideal treatment of hypodontia. This paper presented the work on a single abutment, single pontic cantilever fibre-reinforced composite bridge to replace bilaterally missing maxillary lateral incisors using Ceramage with glass fibres namely Fibrex Lab Pontic System which is incorporated as the fibre-reinforcement of the bridge frame. Indirect fabrication of this prosthesis in laboratory gives a better finish and aesthetic outcome than the direct technique in clinic.*

Keywords: *fibre-reinforced composite bridge, minimum intervention dentistry, resin-bonded.*

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I. Introduction

Hypodontia is defined as the developmental absence of one or more teeth either in the primary or permanent teeth, excluding third molars Patients with hypodontia especially developmentally missing incisors may present in varying degrees of severity prompting them to seek treatment for improvement in dental / facial aesthetics and function. Patients commonly complain of „gaps in their front teeth", non-eruption of permanent incisors following exfoliation of deciduous incisors, disharmony of front tooth size or an unattractive smile. It is quite a common problem often initially seen by the GDP and usually referred to the orthodontist for management/[1,2]

Missing incisors can have a major impact on dental and facial aesthetics and often may affect the self-esteem and social well being of the individual. Usually this condition can be detected at an early age through early diagnosis by the GDP. Hypodontia is often associated with other dental anomalies and early and/or interceptive management can reduce the development of more severe malocclusion and preserve dental structures necessary for restorative procedures.[3,4]The prevalence of hypodontia in the primary dentition is about 0.5% and range from 3.5-6.5% in the permanent dentition in Caucasians, with females outnumbering males by a ratio of 3:2IMaxillary lateral incisors are more commonly missing than mandibular incisors Caucasians. The prevalence rates for lateral incisor agenesis 1,1%, respectively, in Arabs Israel population . [5]

Environmental factors which cause arrested tooth development may include factors that cause failure of tooth bud cell proliferation from the dental lamina. This may be due to infection (eg. rubella, osteomyelitis), trauma in the dental region such as fractures, surgical procedures on the jaw and extraction of the preceding primary tooth,drugs (eg. thalidomide), chemotherapy or radiotherapy at a young age.10

Hypodontia usually has a genetic basis and often a high proportion of affecte individuals have a family history of hypodontia or associated dental anomalies. Mutation in transcription factors MSX1, PAX9 and AXIN 2 have been identified in families with an autosomal dominant oligodontia. Normally, teeth which are „end of series" are more commonly absent, i.e. lateral incisors, second premolars and third molars.[6] Hypodontia is also often seen in patients presenting with syndromes such as ectodermal dysplasia, Down"s syndrome and hemifacial microsomia and in non-syndromic conditions such as cleft lip and palate. However, familial hypodontia iscomplex and multifactorial; influenced by a combination of gene function, environmental interaction and developmental timing. [7] This interdisciplinary approach may involve prepros-thetic orthodontic treatment following consultations with an oral surgeon or a periodontist and a restorative dentist to ensure that orthodontic alignment will facilitate the surgical, implant and restorative treatment . [8]For patients with congenitally missing lateral incisors, who have over-retained primary lateral incisors or canines, keeping the primary tooth as long as possible should be considered to preserve the supporting alveolar bone for future implants.[9] When planning for the placement of a single-tooth implant, the orthodontist must ensure adequate

space between the crowns and roots. Both the quantity and quality of alveolar bone must be assessed before implant placement isconsidered. To accommodate a standard implant there should be a minimum of 10 mm of incisogingival bone and a minimum of 6.0 mm of facial-lingual bone.[2,9]Incases where there is insufficient alveolar bone for implant placement, ridge augmentation may be necessary in addition to orthodontic repositioning ofadjacent teeth.3 Adequate space for the implant is also required between the adjacent roots. The average dental implant fixture is 3.75 mm wide, and 1 to 2 mm of spaceis necessary between the fixture and the adjacent roots.[11]Typically, between 6 and 8 mm of bone between the central and canine roots is recommended. Creating adequate space between the roots must be specificallyaddressed since the central and canine roots may be brought into closer proximity when the teeth are initiallyaligned orthodontically. 2, 9 To create adequate space forthe implant, further orthodontic treatment may be necessary to move the roots further apart. Space for the coronal restoration must also be assessed. The averageimplant platform, which is 4.0 mm wide, requires a space of 1.0 mm mesially and distally between the platform and the adjacent tooth to facilitate proper healing andthe development of a papilla postoperatively; thus, a minimum of 6 mm of space for the lateral crown is required.[9, 10,12]This paper presented the work on a single abutment, single pontic cantileverfibre-reinforced composite bridge to replace bilaterally missing maxillary lateralincisors using Ceramage with glass fibres namely Fibrex Lab Pontic System which is incorporated asthefibre-reinforcement of the bridge frame. Indirect fabrication of this prosthesis in laboratory gives a better finish and aesthetic outcome than the
direct technique in clinic.

