



# PROSTHETIC RESTORATIONS FOR CHILDREN AND ADOLESCENTS UNDER 18 YEARS OF AGE

Uzupełnienia protetyczne dla dzieci i młodzieży do 18. roku życia



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## Abstract

**Introduction:** Premature loss of primary teeth in children under 18 years of age is most often caused by active carious disease of primary and permanent teeth, especially the first molars, and the need to extract them. Missing teeth in children may also result from congenital absence of permanent dentition, developmental defects and injuries. The consequences of missing teeth depend largely on the child's age when the gaps occurred. However, they always lead to dysfunctions of the masticatory system and temporomandibular joint, speech and aesthetic disorders and, finally, lack of peer acceptance. **Aim:** The aim of the study is to review the literature on the treatment of patients with premature loss of primary teeth due to congenital defects and injuries. Studies dealing with the topic of early prosthetic rehabilitation in the group of patients under 18 years of age were taken into account. **Materials and methods:** A review of available studies on missing teeth in children and adolescents and their consequences for the development of the stomatognathic system was conducted. **Result:** All authors discussing the topic of edentulism in children point to the need for prosthetic treatment. At the same time, they recommend an individualised choice of prosthetic restorations. The child's age; the type, extent and location of missing teeth and the child's willingness to cooperate are the main determinants of this choice. **Conclusions:** Prosthetic rehabilitation should be provided to children with prematurely missing teeth as early as possible to avoid multiple short and long-term complications affecting the development of the stomatognathic system.

## Streszczenie

**Wprowadzenie:** Przedwczesna utrata zębów mlecznych u dzieci poniżej 18. roku życia jest najczęściej spowodowana aktywną chorobą próchnicową zębów mlecznych i stałych, zwłaszcza pierwszych trzonowych, oraz koniecznością ich ekstrakcji. Braki zębowe u dzieci wynikają również z wrodzonych braków zębów stałych, wad rozwojowych i urazów. Konsekwencje braków zębowych zależą w dużej mierze od wieku dziecka, w którym wystąpiły luki, zawsze jednak prowadzą do dysfunkcji narządu żucia, stawu skroniowo-żuchwowego, do wad wymowy, zaburzeń estetycznych i ostatecznie do braku akceptacji ze strony rówieśników. **Cel pracy:** Celem pracy jest przegląd literatury dotyczącej leczenia pacjentów z brakami zębowymi wynikającymi z przedwczesnej utraty zębów mlecznych, wad wrodzonych i urazów. Uwzględniono prace podejmujące tematykę wczesnej rehabilitacji protetycznej w grupie pacjentów poniżej 18. roku życia. **Materiały i metody:** Przegląd istniejących badań dotyczących braków zębowych u dzieci i młodzieży oraz ich konsekwencji dla rozwoju układu stomatognatycznego. **Wynik:** Wszyscy autorzy poruszający temat bezzębia u dzieci widzą potrzebę leczenia protetycznego. Jednocześnie zalecają indywidualny dobór uzupełnień protetycznych. Głównymi czynnikami determinującymi ten wybór są wiek dziecka, rodzaj, wielkość i umiejscowienie brakujących zębów oraz chęć współpracy dziecka. **Wnioski:** Aby uniknąć licznych wczesnych i odległych powikłań w rozwoju układu stomatognatycznego u dzieci z przedwczesnym brakiem zębów, należy jak najwcześniej zapewnić dzieciom rehabilitację protetyczną.

**Keywords:** premature tooth loss; paediatric dentures; prosthetic rehabilitation

**Słowa kluczowe:** przedwczesna utrata zębów; protezy dziecięce; rehabilitacja protetyczna

DOI 10.53301/lw/190434

Received: 20.06.2024

Accepted: 25.06.2024

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**Introduction**

Prosthetic rehabilitation of the youngest children with premature loss of primary teeth is particularly challenging. It must take into account the dynamic changes that occur during the development of the stomatognathic system. Missing teeth give rise to many stomatognathic complications. However, these may be prevented if prosthetic treatment is properly implemented in this age group.

