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Prosthetics in Paediatric Dentistry

SUMMARY

Premature loss of teeth in children may lead to both functional and esthetic problems. Missing teeth in both anterior and posterior regions may cause malfunctions in mastication and proper pronunciation. If the missing teeth are not replaced, further complications may occur, including adjacent tooth migration, loss of alveolar bone, and irregular occlusion. Considering the sensitive nature of children, loss of teeth may cause the development of insecurities and low self esteem problems. Due to dynamic nature of growth in children and adolescents, prosthetic appliances must not hinder development of orofacial system, and must meet adequate esthetic and functional standards. Dental prosthetic appliances in paediatrics must be planned with respect to the special conditions that led to tooth loss or damage. Multi-disciplinary approach is needed, under constant supervision of paediatric dentist and orthodontist, as well as regular checkups with clinical and radiographical examinations.

Key words: Prosthetic, Child, Dental Crown, Adhesive Bridge, Denture

Zoran Vulićević[1], Miloš Beloica[1], Dušan Kosanović[1], Ivana Radović[1], Jelena Juloski[1], Dragan Ivanović[2]

[1] Clinic for Pediatric and Preventive Dentistry
Faculty of Dental Medicine
University of Belgrade, Serbia
[2] Faculty of Medicine, University of East Sarajevo
Republic of Srpska, Bosnia and Herzegovina

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Introduction

Premature teeth loss, both deciduous and permanent, may cause functional problems in children, such as malfunctions in mastication, improper teeth placement or eruption and hindered pronunciation. Esthetical issues are also present, as child may be mocked or bullied, leading to insecurity, development of complexes and low self esteem.

Modern dental prosthetic appliances need to fulfill several important criteria in order to be considered as an adequate treatment options in children:

1. Rehabilitation of masticatory functions and efficiency: Prosthetic appliance needs to be able to replace missing teeth without hindering child's ability to chew. They must be designed properly to avoid or minimize wear on the opposing dentition.
2. Protection of dental pulp: Vitality of dental pulp should be preserved whenever possible. Prosthetic restoration must be made with great care not to disturb vitality of the tooth it is on (if vital), as well as adjacent or opposite teeth. Prosthetic restoration needs to be regularly checked and adjusted accounting for child's growth and development.
3. Esthetic criteria: Restoring esthetics is one of the pillars of modern dentistry. Caring about personal appearance is very important to children, especially in adolescence[1]. However, there are recent studies showing that even children in preschool period (age 3-5) have a developed consciousness about their body image, and do care about how they are perceived by other children and adults alike[2].
4. Proper speech function: Missing teeth, especially in anterior regions, may cause improper speech. Missing incisors often lead to a child being unable to properly pronounce dental consonants such as "t", "d", "n" and in some languages "l". Similar problems may develop in children with cheilo-gnato-palatoschisis. This may lead to development of improper speech patterns that need to be corrected with the aid of speech therapist after the missing teeth or defects are taken care of with adequate prosthetic appliance.
5. Prosthetic appliance must support optimal and proper development of teeth and their eruption, as well as support growth of the dental arches, and facial bones. Prosthetic appliances need to be regularly maintained, adjusted and checked in order to prevent

them from inhibiting proper orofacial development. In that sense, considering the fluid and changing environment of a child's oral cavity, all dental prosthetic appliances have a temporary function.

6. Prevention of harmful habits: missing teeth or improper teeth alignment may cause the child to develop bruxism (teeth grinding), or to repeatedly clench their jaws. These habits can also develop in some children as a response to pain, sometimes during teeth eruption. Also, kids with certain medical condition, such as cerebral palsy, are also prone to develop bruxism. The purpose of the adequate prosthetic appliance in these cases is to prevent harmful habit by stabilizing occlusion and preventing painful sensations.
7. Provision of space maintenance: If the missing teeth are not replaced with a prosthetic appliance, adjacent teeth can migrate towards the toothless alveolar ridge, leading to occlusion problems and issues with dental eruption.
8. Fixation of loosened teeth after trauma: Splints, both wire and composite or fiber, perform a crucial role in saving teeth that have been loosened by trauma. Detailed examination with x-rays must be performed before splinting the teeth, and regular dentist supervision and checkups must be maintained for the duration of the splint, to avoid ankylosis.

