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New Trends in Prosthetic Dentistry

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Abstract: Prosthetic dentistry is one of the fundamental pillars of dentistry. Even though it is highly specialized in replacement of missing teeth and adjacent soft and hard oral tissues, the cooperation with other branches of dentistry is very important. It usually provides final stages of rehabilitation of the whole maxillofacial system. The loss of several teeth doesn't have to be an immediate threat to the function of the whole dentition, but it can initiate serious problems related to the whole orofacial region, psychics and the wellbeing of the patient. From this point of view prosthetic dentistry is a valuable tool with high therapeutical and preventive character. Modern prosthetics offers classical solutions with simple fixed and removable dentures, and advanced solutions with dental implants support for rehabilitation of dental defects. Final quality and prognosis of prosthetic treatment depends both on materials and technologies used and on the patients' motivation and dental care. Superior esthetical demands and biocompatibility issues drive dental manufacturers to introduce new materials with defined properties. Nowadays the most sophisticated systems are based on ceramics, dental implants and CAD/CAM technologies.

The most widely discussed problems in prosthetic dentistry today can be classified into several groups: aesthetics, biocompatibility and the replacement of missing teeth with fixed prosthetic appliances.

In recent years more and more people have come to realize the importance of a nice smile. Pleasant bearing with a smile, accented by perfect dentition, has become necessary both in the office and in private life. Pleasant appearance, with teeth in fair condition, is a mark of personality. The overall neglected look, including decayed dentition does not speak highly about the person. Therefore "keep smiling".

Aesthetics has come in to the limelight of our dental patients. Each person has a different idea of which teeth are beautiful. Somebody wants to have extremely light teeth regularly arranged in a dental arch with rounded edges, which simulate the teenager look. Another patient prefers new teeth with natural irregularities and varying shades according to changes in natural dentition during the process of aging. Some people prefer classical Greek beauty, other emphasizes improvisation.

The prosthetic materials and technologies used in manufacturing dental appliances can help us satisfy a lot of the esthetical requirements of the patients. We can meet perfect prosthetic rehabilitation, which looks natural in different age categories and likewise the perfect smile of an eighty-year old lady with extremely light and strictly regular artificial teeth, such as are typical for teenagers. We meet this both in Europe and overseas. Our perception of beautiful teeth is truly individual [1].

In the field of aesthetics our prosthetic dentistry meets a lot of other branches: biocompatibility, biomechanics, and the environment. The main aim of today's research into and development of dental materials is the perfect aesthetics

supported by the reliable function of dental appliances made of a biocompatible material, which does not stress the human body or our environment.

Materials for artificial teeth used all over the world are metals, plastics and ceramics. Metals and their alloys belong to the oldest substances used for dental appliances. We register a lower interest in their use due to their unfavourable esthetical properties and lowered biocompatibility [2]. The, of late, very popular plastic materials are now considered an economic variant to ceramics, in fixed appliances. There is a real boom in ceramics today thanks to new material research. The former apprehension of brittleness and hardness has no foundation any more today.

Dental ceramics are noted for excellent esthetical properties, high biocompatibility and reliability. Their disadvantage is the complicated manufacturing process and, therefore, the relatively high price. Ceramics are used for manufacturing aesthetical veneers on natural teeth, for inlays, onlays, crowns and bridges. They are very popular in reconstruction with dental implants and titanium.

The following chapters present a short overview of today's dental prosthetics possibilities.

The tasks of prosthetic dentistry

The objective of prosthetic dentistry is the complex rehabilitation of the orofacial system – i.e. the rehabilitation of the masticatory function, phonetics and aesthetics. This complex rehabilitation is very important for a patient's self-image.

Prosthodontics deals with the replacement of lost teeth and the adjacent alveolar ridges and missing soft and hard maxillofacial tissues. The causes of these losses may be different. The loss of teeth caused by extractions or injuries is the main reason for such situations. Further reasons are: physiological processes during the aging, insufficient care on the part of the patient for oral health and hygiene. A smaller group consists of patients with diagnoses, which can lead to the early loss of the natural dentition.