II. Case Report

A 17-year-old girl was referred by orthodontist to our clinic for a restorative management to replace her congenitally missing maxillary permanent lateral incisors. Both maxillary central incisors and canines were unrestored and free from periodontal diseases. A slight open bite around tooth 11 and 21 was noted and it was an advantage if resin-bonded bridges are to be considered. One third incisal of the central incisors appeared slightly translucent which was a concern should an alloy-based restoration is to be the treatment of choice. **Fig.**

Fig. 1 Intraoral photograph showing missing maxillary right and left lateral incisors.

Mesiodistal space of the left lateral incisor region was also slightly wider than the contralateral side causing asymmetrical concern. The maxillary lateral incisors sites had sufficient interocclusal clearance but the thickness of the labial plate appeared quite thin in which great caution was deemed necessary if implant placement is in mind, All the treatment options had been discussed ranging from removable denture, resin-bonded bridges, conventional bridges to implant-retained prosthesis. With all factors taken into consideration, the missing lateral incisors would be replaced with indirect 2-unit cantilever fibre-reinforced composite bridges. Both central incisors were chosen to be the abutments. Patient was made aware of the risks and limitations of resinbonded bridges and frequent follow up over the years. **Fig. 2**

Fig. 2 Lateral view of missing maxillary right **(a)** and left **(b)** lateral incisors.

Tooth preparation for both lateral incisors followed the classical design with minimal palatal preparation limited to enamel (0.5 mm), maximum coverage (180 degrees wrap around) of palatal surface as much possible however not to compromise the aesthetic component.[13] Proximal grooves were not done for the present case in view of recent quality bonding system as a result of technology advance in adhesive dentistry. The issue with the mesiodistal space of left lateral incisor which was too wide had been overcome by adding direct composite resin on the mesial of the left upper canine to narrow down the distance . Using a special tray, a complete final impression of the arch with polyvinyl siloxane elastomeric impression material was registered. The work had been sent to laboratory for the fabrication of the bridges.

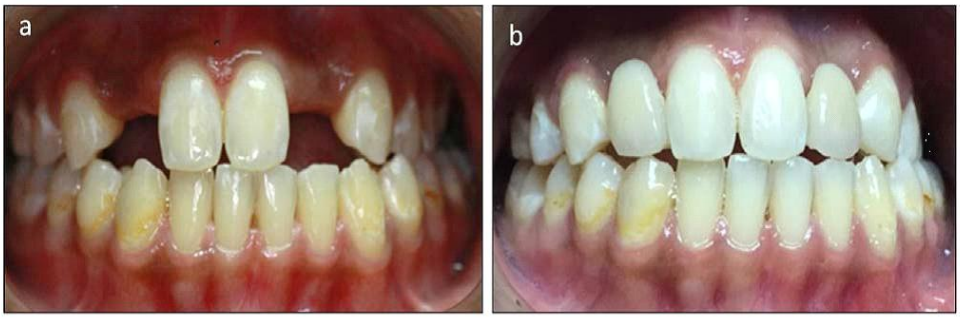

Fig. 3; Frontal view: (a) Preoperative, (b) Postoperative

1. The fibre-reinforced composite bridge was constructed using Ceramage with glass fibres namely Fibrex Lab Pontic System which was uncorporated as the fibre-reinforcement of the bridge frame. Ceramage is a zirconium silicate integrated indirect restorative material.
2. At the insertion appointment, flowable nanohybrid composite namely G-aenial
3. Universal Flo was used to cement the cantilever bridges .
4. Teeth were isolated with rubber dam before cementation procedure. 2-steps
5. etch-and-rinse technique was used to prepare the palatal surfaces of both
6. central incisors. The seating and marginal adaptation of both prostheses was
7. checked and excess of material was removed prior to light activated with LED
8. LCU . Minor occlusal adjustment was performed where needed.
9. The patient was happy and satisfied with the treatment received. A 6- monthly follow-up was scheduled.