Studies have shown that the problem of missing teeth affects a large group of children and adolescents. Over 13% of 3–8-year-olds have prematurely lost teeth. More than 20% of children and adolescents aged 7–16 years qualify for prosthetic treatment [1]. Premature loss of primary teeth occurs 3–4 years before normal physiological exfoliation [1]. It may arise from many abnormalities dependent or independent of the child or parental behaviour, including environmental or socio-economic factors.

The causes of missing teeth in children and adolescents include:

- Dental caries resulting from the lack of or improper oral hygiene, insufficient home-based prophylaxis, poor dietary habits. It is also a result of failure to undertake treatment in the case of initial dental caries or lack of regular check-ups. The rapidly progressing carious process typical of primary teeth leads to their complete destruction, which often necessitates extraction [1–8].
- Injuries, such as crown or root fractures, damage to enamel or dentin, partial or complete avulsion. Injuries to primary teeth can also cause damage to permanent tooth buds. Incisors are particularly susceptible to trauma. Primary tooth trauma is most likely to occur at the age of 1–2 years and 4–6 years [1, 3, 9].
- Hypodontia or anodontia of primary or permanent teeth. These disorders are significantly more common in permanent teeth, which means that they occur in the older group and are identified during tooth replacement. In this case, mandibular second premolars, maxillary lateral incisors and maxillary second premolars are most likely to be missing.
- Genetic factors.
- Environmental factors, such as improper nutrition, hormonal disorders, maternal health problems and/or pharmacotherapy during pregnancy.
- Congenital absence of tooth buds, which is associated with disorders such as ectodermal dysplasia syndrome, Down syndrome, primary and secondary clefts.

The consequences of premature loss of primary teeth depend on the number and location of missing teeth, as well as the age at the time of their loss [1, 10, 11].

It has been shown that the earlier the tooth loss occurs and in greater number, the more serious the short- and long-term consequences will be [2]. The most severe sequelae of premature loss of primary teeth, depending on the number and location of lost teeth, and the absence of permanent tooth buds, include:

- Inhibited bone growth due to insufficient functional stimulation [1, 6, 10, 11]. Premature extraction of primary teeth results in the lack of occlusal/modelling forces that guide the growth of the alveolar process. They are necessary for the correct three-dimensional growth of the alveolar process, and when absent, one-dimensional vertical growth of the processes occurs.
- A change in the mandibular position due to limited functional stimuli as a result of reduced chewing surface. Additionally, consolidation of muscle work patterns gives rise to malocclusion or consolidation of the existing tendency [1, 12].
- A change in the height of the alveolar process along with the teeth in the segment devoid of opposing teeth.
- Formation of a dense bone scar, which will delay or even prevent eruption of permanent teeth.
- Tongue dysfunction, breathing through the mouth and infantile swallowing pattern. These disorders will contribute to the development of malocclusions and speech defects [13].
- Malocclusions and facial defects caused by the dysfunction of the masticatory muscles as a result of compensation.
- Malocclusions caused by the loss of space for permanent teeth due to shifting of previously erupted teeth, which may contribute to midline shift, crowding, and other orthodontic problems [13].
- Displacement, mesial or distal tilting of the teeth adjacent to the gap.
- The load on the teeth remaining in the arch, which take over the function of the missing teeth.
- Occlusal disorders, formation of traumatic nodes, bite disorders, excessive tooth wear, temporomandibular disorders.
- Mental and emotional problems, especially in teenagers, due to missing teeth, permanent in particular.

Prosthetic treatment should be started as early as possible. The age of 5–6 years is most often mentioned, which usually results from the significantly greater chances of cooperation between the child and the doctor and the patient's compliance with medical recommendations [14]. According to some researchers dealing with prosthetic restorations, 3 years is the appropriate age for prosthetic interventions in children. Such an early onset of treatment allows for the most effective rehabilitation of children [15–17]. In the developmental period, prosthetic treatment is temporary due to the constant growth of

the child and the development of their stomatognathic system [14, 17].