We would like to emphasize that keeping the natural dentition functional to an advanced age is the main aim of dentistry as a whole. Prevention holds first place in this field. Prosthetic dentistry takes effect in secondary and tertiary prevention. Dental appliances with their therapeutic function prevent the rise or deterioration of existing clinical problems. An early indicated prosthetic appliance can stop teeth inclinations, movements and overloading, changes in the occlusal plane and inter-jaw relations and prevent possible temporomandibular joint problems or digestive disorders caused by insufficiently chewed food.

Natural teeth with healthy periodontal tissues are the most important subject for the optimal function of the whole maxillofacial system and even a very carefully manufactured dental appliance of state-of-the-art materials cannot replace them fully.

The denture design must conform to the existing anatomical structures, the general expression of the face, and it must meet the aesthetic requirements of the patient.

The dentist must know the individual patient's conditions perfectly before he chooses the optimal prosthetic solution. Before starting treatment the dentist must consider the following conditions: The patient's age, local conditions, economic conditions, social circumstances and the dentist – patient relationship [3].

Examination of the prosthetic patient

The objective of the prosthetic examination is to appreciate the individual conditions and to make the diagnosis and treatment plan. The examination before the prosthetic rehabilitation consists of all steps used during the basic examination of a stomatological patient, i.e. the medical and dental history, an extraoral and intraoral examination, X-ray examination and special tests.

Treatment planning

The basic aim in treatment planning is the maximum prolongation of the function and vitality of the natural dentition. Modern prosthetics is characterized by a comprehensive view of the maxillofacial system, including preventive aspects and optimal treatment with a long-term prognosis. The time factor in prosthetic dentistry means that during the course of life we try to transfer the patient's dentition from single fixed prosthetic appliances (inlays, onlays, crowns) through short bridges to extended fixed appliances in combination with removable partial dentures. The final stage of the prosthetic rehabilitation involves complete dentures indicated for edentulous ridges. For the patient the complicated adaptation is the transition from natural dental arches, respectively extended fixed bridges, to complete dentures. Within a short time after this radical change the patient must learn to tolerate a unfamiliar material in his oral cavity, to manage the new way of mastication, avoid extreme movements of the mimic muscles. This period is very difficult for the patient's self-image.

Visiting dental surgery at regular intervals represents a very important preventive factor, which ensures the protection of natural teeth and periodontal tissues by early treatment. These visits can prevent early loss of a larger number of teeth at any one stage.

An important condition for optimal oral reconstruction is treatment planning, divided into rational steps composed of preventive and treatment procedures, which must minimize time delays and optimise the succession of separate stages of comprehensive prosthetic rehabilitation [4].

Diagnosis

The diagnosis before treatment planning includes the whole set of aspects referring to all system components – functional and morphological (dentition,

periodontal tissues, adjacent soft and hard tissues, oral mucosa, jaws, temporomandibular joints, salivary glands, masticatory and mimic muscles). The dental defects diagnosis relating to a concrete type of a dental prosthesis forms the base for treatment planning.

Treatment planning must respect the demands of all stomatological branches, and therefore comprehensive prosthetic rehabilitation involves the cooperation of other stomatological specialists in the initial treatment phases.

Surgical treatment usually includes tooth extractions and pre-prosthetic surgical methods (i.e. pre-prosthetic improvements of jaws and denture bearing tissues), application of dental implants [5]. *Conservative treatment* includes dental fillings and endodontical treatment. *Parodontical care* offers conservation and surgical treatment of periodontal tissues and specialized oral hygiene care. Cooperation with an orthodontist ensures the final treatment of selected dental and facial anomalies.

The treatment planning must incorporate a recall system, which, in a long-term horizon, supports the maximal function and aesthetics of dental appliances and a patient's comfort [6]. With its preventive character it helps prevent irreversible changes in the dentition and adjacent structures of the orofacial system. The recall system also draws the patient's attention to the fact that the fitting of prosthetic appliances is not the end of active care for the teeth as well as cooperation with the dentist. Individual treatment planning is an agreement between the dentist, who offers optimal solutions for concrete situations in a patient's oral cavity, and the patient, who compares them with his wishes, ideas and time and economic possibilities. The final treatment plan should be recorded in the patient's documentation, including cost aspects.