Fig. 3
However, the right side of the bridge broke at the connector and had to be remade. It was noted that her anterior teeth had come into contact possibly due to lip pressure causing interference to the cantilever fibre-reinforced composite bridges. Since then, the clinical condition remained stable and without any
complication.

III. Discussion

Fiber-reinforced composite (FRC), prostheses offer the potential advantages of optimized esthetics, low wear of the opposing dentition and the ability to bond the prosthesis to the abutment teeth, thereby compensating for less-than-optimal abutment tooth retention and resistance form. These prostheses are composed of two types of composite materials: Fiber-composites to build the substructure and hybrid or micro fill particulate composites to create the external veneer surface.[14]

1. A cantilever bridge may reduce the interabutment forces hence overcoming the
2. problem of the retainers debonding. Assessment of occlusion prior to decision
3. making is very crucial to optimize the success of cantilever fibre-reinforced
4. composite bridges. [16,17]Patient with canine guidance or group function would
5. demonstrate a better prognosis with this type of treatment. Lateral and protrusive
6. interferences should also be minimized with slight to no overbite is preferred around the pontic area. Furthermore, the author would like to suggest a 2-3 months recall initially is crucial in the case of post-orthodontic treatment to detect any changes in occlusion that might jeopardize the survival of the prosthesis.[14]Some of the earliest of these experimental preimpregnated fiber-reinforced composites (FRCs) designed for dental applications were based on glass-reinforced thermoplastics by Goldberg et al.[in the year 1994. He studied the flexural property, stress relaxation and hydrolytic stability of FRC based on thermoplastic matrices, types of fibers, and fiber volume fractions. He concluded that Polycarbonate was the preferred matrix material. The flexural modulus and strength was improved when polycarbonate was reinforced with 42 volume percent of glass fibers. The apparent flexural modulus of all composites

decreased with span length in the range of clinical interest. The prevalent mode of failure for all FRC investigated was brittle failure under flexure loading. Although researches have been revolving around improvisation of the mechanical properties of FRC, most of the clinical failures were the result of debonding of the retainers from the tooth surface.[17]

A subsequent clinical trial by Altieri et al. in 1994 evaluated the use of preimpregnated glass-reinforced polycarbonate as the framework for acid-etched fixed partial dentures (FPDs). Fourteen 3 U restorations were placed both in anterior and posterior locations using adhesive techniques and no tooth preparation. Review after 9 years showed that, three restorations were still in service. All 11 failures were associated with separation in the region of the tooth restoration interface indicating the need for adequate mechanical properties of FRCs for use in prosthodontic applications. These problems were resolved by switching to a bisphenol glycidyl methacrylate based resin as the matrix for the FRCs.[18]In 1997, Samadzadeh et al. studied the effect of the addition of chopped length of high modulus polyethylene fibers on the fracture resistance of FRC. He concluded that the fracture resistance improved with the addition of polyethylene fibers.[19]

In 2002, Freilich et al evaluated of 39 light and heat polymerized fixed partial bridges made with a substructure of preimpregnated, unidirectional FRC, veneered with a hybrid particulate composite. Each of the prosthesis was assessed for surface integrity, anatomical contour, marginal integrity, and structural integrity. The results showed that survival was associated primarily with substructure design volume. The survival rate was 95% for prostheses made with a high-volume substructure, when patients with severe parafunctional habits were excluded. This study shows that a unidirectional, preimpregnated FRC can be used successfully to make bridges of variable retainer designs that last up to 4 or more years when a high-volume substructure is used.[20]

In 2003, Li et al. studied the failure modes and failure locations of the direct FRC dental bridge structures with and without adjacent teeth experimentally. The experimental results show a good agreement with the clinical observations. It is found that the bonded interface is indeed the weakest region in the composite bridges. Also, it is suggested that the composite resin reinforced with high modulus polymer fibers and the presence of adjacent teeth could significantly increase the structural strength and stiffness of the bridge and therefore improve its clinical performance.[21]n 2005, Visser and Rensburg did a study to review FRC as an alternative to tooth replacement in South Africa. Although the use of FRCs for this purpose is relatively new in South Africa, 5 years clinical results are very promising .It is not necessary to prepare adjacent teeth, so the biological costs are low. In fact, it makes more sense to conserve as much as possible that part of the tooth which displays the best bonding surface in the oral cavity, that is, the enamel of the tooth. Additionally, as this technique is reversible it allows other restorative options to be evaluated at a later time. These restorations offer a viable alternative to more expensive fixed or removable prostheses.[22]