All of these criteria must be fulfilled in order to create appropriate conditions for definite prosthodontics once the adult age is reached.

In the past, when deciduous tooth was suffering from extensive decay, most often outcome for such tooth was extraction. Pulpotomytreatment, and large carious lesions on primary teeth often led to failure of direct restorations, due to inability provide adequate, saliva free working environment and sufficient retention. Nowadays, crowns are considered a viable alternative[3]. Indications for use of dental crowns on deciduous teeth are:

1. developmental defects
2. fractured teeth
3. teeth after pulpal therapy
4. restoring multisurface caries, especially in patients with high caries risk
5. teeth with extensive wear
6. teeth that need to function as an abutment for space maintainer

Materials and designs used for such crowns varied greatly over the years, and recent improvements in design of dental materials have provided a variety of different dental crowns. Most important factors considered by dentists when choosing adequate crowns are durability, esthetics, retentiveness, adaptability, placement time, allergenicity and cost.

Stainless steel crowns first appeared as a full-tooth-coverage treatment option as early as 1950's[4]. These first crowns, composed of nickel-chromium, were known to cause a variety of unwanted clinical symptoms, mostly due to allergenic potential of nickel. Since then, design of the crowns as well as metals used significantly changed[5]. Nowadays stainless steel crown consist of blend of metals that includes iron, chromium, carbon and 9% nickel, similar to orthodontic wires (Figure 1). Stainless steel crowns are known for their durability, as shown by Prabhakar et al in their in vitro study[6]. Longevity of the crown mainly relies on following proper protocols for crown placement, especially in relation to margins. If it is possible, crown margin should rest on healthy tooth substance, and if it is not, then on amalgam or glass ionomer restorative material, as studies have shown these two material demonstrate least amount of microleakage[7]. Possibly the greatest issue with stainless steel crowns is their poor esthetical appearance, which limits their use to restoration of primary first and second molars. Nevertheless, these crowns may be esthetically satisfactory when veneered using composite materials in frontal teeth.

Figure 1. Stainless Steel. Crown cemented in place

Zirconia crowns are relatively new in dentistry, firstly introduced in 2001. by Suttor et al[8]. However, the material itself has been in use in medicine since 1960's, in orthopedic application during hip surgeries. Zirconia used in dental crowns is yttrium stabilized zirconia[9]. This provides the dental zirconia with highest flexural strength of all zirconia based materials, alongside high chemical and erosion resistance. Furthermore, material is biocompatible, hypoallergenic, and with similar durability as natural enamel. As they cannot be adjusted (unlike stainless steel crowns), zirconia crowns for primary teeth come prefabricated with specific attributes. It is therefore important to trial-fit using the mock-up crown before cementing, to ensure proper tooth preparation, margin and occlusion (Figure 2). Unlike traditional ceramic, zirconia crowns for primary teeth demonstrate low wear on the opposing dentition. Choi et al. in their in vitro study

show that zirconia and stainless steel crowns demonstrate lowest wear rates amongst materials for full coverage paediatric dental crowns, and as such should be primary choice, compared tolithium-disilcate glass ceramic and leucite glass-ceramic[10]. Excellent esthetical appearance of prefabricated zirconia crowns makes them fully usable in restorations in both anterior and posterior regions (Figure 2), with good durability and lifespan, as shown by Ashima et al.[11].

