CR-COBALT ALLOYS AND TECHNOLOGICAL ASPECTS INVOLVED IN THE REALIZATION OF METAL INFRASTRUCTURE WITHIN SKELETAL PROSTHESES

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Abstract: The aim of this study is to bring back to the present the Cobalt chromium alloys extremely used by their properties in dental medical practice respectively in the realization of the skeletons of partially mobilizable skeletonized prostheses through a careful analysis of the technological aspects that lead to successful results. Their biocompatibility has been certified after 60 years of use in the design of partial dentures, presenting excellent flow properties and a modulus of elasticity that gives it a high degree of rigidity. Corrosion resistance is closely related to the chemical composition, which is very stable. Metal alloys have diversified their structure over time in order to achieve that structure that offers an optimal biomechanical behavior adapted to different clinical characteristic

Key word: CR-Cobalt Alloys, metallic infrastructure , mechanical processing

Introduction

Chrome-Cobalt alloys have been made and produced since the beginning of the 20th century and are also known as stellites.

Their biocompatibility has been certified after 60 years of use in the design of partial dentures, presenting excellent flow properties and a modulus of elasticity that gives it a high degree of rigidity. Corrosion resistance is closely related to the chemical composition, which is very stable[1-10].

The alloys in this group are complex mixtures, in which *the basic elements* are :

- chromium (15-30%) which creates a protection against the action of oxygen (exaggerated increase has negative effects on mechanical resistance and flexibility),
- cobalt (1-64%) which participates in completing the chemical stability of the alloy, protecting it from the corrosive action of acids and bases, finishing the crystalline structure
- nickel (4-55%) which participates by increasing the ductility of the alloy (it becomes easier to process),

combating oxidation and improving flexibility
- molybdenum (5-18%) which increases resistance to corrosion and breakage, increases flexibility
- silicon, magnesium
- aluminum prevents oxidation and increases its fluidity[11-17]

Physical-chemical properties:

- they are stainless alloys, resistant to the action of acids and bases
- the specific weight is between 8-10 g/cm ^{3,} and as a result the weight of the prosthesis is small (compared to the one made of gold alloys), the melting range is between 1000-1500 ^{0}C
- it crystallizes when cooled homogeneously and uniformly, with an authentic structure, and the fluidity is greater in the molten state.
- the contraction coefficient is between 1.7-2.3% which is mostly compensated by the expansion of the pattern, the high fluidization temperature and the contraction coefficient upon high cooling require the use of packing materials with silicate or phosphate binders, characterized by : thermal resistance, high hardness and expansion coefficient corresponding to the contraction of the respective alloy, the hardness is between 180-360 kg/mm ^{2} Brinell, a property that causes difficulties in processing by abrasion (unfavorable for the manufacture of microprostheses and dental bridges).
- resistance to shock (breakage), favorable property for the realization of connecting elements between saddles and secondary connectors with reduced volume.
- the wire, the drawn product, has better flexibility, compared to a cast product, at equal dimensions. Thin castings have flexibility, but it is limited.

Processed, they are polished, a property that is preserved for a long time and is favorable for maintaining the hygiene of the oral cavity[18-23].

The cost price of a skeleton prosthesis is 10 times lower compared to the gold-platinum one. Alloys A, B, C, D are alloys for partial denture technology, while HS21 and HS31 are industrial alloys. It is observed that between HS21 alloy and *Co-Cr (A)* there is only an apparent compositional similarity, in reality alloy A *(Co-Cr* - Vitallium type) does not contain nickel[24-30].

The aim of this study is to bring back to the present the Cobalt chromium alloys extremely used by their properties in dental medical practice respectively in the realization of the skeletons of partially mobilizable skeletonized prostheses through a careful analysis of the technological aspects that lead to successful results.

Results and Discussions

On the duplicate model, the design of the prosthesis will be made again, following exactly the design made on the functional model. For the modeling of the metal skeleton we will use calibrated wax of 0.4mm, calibrated foil with striations also of 0.4mm for the imitating jaw component, prefabricated wax for the model of the saddles. (fig 35)

It is a very important step in skeletonized prosthetics because no mistakes are allowed in the modeling or the duplicate model.

A first step towards success is for the duplicate model to be very well dried, usually it is placed in the calcination oven at a low temperature for a few minutes.

In both prostheses, maxillary and mandibular, we used the same technique:

- the scenes were covered with wax

- the route of the main connector was foiled with calibrated wax

- depending on the occlusion and the positioning of the alveolar ridge, I placed the model of the saddles

- for increased resistance, we created thresholds to close the future meeting area of the main connector with the acrylic area of the prosthesis

-within the maxillary prosthesis, we used over the calibrated 0.4 mm film another film with striations that reproduce the sensation and morphology of the palatal vault (fig 34)

- for the main connector of the lower prosthesis, we used 2 overlapping pieces of calibrated wax of 0.6 mm. (fig. 1)

- the mock-up is carefully finished and it is checked whether the requirements related to the design have been respected.