Shinya et al. in 2008 studied the stress distribution in anterior adhesive fixed dental prosthesis and at tooth/framework interface. The design of FPD consists of retainers in maxillary central and canine and pontic lateral incisor. Two different materials were compared: Isotropic Au-pd alloy and anisotropic continuous unidirectional E-glass FRC. A three-dimensional FE model of 3 U FPD with 154 N loading was analyzed to determine the stress distribution at FPD and adhesive interface. The general observation was that the FRC-FPD provided more even stress distribution from the occluding contact point to cement interface than did metal-FPD.[23]Matheus et al. in 2010 used optical coherence tomography (OCT) compared to scanning electron microscopy and optical microscopy to evaluate qualitatively crack propagation and final fracture in restorative composite materials with fiber-reinforcement after cyclic loading. The failures were analyzed using the three methods described. OCT permitted good characterization of internal crack propagation. The results indicated that the deformation occurred in the dental composite and fiber in the direction of the force.[24]Monaco et al. in 2003 clinically evaluated the inlay FRC FPD's. This clinical study evaluated the behavior of inlay fixed partial dentures (IFPD) with conventional and modified framework designs over a period of 12–48 months. Forty-one glass FRC IFPDs were made to replace one missing maxillary or mandibular tooth. The samples were divided into two groups. Group (19 samples) 1 had parallel fibers while Group 2 (22 samples) had parallel as well as woven fibers. All restorations were evaluated by color match, marginal discoloration, secondary caries, surface texture, marginal adaptation, fracture, and postoperative sensitivity. Group 1 showed a 16% fracture failure rate; Group 2 showed a 5% failure rate. However, the difference between the two groups was statistically insignificant. [25]

Bell et al. in 2004 studied the bonding properties of two types of FRC posts cemented into root canals of molars. Serrated titanium posts served as a reference. Prefabricated carbon/graphite FRC posts with cross-linked polymer matrix and individually formed glass FRC posts with interpenetrating polymer network polymer matrix were compared. Push-out force was measured by pushing the post from one end. The push-out force increased with increased height of dentin disc in all groups. Unlike the other posts, there were no adhesive (postcement) failures with the individually formed glass FRC posts, suggestive of an improvised interfacial adhesion of cement to these posts.[26]

Malferrari et al. in 2003 did a prospective clinical follow-up and evaluated the acceptability of quartz-fiber-reinforced epoxy posts used in endodontically treated teeth over a 30-month period. In 132 patients, 180 endodontically treated teeth were restored using quartz-fiber posts. Displacement, detachment, or fracture of posts; core or root fracture; and crown or prosthesis de-cementation were considered as the parameters of clinical failure. Patients were re-evaluated at 6, 12, 24, and 30 months. After 2 weeks, one cohesive failure was observed and recall after 2 months showed two adhesive failures. All three failures occurred during removal of the temporary crown at the cement dentin interface. Over a 30-month period, the success rate was 1.7% but however, it was possible to successfully replace the restoration in all three failed cases.[27]In the present case, flowable composite had been used to cement the bridges as opposed to luting resin cements. A study found that the use of flowable composites was comparable to the luting cements for bonding porcelain laminate veneers that were less than 2mm in thickness .[28,29,30] Dentists are using flowable composites for a wide variety of applications due to its cost effectiveness and versatility. In general, flowable composites have low viscosity with less filler than the common packable composites. As a result, they demonstrated lower mechanical properties but more flexible than the packable composites. Due to this flexibility, the material is suitable not only for restorations purpose but also for cementation of bridges.[31,32,33]

IV. Conclusion

1. In hypodontia patient interdisciplinary treatment approaches are commonly used. FRC bridges offers a simple and cost-effective treatment option for the replacement of a missing anterior teeth after orthodontic correction. Indirect fibre-reinforced
2. composite bridges can offer an alternative treatment for patients who cannot afford
3. implant or as a short to medium term temporary prosthesis while waiting for
4. implant treatment later in life. While definitive long-term evidence about their clinical
5. performance is limited, indirect fibrereinforced composite bridges appear to be a
6. valuable option in the conservative treatment of short span edentulous space.

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