If the patient's ideas cannot be accomplished or if they oppose the "*lege artis*" treatment, the patient should receive several days for reconsideration.

A well-established treatment plan is an important precondition for the effective dental reconstruction without time delays and with minimal functional, aesthetical, social and psychological handicaps for the patient.

Classification of defects and types of prosthetic appliances

The large variety of dental defects (over 4 billion) required simplification. Today's dentistry uses several classification systems, which help in treatment planning. Kennedy classification distinguishes four basic classes:

1. bilateral edentulous area
2. unilateral edentulous area
3. unilateral edentulous area with natural teeth remaining both anterior and posterior to it
4. single edentulous area located anterior to the remaining natural teeth [7].

Modern prosthetic dentistry offers two ways of solution: with classical dental appliances and with dental implants.

Classical fixed and removable appliances can solve all dental defects. Dental implants, which replace natural roots, with added special prosthetic appliances, can replace under strict conditions, single missing teeth or whole groups of teeth, even the entire dentition (Figure 1). Implant-born prosthetic appliances may be fixed or removable and they always represent a high comfort for the patient.

Classical prosthetic appliances can be characterized according to different views: the way of fitting in the oral cavity, the type of support, the amount of tissues replaced, the time factor of the function.

- *Fixed dental appliances* are firmly luted on the teeth or on the dental implants, which imitate dental abutments. They consist of crowns and fixed bridges.
- *Removable dentures* are fitted in the oral cavity in such a way that the patient can insert and remove them by himself. This group contains partial dentures (removable bridges, saddle dentures, plate dentures and overdentures) and complete dentures.
- *Hybrid dentures* are fabricated over a metal framework and retained by screws onto the implant abutments. This hybrid denture can be removed from the oral cavity only by a dentist in a dental surgery.

The way of prosthesis support forms a very important functional criterion for the classification of dental appliances. We distinguish four different types of masticatory forces transmission onto the facial skeleton: dental, mixed (dento-mucosal), mucosal and osseal. Dental support is the most physiological way. Therefore we always prefer the fixed appliances [8].

We distinguish two basic groups – replacement of missing dental tissues and replacement of whole teeth.

We can use: inlays, onlays and crowns. For replacement of missing teeth and adjacent lost soft and hard tissues we have partial and complete dentures. Partial dentures can be fixed or removable.

Figure 1 – Typical screw dental implants made of titanium.

The time characteristics divide the dental appliances into temporary, transitional and final dentures.

Temporary dentures can be immediate and semi-immediate.

- *Temporary dentures* are indicated for patients before planned extractions (immediate dentures), directly after tooth loss (semi-immediate dentures), for the period before final dentures are manufactured (in implantology, with general health problems, during long-term hospitalisation).
  These temporary dentures are made of simply handled and less costly materials – plastic materials with simple metal strengtheners. Such appliances are similar to fixed dentures – crowns, bridges and splints, or are removable – simple plate dentures. Temporary dentures rehabilitate the patients for a relatively short time in function (with some restrictions), aesthetics, phonetics (very well) and psychology (satisfactorily).
  The advantage of the immediate removable dentures is better support of extraction- wound healing, and they help stop bleeding. The denture impression surface relief supports the optimal reconfiguration of the future alveolar ridge.
  The semi-immediate dentures are usually manufactured shortly after tooth loss, most frequently after an injury. They serve during the healing period; they are fixed – acrylic bridges (for the planned final fixed solution) or removable – partial plate dentures for the final fixed or removable dentures. The final solution depends on the future biological value of the abutments and on the patient's possibilities.
  These dentures help the patients get over the period of possible invalidation of inter-jaw relations after the support zone loss, of possible deterioration of the neuromuscular balance and psychological or social problems.
- *Transition dentures* are similar to final dentures, but they are indicated for a shorter period in comparison with a normal denture's lifetime. They are used in situations where we plan a transition to another type of prosthetic denture, e.g. from a saddle to a plate denture or to a complete denture. These dentures are of use during dental reconstruction with a periodontal disease in the surgical phase and during the healing period, when we are waiting for its result and before the final prosthetic treatment planning.
- *Final dentures* are indicated after the stabilization of the treatment results and for the period when we do not suppose any relevant changes of hard and soft oral tissues.