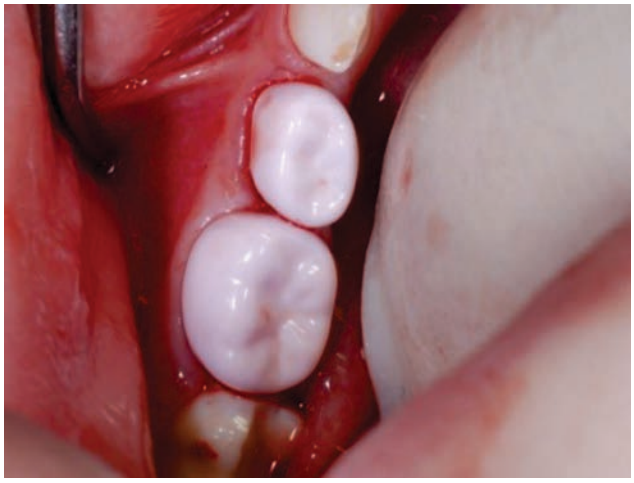

Figure 2. Trial fitting with mock-up crowns before cementing

Partial removable dentures in children must be planned with child growth and development in mind. Design of dentures must be such that it allows for modification when teeth erupt or migrate. That said, long periods without a tooth (or tooth replacement) lead to narrowing of alveolar processes and vertical alveolar defects at sites with missing teeth, over eruption of unopposed permanent teeth, and tipping of adjacent teeth[12].

Tissue supported partial dentures are indicated when we expect a child to be without a tooth for a prolonged period of time, or when bone resorption and remodeling is anticipated immediately following extraction or traumatic tooth loss. They are also indicated in severe cases of hypodontia, weather hereditary (like ectodermal dysplasia) or after cyst or tumor operations. Denture fabrications in early age, especially in cases of hypodontia, may lead to significant improvements in appearance, speech and masticatory functions. Such positive changes may increase the self-confidence of the child and aid in establishing proper dietary patterns. Balla et al. showed that wearing tissue supported dentures does not inhibit maxillar or mandibular growth[13] .

Figure 3. Cemented zirconia crowns

Figure 4. Edentuous state in deciduous dentition, central incisors about to erupt

Figure 5. Tissue supported denture

Retention of tissue supported dentures in children is most often achieved by extended body of acrylic base of the denture, resting on alveolar ridge and palate (Figures 4 & 5). Clasps are only used when necessary, due to force they administer to teeth, but some orthodontic springs may be incorporated in the design of the denture to facilitate necessary tooth movement (if needed).

In recent years, polyamide based dentures have started to be more frequently used in paediatric dentistry, mainly due to its higher elasticity, toxicological safety and good esthetic[14]. Their high adaptability and elasticity makes them especially suited for use in deciduous and mixed dentition period.

Teeth supported dentures can be designed in edentuous states following cyst or tumor operations in mandibular or maxillar region (Figure 6). In these cases, it would not be advisable to apply pressure on compromised gingival or bone tissues, as that could lead to post-operative complications, ulcerations and infections. Retention of teeth supported dentures is achieved via dental clasps and occlusal rests, minimizing as much as possible contact with mucosae, while rigidity of the denture is ensured by the supportive metal frame (Figure 7).

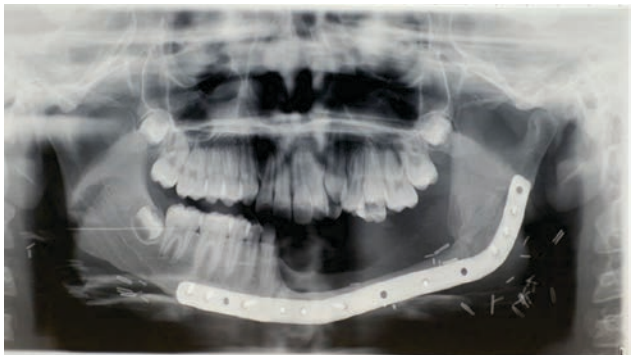

Figure 6. A 12 year old girl, status post osteosarcoma and mandibular resection.

Figure 7. Teeth supported denture, retention with occlusal rests and dental clasps

All dentures designed must allow for proper hygienic maintenance of both denture and child's oral cavity, and insure no damage to surrounding tissues. Regular checkups and recalls must be made every 3-6 months, and modifications must be made to match and accommodate to child's growth and development.