In older age groups, prosthetic treatment depends on the stage of development of permanent dentition, including the roots, and the maturity of the stomatognathic system.

Prosthetic treatment of adolescent patients can be classified into three categories proposed by Carrel and Christiani, depending on the age, type of defects and their location [5]:

- Class I. Patient age:
  - A. from infancy to 6 years,
  - B. from 6 to 12 years,
  - C. from 12 to 18 years;
- Class II. Location of missing teeth or tissues:
  - A. intraoral;
  - B. extraoral;
- Class III. Type of tooth loss:
  - A. acquired (injury, tumour, disease, caries),
  - B. congenital (e.g. ectodermal dysplasia, clefts).

## Aim

The aim of the study was to review the literature on the treatment of paediatric patients with missing teeth, to discuss the consequences of the above-mentioned problem and the possibilities of preventing complications resulting from premature loss of primary dentition and missing permanent tooth buds, as well as to answer the question whether prosthetic rehabilitation of the youngest children is necessary and feasible.

## Results

### *Treatment of patients up to 6 years of age*

This age group is characterised by the most intensive development of the stomatognathic system, with dynamic growth of the mandible, maxilla, alveolar processes and the teeth themselves. It is particularly important to stimulate the proper growth of these structures in the group of the youngest children. Therefore, all actions of parents and dentists to support this development are crucial. In the case of prematurely missing teeth in the youngest and the need for prosthetic rehabilitation, all measures should be taken to provide the child with care as soon as possible.

The time between 5 and 6 years of life is critical. This is when eruption of the first permanent molars is expected to begin. Their occurrence in the oral cavity determines certain functional and structural changes in the future permanent dentition. These changes include stabilisation of the occlusal height, support in maximum intercuspation, protection of TMJ structures from compression, stimulation of growth, anteriorization of the mandible. Hence the important role of prosthetic rehabilitation of children up to the age of 6 years [18, 19].

Prosthetic solutions used in this group of patients should support and stimulate the development of the entire stomatognathic system. The occlusion should be set in a construction position, anatomically and functionally appropriate for this age [14, 17].

Premature loss of individual primary teeth most often occurs in this age group, usually causing dental displacement and the risk of loss of space for permanent teeth. Space maintainers should be used in children with premature loss of single primary teeth, second molars in particular. They enable maintaining appropriate space for a permanent tooth. Space maintainers prevent the teeth surrounding the gap from shifting, and thus from closing or significantly reducing the space for a permanent tooth expected to erupt in place of a prematurely lost primary tooth. Space maintainers can take the form of permanent metal orthodontic rings or removable devices, as part of a functional appliance, or a removable plate precisely fitting against the mucosa [17].

Partial or even complete removable dentures are used in this age group in the case of premature loss of a larger number of primary teeth [18]. Depending on the purpose and development status of the stomatognathic system, they are classified as preventive, therapeutic and retention ones.

Preventive dentures are designed to enable the proper three-dimensional growth of the alveolar processes, maxillary and mandibular development, proper eruption of permanent teeth, as well as to prevent malocclusions in the case of significant edentulism. Their task is to maintain the continuity of the dental arches. These dentures are constructed in a habitual bite [13].

The second group of prosthetic devices is used in children with missing teeth and coexisting malocclusion. These are the so-called prosthetic-orthodontic appliances. These devices are in a construction bite and are enriched with active elements, such as screws and springs [1, 6, 8, 12]. Retention dentures consolidate the outcomes of orthodontic treatment, supplement missing teeth in correct occlusion, but also ensure proper chewing, speech and aesthetics [13].

The types of dentures for edentulous patients, depending on the child's needs (i.e. the number of missing teeth, correct occlusion or malocclusion), are summarised in Table 1.

The use of removable dentures in children requires special care and adherence to the principles of their manufacture so that they do not inhibit the growth of dental arches, but promote their proper development. They should not contain clasps if possible. Retaining elements in the form of Adams clasps, arrowhead clasps, half-arrowhead clasps or ball clasps may be present during the initial adaptation period, but should be removed later.