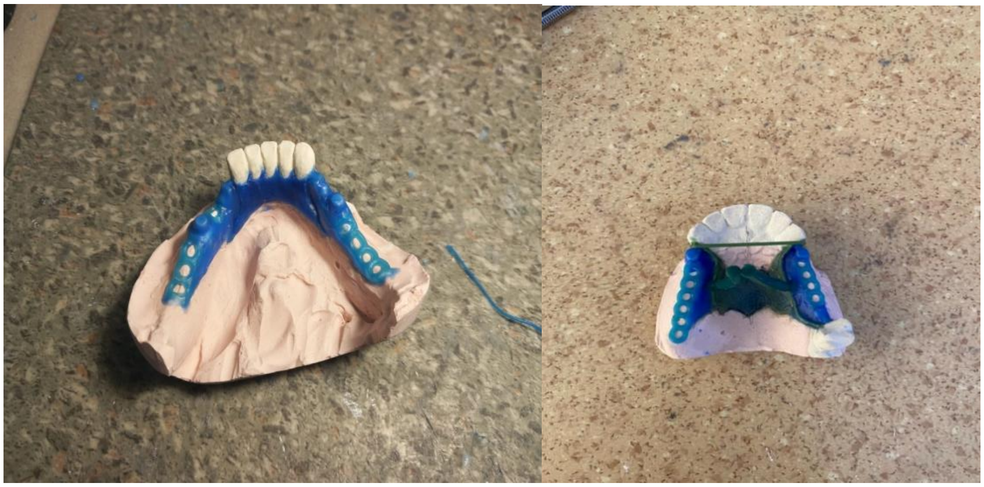

Fig 1 Model of the lower skeleton ; Model of the upper skeleton

For this stage I used 4 mm casting rods and 0.8 mm rods for which they will serve as exhaust channels.The casting rods are applied in the thinner areas of the model to avoid the appearance of pores in the main connector.The casting cone is prepared from the packing table in a conformer beforehand, the model being solidarized with wax to the casting cone. (fig.2)

The 2 halves of the sink are solidarized with elastics and the packing mass is prepared with a vacuum mixer. The material takes 30 minutes.

