

# Longevity of Use of the Fixed Prosthetic Constructions in Relation to the Used Alloy

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**Abstract:** ***Introduction:** The process of mixing metals with non metals is called alloying, and the resulting mixture alloy. Alloys are composed of at least two elements, from which one must be metal. They are divided into alloys for fixed partial dentures-FPD (golden, golden-platinum, silver-palladium alloys, alloys for soldering and alloys for metal-ceramic dentures). **Purpose:** the main purpose is to investigate the longevity of fixed partial dentures-FPD in patients in relation to the basic properties of the used alloys for their fabrication. **Material and methods:** As material we observed 81 clinical case of patients in which was used FPD with implementation of different types of alloys. We selected 81 clinical cases with FPD for metal-ceramics. In 27 clinical case with FPD was used alloy with highest nickel percentage. In another 27 patients in the base of the alloy there was highest percentage of palladium, the third group was patients with FPD fabricated from alloy with highest cobalt percentage. All clinical cases from the third examined groups of patients were observed for ten year period. **Results:** The alloys for FPD were applicable without the need reparation in average period of 9.7 years. Only in a small part of the patients that weren't covered with this investigation there was a need for reparation or replacement with new FPD. The longevity that we measured for FPD fabricated with palladium alloy was 11. 1 years, for chrome alloy was 8.2, and for nickel alloy was 9.5 years. **Conclusion:** We determined that FPD have long durability because of the components of their alloys which create bond between the metal and the ceramics and presence of retentive oxides suitable for baking of ceramic masses. Therefore we justify the application of alloys as choice materials in the dental prosthodontics. In the examined patients the highest longevity was measured in patients with palladium as a used alloy in the FPD.*

**Keywords:** alloys, palladium, cobalt, nickel, fixed prosthetic construction

## 1. Introduction

Alloys are mixture of two or more metals or metalloids that are mutually soluble in the molten state. Metal + metalloid = alloy. Alloying elements are added to alter the hardness, strength, and toughness of a metallic element, obtaining properties not found in the pure metal. Alloys are composed of base metal - definite crystallization type (Ni, Co), particle elements (Al, Be, B, Cu, Ga, In, Fe, Mn, Mo, Ni), impurities and solute (chrome). Dental alloys properties are biocompatibility, chemical resistance, corrosion resistance, small contraction, low melting interval, ease of melting, casting, soldering, grinding and polishing. Internal structure of alloys is a crystalline form with crystal grid determined by the basic metal with homogeneous or heterogenic position of atoms of all the components placed in crystal grid depends of alloy type [1]. The crystalline form according to the grid could be divided in separate groups: alloys with equal homogeneous crystals, alloys with unequal mixed crystals, eutectic - mechanical mixture alloy with heterogeneous crystals, chemical compounds, inter metallic compounds-metalloids. Alloy properties are physical and mechanical [2]. Physical alloy properties are contraction, spreading, hardening and melting. Contraction is the reduction of the linear dimensions and the volume that results from the formation of castings by reducing the temperature (during cooling), from temperature of crystallization to room temperature [3]. With increase in temperature metals and alloys change their volume or spread. The expansion may be linear or voluminous. Hardening is performed in a period from liquids to solidus point. Adding further heat increases the percentage of molten metal, to the point it reaches liquid's line. Mechanical alloy properties are modulus of elasticity, tensile elongation, ductility, plasticity, toughness, hardness and yield strength [4]. Modulus of elasticity is the

capability for a ductile casting alloy to strain under pressure and undergo substantial permanent deformation before fracture [5]. Ductility is the ability of alloys when loaded to stretch and decrease their cross section [6]. After the strain is over, the elastic material retains its shape. Toughness is the alloy's resistance to external forces that tend to change shape and body dimension, and resistance to fracture.