Fixed appliances

A. Crown restorations

Crown restorations replace the lost part of the tooth, complement or modify its shape or mechanically strengthen the whole tooth. They can serve as bridge abutments.

Crown restorations are inlays, onlays and crowns.

- *Inlays* include: *cast metal inlays, ceramic inlays* (Figures 2a, 2b) and *inlays from special plastics.* Inlays are cemented (luted) in the crown part or in the root part of the tooth.
- *Coronal inlays* are indicated for teeth, where a plastic filling is contraindicated due to its insufficient strength or unsuitable aesthetics. The use of cast metal inlays is today limited because plastic filling materials with perfect esthetical and mechanical properties are available. Ceramic inlays have become more popular lately in view of their excellent aesthetical and biological properties, sufficient strength and perfect fit [9].
  Modern prosthetics can offer ceramic veneers for labial parts of the frontal teeth (Figures 3a, 3b), ceramic inlay systems supported with CAD / CAM fabrication, and ceromer's inlays.
- *Onlays* are derived from inlays, but they cover the whole occlusal surface with lost cusps. Onlays are made of metal alloys, special ceramics and plastics [10].
- *Root inlays* serve to complement the destroyed coronal part of the tooth, and they are anchored with a core in a root canal. The coronal part has its design similar to a prepared abutment, which is complemented with a full crown. Dowel-cores are indicated in endodontically treated teeth after the loss of the coronal part due to dental caries or injury.
  Suitable materials for dowel-cores are metal alloys with good mechanical properties and high biocompatibility (high-content gold alloys, chromium-cobalt alloys, titanium and its alloys), ceramic materials (zircon cores) or fibre reinforced composite materials [11].
- Artificial *crowns* serve as complementation or modification of the shape of the tooth, its strengthening and caries prevention. Artificial crowns with excellent

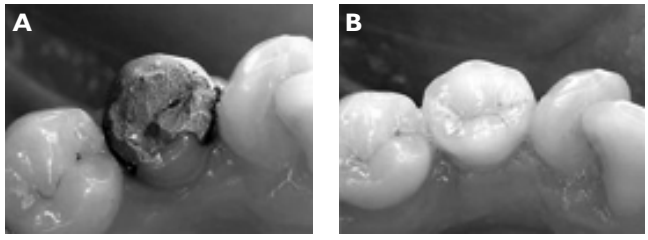

Figure 2 – a) Insufficient MOD amalgam filling on premolar b) A tooth from Fig. 2a treated with ceramic inlay.

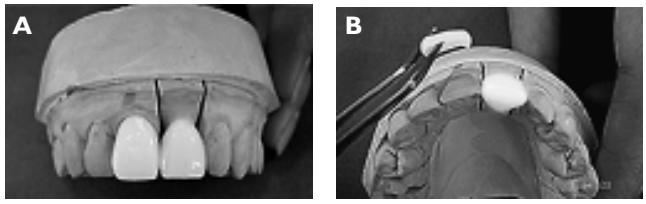

Figure 3 – a) Esthetic ceramic veneer (11) and full-coat ceramic crown (tooth 21) b) Occlusal view of frontal teeth from Fig. 3a.

mechanical properties are used for abutments. Crowns can be divided into *full* and *partial crowns, reduced crowns, post crowns, telescope* and *conical crowns*. Popular crowns today are porcelain fused to metal crowns, veneer crowns and jacket crowns made of ceramics and special plastic materials [12]. All types of crowns have their indications, advantages and disadvantages.