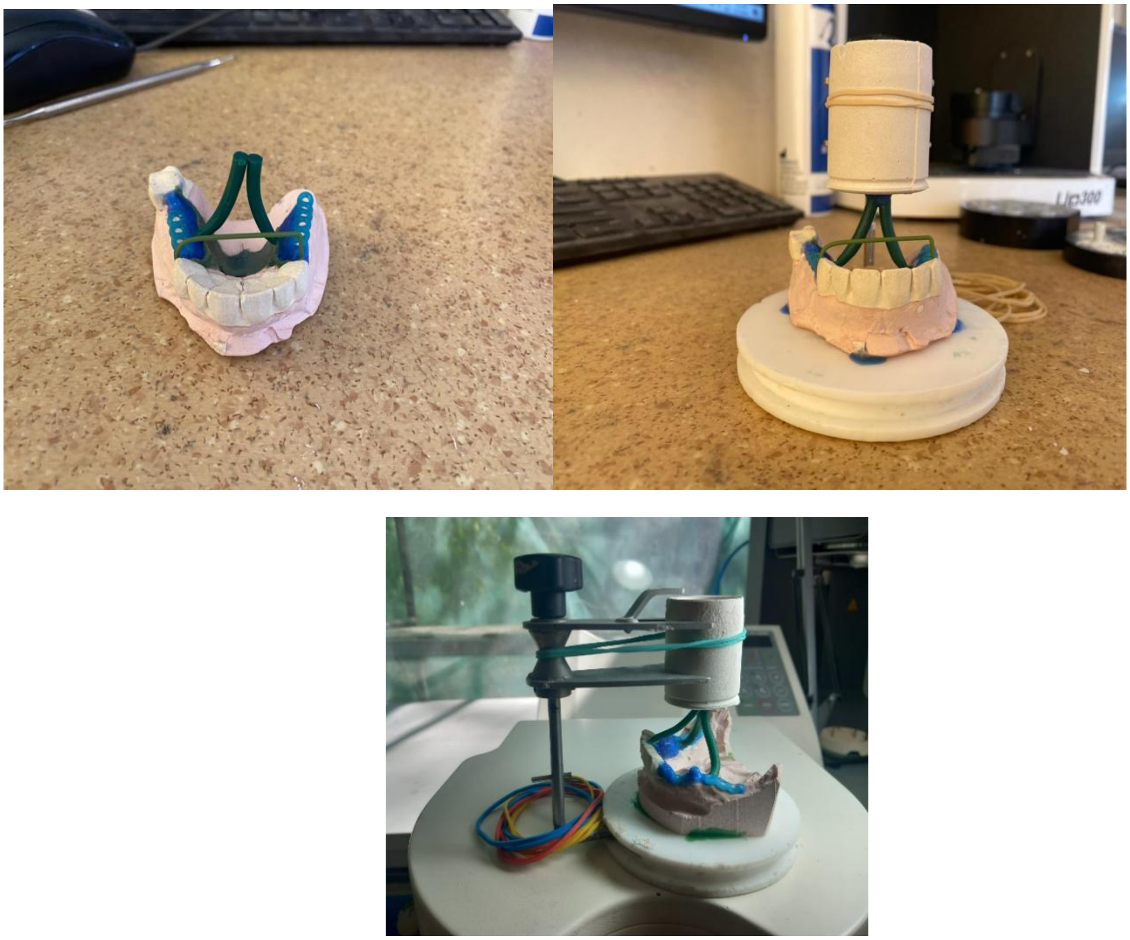

Fig. 2 Preparation for packaging

Melting and casting

The same procedure is followed as in the case of the fixed work, i.e. slow growth for 2.5 hours up to 950 degrees.

Casting is done with the help of induction with a device called Tristolit using induction, vacuum, and pressure to introduce the fluid alloy into the mold.

The alloy is specially designed for skeletonized prostheses with a high resistance, its melting is done directly in the crucible and is introduced when it is completely melted. (Fig. 3, 4,5)

Any small error in this step, whether it is represented by sink or alloy errors, leads to irreversible actions and the whole process will be repeated.

Fig 3 Tristolit molding machine

Fig. 4 Calcination furnace

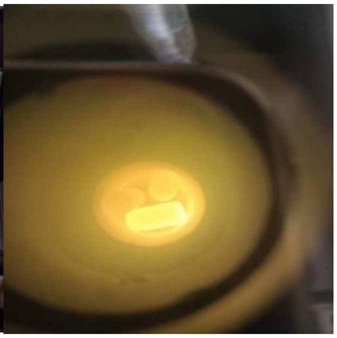

Fig. 5 Melting phase of the alloy

Unpacking and mechanical processing

After the slow cooling of the sink, the structure is unpacked and sandblasted with Al2O3 particles to remove the packing mass from the surface of the skeleton.

We check the integrity of the metal skeleton and check possible errors that appear for various reasons, the main errors are related to missing portions of the backstage, missing portions of the connector, pores, pluses on the entire surface or even the complete absence of the prosthetic part.

Once these errors are observed, the whole process will have to be restarted.

The processing aims first of all at a very good adaptation in the prosthetic field and at the level of the backstage. We aim to create a work with a very well polished lingual surface (fig 41), without unevenness or additions with a transition as smooth and smooth as possible between the fixed work and the main connector .

It is made with a rotary tool, extrusion milling discs, polypants and finally brushes and polishing pastes for the main connector. (fig. 6, 7,8)

Fig. 6 Tools used to adapt and process the metal

Fig. 7 Polishing the metal skeleton

Fig .8 The metal skeleton polished and sandblasted

Due to this compositional element, this alloy has been used extensively in dentistry and medicine for implants.

Alloys *have* cobalt as a balancing element, and can be considered as an essential solid solution of 70% - cobalt and 30% - chromium.

- *Chromium* - has a passive effect, it gives the alloy corrosion resistance. Together with other elements, it hardens the solid solution. The maximum percentage is 30%, it is considered the ideal limit for - obtaining maximum mechanical properties.
- *Cobalt* - increases the modulus of elasticity, mechanical strength and hardness.
- *Nickel* - additional percentages of Ni in Co damage decrease mechanical strength, modulus of elasticity and melting temperature, while ductility increases. The alloy becomes easier to process.

Conclusions

Metal alloys have diversified their structure over time in order to achieve that structure that offers an optimal biomechanical behavior adapted to different clinical characteristic

The alloy confers technical benefits, especially in the case of plating the base with porcelain teeth (firing temperature of 1000 0^{C}) without subsequently requiring the application of special elements to retain them in the base of the prosthesis.

The modulus of elasticity is 2 times higher than that of noble alloys, which also gives some aesthetic advantage, being able to create a delicate and at the same time rigid design.

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