The Vickers and Knoop tests measure the microhardness of alloys against external force, without changing the form [7]. Yield strength is useful strength of a dental alloy, because stresses due to biting forces should not exceed the YS and result in permanent deformation of the alloy [8]. The metal ceramic alloys are classified in several groups according to their composition: alloys for fixed prosthetic constructions (golden, gold-platinum alloy, silver-palladium alloys, soldering alloys, metal-ceramic alloys), alloys for mobile prosthetic constructions (partial dentures and skeletal dentures) as well as Co-Cr-Mo alloys, steel, Au-Pt alloys. The golden alloys are further classified by hardness according to Brinell into few separate groups: I group is from 392 to 736 n/mm<sup>2</sup>, (soft alloys) are used for one surface inlay, rings for two component crowns, two-part castings, II group is from 687 to 981 n/mm<sup>2</sup> (medium hard alloys) are used for one and two-part cast crowns, richmond crowns, II class inlays, massive bridges, III group is from 833 to 1375 n/mm<sup>2</sup> (hard alloy) are used for all types of fixed prosthodontic devices (telescope, partial, one-piece molded crowns), circular bridges, milling technique and IV group of alloys is from 1275 to 1962 n/mm<sup>2</sup>, (super hard alloys) are used for for molded skeleton of partial dentures, tiles, varnishes, cast hooks, bridges and crowns with attachments [9].



**Figure 1:** Palladium alloys for metal ceramics, a. metal framework, b. complete FPD

### 1.1. Purpose

The main purpose is to investigate the longevity of fixed partial dentures-FPD in patients in relation to the basic properties of the used alloys for their fabrication.

## 2. Literature Survey

Prior to 1855, dentistry consisted mostly of extracting decayed and abscessed teeth and replacing them with some sort of removable denture. Practitioners used the lost wax technique which required carving a wax replica of an item (tooth) and then duplicating it in gold.

In 1907, William H. Taggart invented a centrifugal casting machine for use with the lost wax technique. Today, metal castings are made and used to restore and replace teeth and as frameworks for removable partial dentures. They are also used as frameworks to support porcelain crowns or fixed partial dentures. Until the mid-20th century, gold and amalgam were virtually the only materials available for the restoration and replacement of posterior teeth. In 1962, Dr. Abraham Weinstein patented the first gold-based alloy upon which porcelain could be baked. The metal substructure reinforced the porcelain and gave it the durability and the strength to resist fracturing. For the first time, it was possible to replace missing teeth with natural looking, tooth colored, fixed bridgework.

Base-metal alloys have been around since the 1970's. They contain less than 25% noble metal. They can be used for full cast, and partial denture frameworks.

## 3. Materials and Methods

We studied 81 clinical cases using different types of alloys.

From the patients with fixed prosthetic constructions we selected 81 case. The patients were divided into 3 separate groups. Each of the three groups of patients were wearing a FPD fabricated from three different types of alloys for metal

ceramics based on palladium (Fig 1), cobalt (Fig 2) and nickel (Fig 3) accordingly. We selected 81 clinical cases with FPD for metal-ceramics. In 27 clinical case with FPD was used alloy with highest nickel percentage. In another 27 patients in the base of the alloy there was highest percentage of palladium, the third group was patients with FPD fabricated from alloy with highest cobalt percentage. All clinical cases from the third examined groups of patients were observed for ten year period.



**Figure 2:** Alloys of cobalt for metal ceramics, a. metal framework, b. complete FPD



**Figure 3:** Base Nickel alloy for metal ceramics, a. metal framework, b. complete FPD

We followed the condition of the fixed partial dentures of the patients for a period of 10 years and checked for any caused discomfort or change in the quality of the prosthetic device. The data collected for each patient was carefully stored in special chart for the purpose of this investigation. The value for the longevity of the FPD fabricated from different types of alloy was calculated as a mathematical average from the duration of applicability measured in years for each patient wearing a FPD.