**Table 1.** Prosthetic restorations for children with primary teeth used depending on the needs

Types of prosthetic devices
Complete maxillary denture
Complete mandibular denture
Complete maxillary/mandibular overdenture (OVD)
Maxillary partial denture with orthodontic clasps and a central screw
Partial maxillary denture with reduced vestibular screen
Partial mandibular denture with orthodontic clasps

The denture should be retained by means of adhesion, cohesion and impaction [1, 2, 4].

The acrylic screen should be separated from the mucosal side by about 1 mm. Such design of a denture will not interfere with the growth of the alveolar processes.

The dentures should contain no vestibular screen. Such a screen is used in complete dentures and generates the need for frequent replacement of the appliance and the use of a short screen [1, 4, 5, 8].

These should always be mucosal dentures that can be easily adapted to the changes occurring during maxillary and mandibular growth.

It should be easy to put on and take off dentures, as well as to maintain their hygiene. Also, the appliance should be inexpensive due to the need for its frequent replacement.

When using dentures in children, class IA dentures in particular, the intensive growth of all stomatognathic structures needs to be considered. The growth and development of the alveolar processes, maxillary and mandibular bones and finally the teeth make it necessary for the attending specialist to arrange frequent patient check-ups. As a result of the above changes, dentures need to be frequently replaced to support the proper development of all structures. Prosthetic appliances should be replaced every 8–10 months up to the age of 11 years, every 1.5 years between 11 and 15 years, and every 2 years between 15 and 18 years of age. All suggested dates for replacing dentures are conventional and depend on the pace of the child's development. In practice, dentures should be replaced as often as needed [4, 18].

The changes occurring in the oral cavity and the need to adjust the denture require good parent-doctor cooperation. Follow-up visits are recommended every 2–3 months, or even every month if necessary [8, 12]. After ensuring that the denture fits in the oral cavity, necessary corrections should be made so that it adheres properly to the supporting tissue and has proper contact with the opposing teeth. If necessary, the physician should adjust the denture during the follow-up visit by filing down its unnecessary fragments that may delay the growth of the alveolar processes or teeth blocked by the denture. The denture may be supplemented with rapidly polymerizing mass if needed.

It should also be appreciated that a denture intended for a child must be comfortable and acceptable for the patient. This is extremely important as the appliance is worn throughout the day, and in the case of a medical denture, also at night [6, 18].

### Prosthetic treatment for children aged 6 to 18 years

Mainly clasp-free dentures or those with orthodontic clasps are recommended in this age group. Depending on the diagnosis, prosthetic and orthodontic restorations are used. Prosthetic solutions in the form of crown-root inlays are allowed in the case of significant carious destruction of the permanent tooth provided that accurate and effective root canal treatment of the tooth with

completed development and a closed root apex was performed. Prosthetic crowns are a temporary solution in young patients. They may be acrylic, composite, metal or acrylic/metal. The use of ceramics, which requires excess preparation of the teeth, is not recommended.

Two-abutment bridges are an unacceptable method for treating missing teeth in this age group. This solution prevents maxillary growth. However, dentures with one abutment are acceptable, especially in children over 10 years of age [18].

Prosthetic treatment of edentulism in adolescents over 16 years of age is similar to the one used in adults. It usually takes place in two stages:

- Stage I – clasp-free partial dentures;
- Stage II – skeletal dentures, with possible implants after reaching maturity [18].

Rochette and Maryland bridges, as well as adhesive bridges made of glass fibres also represent prosthetic solutions acceptable in this age group. Such appliances can be used after the age of 12 years. It is important that they do not inhibit the development of the alveolar process. Classical bridges are not allowed in this patient population [18, 20–23].

In the case of extensive agenesis, congenital defects, e.g. ectodermal dysplasia, and in the absence of favourable conditions for retaining dentures in the child, implants may be used as elements to increase denture retention and stabilisation. However, this is not a commonly used method as the implant may dislocate as a result of growth processes (resorption and apposition in various maxillary and mandibular regions. Implants may be safely used after the growth of the stomatognathic system is completed [1, 2, 4, 8, 14, 15].