- *Characteristic of the porcelain fused to metal crown* are good mechanical properties thanks to the internal metal framework and excellent aesthetics due to the full ceramic veneer. *Jacket ceramic crowns* are the most popular coronal restorations with excellent aesthetics (Figures 3a, 3b) and biological properties [13].
- *Jacket acrylic crowns* are often indicated as temporary crowns for prepared teeth. Crowns fabricated from a composite material are a less costly solution in comparison with ceramics. Some composite materials are brittle, some are of limited mechanical resistance and their aesthetical and biological qualities are insufficient, and therefore they cannot be compared with ceramics [14].

B. Fixed bridges

Fixed bridges are dental appliances firmly luted on the natural teeth. They are indicated for gaps in the dental arch. Their characteristic features is dental support, i.e. all masticatory forces during mastication act on the whole surface of the bridge construction and are transferred to the maxillofacial skeleton only by the periodontal tissues of dental abutments [15].

We must carefully take into account both the biological value of the future abutments and the biological value of the whole dental arch and consider the inter-jaw relations during treatment planning.

We try to avoid treatment planning for one jaw quadrant only but always set out with a complex treatment plan including all aspects corresponding to other stomatological branches. This "*lege artis*" procedure ensures a long-term prognosis for prosthetic appliances and valuable abutments. Such strong and healthy abutments can serve several times during a person's lifetime as dental support for different prosthetic appliances. The same quality of all dental abutments is an important prerequisite for the long-term prognosis of the fixed bridge [16].

Fixed bridges have their own indications and contraindications. Relative contraindications include extreme atrophic changes of periodontal tissues, chronic inflammations of the marginal gingiva, too low and too advanced age of the patient, progressive stages of a periodontal disease. Removable bridges are indicated for these patients [17].

Fixed bridges consist of construction elements, pontics and connectors. These constructions must have sufficient mechanical properties, responsible for retention in the oral cavity, and they must respect aesthetical demands [18].

Aesthetical fixed constructions indicated for the visible part of the dentition are ceramic and metal-ceramic full-crowns and pontics and metal-free restorations made of special plastic materials [19].

Connectors must have reliable mechanical properties; they must respect the marginal gingiva and the inter-dental papillae and ensure sufficient space for dental hygiene.

Connectors can be rigid or divided. Precise attachments can achieve this second type of connectors.

For fixed bridges support teeth must be prepared. This preparation means a reduction of the whole tooth surface to gain space for the material of the future abutment. The preparation, at the same time, removes all undercuts of the natural crown. Tooth preparation and impressions are performed under a local anaesthesia, in special cases, complete anaesthesia is indicated.

Fixed bridges are usually manufactured from dental alloys, ceramics and plastic materials. With growing awareness of aesthetics and biocompatibility, patients increasingly request metal-free restorations even for extended fixed partial dentures (FPDs). The use of zirconia ceramics for multiunit FPDs has been facilitated by the advent of CAD/CAM systems (Figure 4). The number of all-ceramic materials available for FPDs is, however, limited and the application is subject to certain reservations. Glass-infiltrated oxide ceramic materials are indicated for three- to four-unit frameworks up to an extension of 38 mm. The material is provided as machinable blanks for CAD/CAM systems (Figure 5). An alternative for multiunit frameworks is zirconia material, which is a polycrystalline material without a glassy matrix and is partly stabilized by yttrium oxide (approximately 3 mol%). CAD/CAM techniques involve scanning, software and machining procedures [20].

Special luting cements are used for the cementation of bridges on the prepared teeth.

Adhesive bridges are fixed appliances with excellent aesthetics. They have strict indications. This type of bridge is very popular for frontal rehabilitation for teenagers [21].

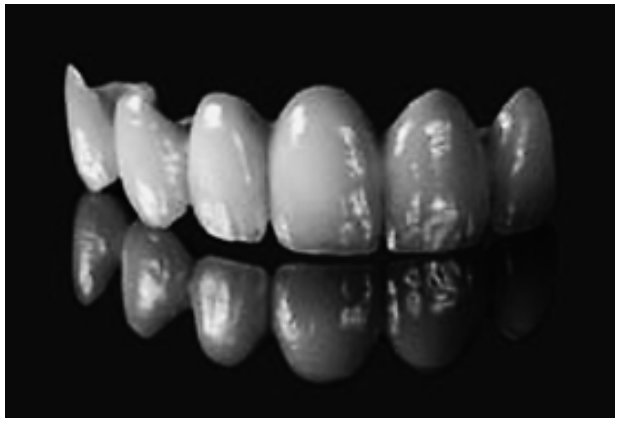

Figure 4 – Fixed bridge – metal-free restoration made of zirconia-based ceramics.