## 4. Results and Discussion

As seen in Table 1. Alloys for fixed prosthetic devices showed stability during average period of 9, 7 years. Cobalt alloys showed average durability of 8.2 years, nickel alloys 9.5 years and palladium alloys showed average durability of 11. 1 years (Table 1).

**Table 1:** Composition and endurance of alloys for fixed prosthetic works

Table 1.	FIXED PROSTHETIC WORKS		
Type of alloy	I group of patients Nickel	II group of patients Palladium	III group of patients Cobalt
Number of clinical cases	27	27	27
Alloy composition	Nickel, copper, molybdenum, mangan, aluminum	Silver, palladium, gold, zinc, copper, iron	Cobalt with no additional components
Endurance of alloy in period of time	9.5 years	11. 1 years	8.2 years

Alloys for fixed prosthetic works are divided into palladium alloys for metal ceramic constructions, alloys of cobalt for metal ceramic constructions and base nickel alloy for metal ceramics. The advantages of palladium alloys are: good castability, low density and hardness, good porcelain bonding and low cost. The disadvantages of palladium alloys are: discoloration and high coefficient of thermal expansion. The advantages of cobalt alloys for metal ceramics are: poor thermal conductors, low density and low cost. The disadvantages of cobalt alloys for metal ceramics are: occlusal wear due to high hardness, difficult to process and high oxidation. The advantages of base nickel alloy for metal ceramics are: low density, low cost and do not contain beryllium. the disadvantages of base nickel alloy for metal ceramics are: hardness makes them difficult for process, high melting temperature over 1300 ° c and nickel sensitivity [10], [11].

## 5. Conclusion

From the results and the data collected from the patients we arrived at the following conclusions:

1. Conclusion is that the alloys are the material of choice in dental prosthetics;
2. Metal ceramic constructions have good longevity thanks to its alloy components that provide chemical bond between metal and ceramics;
3. Presence of retention oxides is suitable for the ceramic masses;
4. From all of the materials that we used for the fabrication of the fixed partial dentures, we find that the palladium is most suitable and with highest rate of longevity.

## 6. Future Scope

A comprehensive, cost-effective, scientific clinical research center needs to be established to address the numerous questions that exist in the areas of restorative materials and dental implants. This center would involve the coordinated

efforts of both basic and clinical investigators and would focus research on:

1. Improving the sensitivity of clinical research instrumentation and methodologies;
2. Defining the long-term effects of "materials" on "favorable and unfavorable" clinical performance;
3. Determining the properties that are needed for clinical success, and (4) identifying the "in vitro tests" that accurately predict clinical success.

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## Author Profile



**Biljana Kapusevska** is professor at the department for dental prosthodontics at the faculty of Dentistry – University St. Cyril and Methodicus, Republic of Macedonia. Magistrate of dental sciences 1990, doctorate of dental sciences 1998, primaries 2010. Author of 150 scientific articles, monographies, textbooks and educational literature. "Instrumenti I aparati vo zabotehnicka laboratorija" (2005) – textbook; "Sila na mastikacija na zabite nosaci na fiksno protetickite konstrukcii vo uslovi na namaleno parodontalno zdravje (2010) – monographie; "Bolka i osetlivost na prepariran i impregniran zab vo korelacija so kolicestvoto na fluor (2012) – monographie; "Tehnologija na fiksni protezi (mostovi)" (2013) – textbook. Special interest in the clinical work is readiness, approach and fabrication of fixed partial dentures in patients with condition of lowered periodontal health. She participated in FDI congresses: Belgrad -1985, Hong Kong – 1995, Orlando – 1996, Seul – 1997, Barcelona 1998, Istanbul-2014, and at the moment she is registered to participate at New Delhi -2014. She has been awarded with certificates, diplomas, plaques for participation and member of faculty of Dentistry – University St. Cyril and Methodicus, Republic of Macedonia. She is a chief of the department of fixed prosthodontics at the public dental clinical centar St. Pantelejmon, Skopje, R. Macedonia.