Loss of anterior teeth in children and adolescents is more often a result of injury and/or complication from previous trauma (like ankylosis or root resorption). Central maxillary incisors are teeth most frequently affected by trauma[15]. During period of childhood, and especially in puberty, a non-invasive long term interim restoration should be designed until implant is indicated. Because of risk of complications such as implant infraposition, implant therapy should be postponed until adulthood is reached[16].

Resin bonded or resin retained bridges represent a minimally invasive option for replacing missing teeth. This type of restoration was first described in 1970's, and since then, they have evolved significantly in both design and materials used. First type of resin bonded bridge was known as Rochettebridge, which generated its retention through resin cement bonding through characteristic perforated metal retainer. The commonly used nickname for resin retained bridges "Maryland bridge" results from the type of electrochemical etching developed at university of Maryland, which improved and enhanced resin bonding to the metal alloy.

In recent years, with development of new materials, traditional metal-resin restorations are starting to slowly be abandoned in favor of modern fiber reinforced composites. Evolution of fiber products for dental use has transitioned from plain fibers, over pre-impregnated fibers to fully resin impregnated fibers. Most common types of fibers for use in resin bonded bridges are polyethylene, Kevlar and glass based fibers. Also, the fibers may be unidirectional, braid, mesh/network or woven. Different types of fibers and weaves create different adaptability and manageability, as well as different capabilities to distribute the force multidirectional. Majority of clinical studies of resin bonded bridges report on unidirectional fibers, and out of those, most used areglass fibers, mainly due to their strength and aesthetics[17]. The use of fiber reinforced composites in resin bonded restorations is advised for their favorable elastic module in comparison to metal, and better adhesion of the composite to the framework[18].

Main advantages of resin bonded bridges are their preservance of healthy tooth substance, needing no or minimal preparations, reduced costs and generally good patient acceptance[19]. Also, they tend to remove pressure from mucosae and alveolar ridge (unlike tissue supported partial denture), therefore reducing the risk of alveolar bone resorption and possible complications with future implant therapy. Careful planning is needed in order properly distribute masticatory pressure on the adjacent teeth. Resin bonded bridges are relatively easy

to install, rarely require local anesthesia, and are therefore appropriate for patients who may have increased anxiety in dental chair, or are unable to devote themselves to multiple dental appointments. Patients should, however, be properly introduced and motivated of the importance of adequate oral health and hygiene, as poor maintenance of resin bonded bridge may lead to gingivitis, periodontal issues, and failure of the restoration.

Most common reasons of failure of resin bonded bridge are de-bonding, and discoloration and chipping, especially in areas where fibers have been exposed to oral cavity. Majority of the studies show that the expected survival rate of resin bonded bridge to be around 72-74% after the period of 3-5 years[20]. Also, it is reported that anterior restorations can be expected to last longer than posterior ones, as well as that survival rate of resin bonded bridges in maxilla is higher as opposed to mandible (81% vs 56% after 2.5 years). There is however a definite lack of detailed, standardized information in the literature concerning longevity of resin bonded bridges. It is also important to note that developments of new generations of composite restoration materials and bonding agents can possibly question validity of the results of the older publications.

Conclusion

Childhood and adolescence represent a period of intense growth and development of orofacial system. In such gentle period, replacement of missing teeth is of vital clinical importance, and variety of materials and restoration design options exist to ensure that proper chewing, aesthetics and pronunciation are achieved. Adequate prosthetic restoration in children or adolescents must not in any way hinder proper development of jaw bones, dental arches and permanent teeth, but rather guide and preserve oral tissues in a minimally invasive way to ensure that satisfactory definite restoration can be achieved once adulthood is reached. Frequent checkups and careful clinical supervision are advised, as well as maintaining adequate oral hygiene of the patient.

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Correspondence:

Zoran Vulićević
Clinic for Pediatric and Preventive Dentistry
Faculty of Dental Medicine, University of Belgrade, Serbia
e-mail: zrvdent01@gmail.com