Removable dentures

There are two types of removable dentures – partial dentures and complete dentures.

A. Removable partial dentures (RPD)

RPDs with special indications are: removable bridges, saddle dentures, plate (acrylic) dentures and overdentures [22].

Removable partial dentures with a metal cast framework are suitable for gaps and shortening of the dental arch (Figure 6). These RPDs provide mixed support (dento-mucosal).

Plate (acrylic) dentures are removable prosthetic appliances with simple wire clasps (retention), providing mucosal support. These dentures are indicated as temporary – immediate and semi-immediate dentures. The long-term use of these dentures can destroy the last remaining teeth in a relatively short period.

Figure 5 – Ceramic blanks of different color shades prepared for CAD/CAM technique.

Figure 6 – Classical upper partial denture framework with free-end saddle (clasp system).

Removable partial dentures are used as a temporary, transitional or final prosthetic solution.

Overdentures form a special group of RPDs. Overdentures are similar to complete dentures but are supported by natural roots or dental implants (Figure 7). Overdentures have dental or mixed support. Natural roots can be treated with good quality fillings, root inlays or precise attachments. These attachments are responsible for good retention and the stability of this RPD.

Removable partial dentures are fitted in the oral cavity with: clasp systems, attachments, support bars, telescope crowns or precise locks.

The clasp system is the simplest and cheapest solution but it has relatively poor aesthetics.

The working procedure is similar for all removable partial dentures. It is based on jaw impressions with abutment teeth prepared in advance. After fitting an RPD it is necessary to give instruction to the patient on how to insert and replace his denture, how to clean it and to recommend the best way for adaptation and the importance of the recall system needs to be explained.

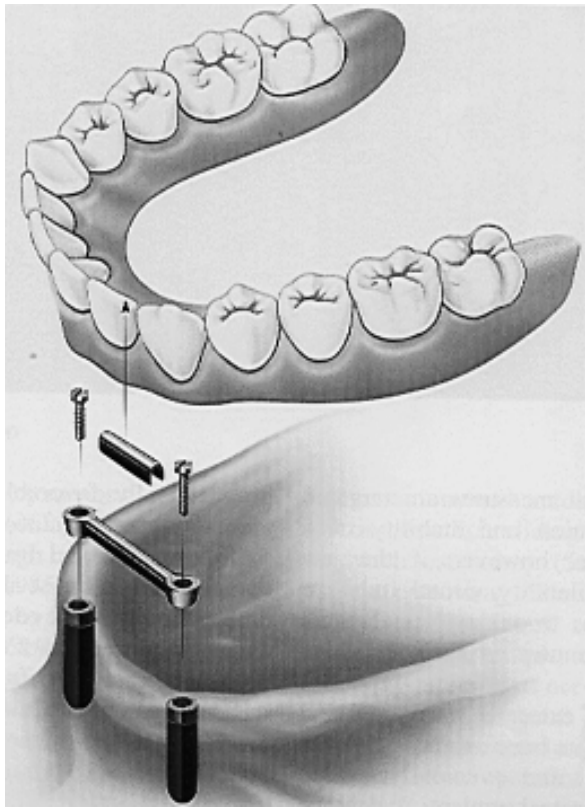

Figure 7 – Prosthetic solution of lower edentulous jaw – implant-born overdenture (scheme).

The metal framework of RPDs is fabricated from metal alloys – chromium-cobalt and golden or from titanium. Saddles are made of acrylic base material; artificial teeth are acrylic or ceramic. RPDs, including clasps, are available also in a polyamide material.

Removable partial dentures with a cast metal framework fully rehabilitate a dental patient in functional, aesthetical and social aspects. RPDs are appreciated for their splinting effect.