The choice of dentures should be based on oral examination, including the quality of supporting tissues, the extent of missing teeth and the child's/parental willingness to cooperate. This is extremely important because prosthetic treatment of children up to 6 years of age is intensive, based on response to constant and rapid changes in the child's stomatognathic system.

Analysis of clinical cases allowed for establishing a prosthetic treatment algorithm for patients with missing teeth. The therapeutic methods used were the result of the assessment of prosthetic tissue support in relation to the patient's age, taking into account the indications and contraindications to individual types of prosthetic devices, as well as the child's/parental willingness to cooperate. The management algorithm proposed by Wojtyńska is presented in Table 2 [19].

### Discussion

The demand for prosthetic treatment among Polish children remains high. As reported by Strada et al., 15,000 children aged 7–16 years, including 21.72% qualified for prosthetic treatment, were assessed by Faliński et al. [18]. Similarly, in their study conducted in Warsaw among 200 high school students, Krzeski and Tarcz found missing teeth requiring dentures in 20.81% of the assessed ado-



**Table 2.** Algorithm for the treatment of children with primary teeth proposed by Wojtyńska [19]

Patient's oral cavity status	Management
The teeth present in the oral cavity, due to their arrangement and shape, allow for the retention of the orthodontic appliance	Functional appliances or orthodontic plate prosthesis that will stimulate growth and will be adapted to the changing supporting tissue
The number of teeth, their arrangement and shape do not guarantee the correct functional effect of a removable orthodontic appliance	Paediatric prostheses with orthodontic clasps and a reduced vestibular screen
The number of teeth, their arrangement, shape and the condition of the supporting tissues do not guarantee proper retention of partial dentures	OVDs covering suboptimal clinical crowns
Anodontia or loss of all teeth due to dental caries	Conventional full dentures
Inadequate supporting tissue	Direct denture relining with silicone-based material, with unburdening of the areas around erupting teeth
In each case, it is necessary to establish an individual follow-up schedule, depending on the patient's growth profile and the stage of stomatognathic development	
Uncooperative patients	It is recommended to schedule adaptation visits to accustom the child to both medical personnel and dental office. Motivation and dental education of parents are essential. Providing parents with impression trays, allowing the child to get accustomed to a tray being introduced into their mouth and preparing them for office procedures through play will have beneficial effects

lescents [18]. Olczak-Kowalczyk, who assessed a Warsaw group of children aged 3 to 8 years, reported that 13.06% of them required prosthetic treatment but still had a correct bite, while combined prosthetic/orthodontic treatment was needed in 4.29%. Such a large percentage of children requiring prosthetic management due to missing teeth indicates that the problem is underestimated and undertreated [10].

Many authors point to the relationship between the method of prosthetic treatment in children and the child's age, the type and extent of missing teeth, and consider the above factors to be the main determinants of the choice of dentures [19–22].

Mainly removable dentures are used in children up to 6 years of age due to the development of the facial part of the skull. Their purpose is to stimulate the correct three-dimensional growth of the alveolar processes, maintain the correct shape of dental arches and prevent horizontal and vertical shifting of teeth and malocclusions. If the patient has multiple missing teeth (regardless of aetiology), removable dentures are recommended, with a reduced vestibular screen, with or without expansion screws (depending on the needs), as well as with orthodontic clasps and springs [19]. The range and shape of the designed prosthetic plate should consider the quantity, quality and arrangement of the remaining teeth in the oral cavity. In the case of acceptable retention, partial removable dentures with orthodontic clasps and a reduced vestibular screen can be used [23, 24].

Similar recommendations were proposed, based on their experience, by Bidra et al., Pae et al., and Tarjan et al., who emphasized the need to consider such factors as facial skeleton growth dynamics and the eruption of permanent teeth in the prosthetic treatment of the youngest children [24–27].

Despite the recommendations to start treatment in children with premature loss of primary teeth as early as

possible, the issue of its actual initiation seems to be controversial, with varying opinions among authors.

The need for early prosthetic rehabilitation of children with prematurely lost primary teeth in the group up to 6 years of age is supported by the fact that these patients show significantly faster adaptation to the appliance, with simultaneous stimulation to effectively change children's habits, such as swallowing, chewing, and mouth breathing. Children of this age get used to dentures faster and easier. Also, they rapidly learn daily functioning with these devices. Such conclusions were presented by Tarjan et al. [27] and Paschos et al. [28].

The success of prosthetic rehabilitation depends to a large extent on the willingness of the child to cooperate with the doctor. Some authors believe that dentures should be used in children as young as 3 years of age [1, 2, 6]. Others consider it reasonable to begin treatment at the age of 4 years, suggesting that such children are more cooperative and the adaptation process lasts about 3–7 days [15]. Still, other authors consider the age of 5–6 years as the most effective for treatment due to good cooperation [19].

Missing permanent tooth buds, carious processes, especially in the first molars, with significant loss of hard tissue or tooth extraction, make it necessary to implement early rehabilitation of missing permanent teeth.

In the older age group, prosthetic rehabilitation is particularly important for emotional and psychological reasons. Missing teeth at this age are a source of lower self-esteem and psychological problems. Implants are particularly beneficial and expected in the older age group and they are usually more acceptable as a convenient and natural way to replace missing teeth, as noted by many authors [29, 30].

However, all authors emphasise the importance of child and parental cooperation in the process of prosthetic re-

habilitation. The child's acceptance of the denture is the basis for both good cooperation and the actual use of the device [13, 15, 19, 29].

Studies investigating paediatric prosthetic appliances encounter a number of limitations that may affect the results and their interpretation. The most important include:

- **Variations in growth and development.** Children are at different stages of growth and development, which may affect the fitting and long-term effectiveness of their dentures. The changing mandibular and dental dimensions may require frequent prosthetic adjustments.
- **Lack of standardisation.** The lack of uniform protocols and standards for paediatric dentures makes it difficult to compare different studies. Different diagnostic and therapeutic approaches can lead to variable results.
- **Short-term data.** Most of the available research focuses on short-term treatment outcomes; long-term studies assessing the durability and functionality of prosthetic appliances in children are missing.
- **Patient cooperation.** Children may have difficulty cooperating and accepting the prosthetic treatment process, which may affect the effectiveness and comfort of using dentures.
- **Ethical and practical challenges.** Conducting clinical trials involving children requires meeting strict ethical requirements, which may limit the number of available studies and their scope.
- **Costs and availability.** Paediatric prosthetics can be expensive and access to specialist prosthetic services is limited in some regions, which prevents extensive research.

Taking these limitations into account is crucial for the interpretation of research and for further development of effective prosthetic approaches for paediatric patients.

## Conclusions

Rehabilitation and prosthetic treatment in children should consider such factors as the clinical picture (location and extent of teeth loss, health of the supporting tissue), the age of the patient and the dynamics of the development of the stomatognathic system.

Prosthetic treatment should be undertaken as early as possible from the point of view of cooperation between the child, the doctor and the caregivers. Good cooperation of the child and parental involvement will allow for achieving the expected results. Early treatment helps avoid possible consequences of failure to intervene, such as improper growth and development of the masticatory system.

When planning prosthetic treatment in young children, individual solutions adapted to the age and needs of the child, including orthodontic needs at a given treatment timepoint, need to be considered.

When treating a child up to 6 years of age, their dynamic growth should be considered. Changes occurring during this period prompt frequent check-ups and require awareness of the need to modify the prosthetic device.

The doctor, parents and the child should also be prepared for relatively frequent replacement of the prosthetic device (every 8–10 months).

Prosthetic treatment in the age group of 6–18 years may be easier and more desirable by the patients themselves, especially in those between 16 and 18 years of age. Implants are a particularly attractive treatment approach for young people.

Prosthetic treatment in the older age group is very important due to the mental state of children and lower self-esteem in the case of extensive and noticeable hypodontia.

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