B. Complete dentures

Total edentulousness means a considerable handicap for each patient from functional (mastication) as well as from the phonetic, esthetical, psychological and social point of view [23].

There are two possible ways of rehabilitation of the total edentulousness in today's dentistry: first – complete-dentures fabrication (Figure 8), second – dental implant application with special prosthetic appliances (overdentures and hybrid dentures) (Figures 9a, 9b).

Complete dentures replace missing natural teeth and adjacent alveolar ridges. The complete denture fabrication involves specific working procedures at the chair side and in the prosthetic laboratory. We deal with individual problems concerning denture support, retention and stability, inter-jaw relations and the arrangement of the artificial teeth.

Most teeth are extracted as a result of caries or periodontal disease. The former is the most common oral disease in the younger age groups, while periodontal disease increases in prevalence and severity with increasing age. These two age categories have different demands, wishes, motivation and also a different adaptability to new complete dentures. The transition from the removable partial denture to the complete denture is not a great qualitative problem for the patient. But massive tooth loss is a much more challenging situation for the patient,

Figure 8 – A set of complete dentures.

especially after the removal of the extended fixed bridge with the extraction of last damaged abutment teeth. An *immediate complete denture* is a substantial contribution at this stage. This immediate solution can preserve former inter-jaw relations [24].

The reconstruction of the inter-jaw relations belongs to the most complicated and highly important prosthetic tasks, and it can influence the complete denture function, neuro-muscular balance of the masticatory muscles and temporomandibular joints [25].

The size, shape and colour of artificial teeth are a very important aspect of the complete edentulousness rehabilitation and sometimes become a field of discussion when the patient's wishes and the doctor's opinion do not correspond. The final solution is usually a compromise. Ceramic frontal teeth can satisfy all aesthetical demands of our patients. After fitting complete dentures we must instruct the patient how to use and clean his new dentures and how to speak, because that is very important for future comfort. It is essential to set up a programme of review appointments after fitting the dentures to ensure that the tissues are not being damaged and that the dentures are functioning efficiently. We talk about a short-term and a long-term recall system, which provides stomatological prevention.

Conclusion

The main goal of today's prosthetic dentistry is the functional and aesthetical rehabilitation of the whole maxillofacial system. The dentists have to meet growing demands for prosthetic rehabilitation due to population aging and higher requirements on the quality of life. That means higher demands on the functional reliability of dental appliances, their aesthetical and biological properties. We emphasize the biocompatibility of prosthetic materials used – especially metals and their alloys. Dental research teams and industry are looking for new materials with properties very similar to natural oral tissues, requiring simple handling. The new materials involve new technologies and devices. New types of composite materials

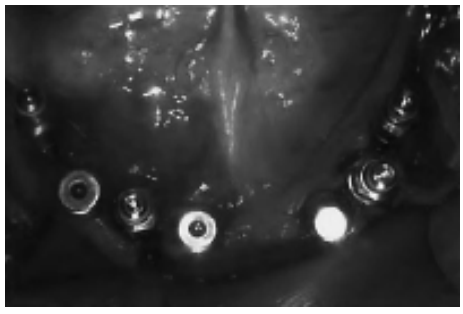

Figure 9a – Lower edentulous jaw with inserted dental implants.

Figure 9b – Situation from Fig. 9a with screwed lower fixed denture.

and ceramic systems, more precise and universal impression materials, perfect micro-motors, hand-pieces and special burs have recently been introduced in the dental world. Nowadays modern prosthetic laboratories are equipped with microprocessor-controlled appliances, laser-welding devices, microwave-polymerisation, "galvanoforming" of metal constructions and with special titanium casting equipment.

Computers with expert systems help us in many areas, e.g. in diagnostics or in treatment planning.

New materials and technologies are being introduced into practical dental work from cosmic and other hi-tech projects. Modern technologies bring both expensive systems (ceramics, titanium, dental implants), and cost-saving solutions (plastic materials). The offer of materials and technologies is continuously growing on the dental market. Time and practical experience will help us in the choice of the best-quality materials and working procedures for prosthetic rehabilitation.

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