Defects in Dental Alloys Cast Single Tooth Restorations

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Casting failures of alloys in dental technology should be the exception, not the rule. They have to be detected in time and associated with possible causes. For the experimental part base metal alloys single tooth restorations were achieved using the conventional lost wax process for casting in order to be evaluated. Some casting defects obtained during the experimental part are exemplified: incomplete castings, absence of the castings, voids, distortions, nodules, porosities. Selecting the appropriate casting techniques for each alloy and dental restoration and accurate following of the technological steps are essential to avoid casting defects.

Keywords: defects, casting, dental alloys, restorations

Unsuccessful castings in dental technology result in considerable trouble and loss of time. Generally dental casting defects can be avoided by a strict manipulation of the involved materials and following of the procedures governed by certain fundamental rules and principles.

A proper design and preparation of the teeth, an accurate impression, a good and accurate die and proper waxing and investing are all important steps in achieving an acceptable cast restoration. Seldom there is a defect in a casting attributable to other factors than carelessness or ignorance of the operator regarding all the materials manipulation and technologies.

Casting failures should be the exception, not the rule, and have to be detected. They must be detected in time and associated with possible causes. Defects in casting can be classified in different categories [1] as follows:

- dimensional inaccuracies or dimensional errors in casting, following a balancing out of contraction and expansion which occurs during its construction;
- distortion of the casting, probably related to wax pattern distortion;
- surface roughness, finely spaced surface imperfections whose height, width, and direction establish the predominant surface pattern;
- surface irregularities refer to isolated imperfections, such as nodules, that do not characterize the total surface area;
- fins, caused by cracks in the investment that have been filled with molten metal;
- pits (inclusion porosities), particles of investment dislodged and included during casting.

Incomplete casting, if the molten alloy is prevented from full or partial filling of the mould and incomplete or even no casting.

Porosities may occur both within the interior region of a casting and on the external surface. The latter is a factor in surface roughness but also it is generally a manifestation of internal porosity. The porosities can be solidification defects (localized shrinkage porosity, microporosity) and trapped gases (pinhole porosity, gas inclusions, subsurface porosity, residual air).

The final restorations can be analyzed nondestructive by visual inspection macroscopically, microscopically, with penetrant liquids, silicone materials, and radiographic [2, 3] in order to evaluate the quality of the casting.

In dentistry, lost wax process of casting metals has been used since ancient times and became a common practice [1, 4]. Frameworks obtained after milling of soft metal block and selective laser sintering techniques are an alternative to those obtained with the traditional lost wax and casting method [5].

The base metal alloys casting process used in dentistry based on the lost wax technique has been receiving continuous investigations exploring the behavior of the materials and techniques involved [6].

Experimental part

Base metal alloys single tooth restorations were achieved using the conventional lost wax process for casting in order to be evaluated.

The casting evaluation requires great attention to details to select only successful restorations to be sent for clinical use.

Some casting defects obtained during the experimental part are exemplified.

An unsuccessful casting can be only a partial complete casting or perhaps no casting at all (fig. 1 - 6). The cause is that the molten alloy has been prevented, in some manner, from completely filling the mold. Different factors might inhibit the ingress of the liquefied metal in the mold, like insufficient venting of the mold, related to the back pressure exerted by the air in the mold, high viscosity of the fused metal, incomplete elimination of wax residues from the mold, excessive cooling, to thin or incomplete wax areas, insufficient casting force, not enough metal, metal spillage.

A distortion of the casting is probably related to a distortion of the wax pattern (fig. 7).

Air bubbles that attach to the pattern during or subsequent to the investing procedure cause small nodule on a casting (fig. 8, 9). Such nodules can sometimes be removed if they are not in a critical area. However, for

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Fig. 1. Spillage of the alloy in the crucible followed by no casting.
nodules on margins or on internal surfaces, removal of these irregularities might alter the fit of the casting. The best method to avoid air bubbles is to use the vacuum investing technique.

Porosity may occur both within the interior region of a casting and on the external surface (fig. 10). The latter is a factor in surface roughness, but also it is generally a manifestation of internal porosity. Although the porosity in a casting cannot be prevented entirely, it can be minimized by use of proper techniques.

**Results and discussions**

All the technological steps in achieving cast dental restorations require carefully attention to detail to obtain a properly fitted casting. There have been numerous reports, on attempts to perfect the casting procedures by improving investment materials and techniques [7, 8]. The majority of these efforts deal with so-called “conventional” investing and casting techniques which is more time consuming. Accelerated casting techniques have been reported in an effort to achieve similar quality results in significantly less time. These techniques have the ability to shorten the investing and casting process, thereby improving productivity. The accelerated casting technique is an alternative time-consuming conventional techniques [9, 10].

The ringless investment technique can produce castings with higher accuracy and can be favorably combined with the accelerated wax-elimination method as a vital alternative to the time-consuming conventional technique of casting restorations in fixed prosthodontics [11].

Base metal alloys require casting techniques specifically designed for their physical properties because of their low density and high melting range [12]. The low density of base metal alloys presents problems of castability because it allows these alloys to absorb gases more easily at high temperatures. Thereby the sprue designs for base metal alloy castings vary according to the physical properties of the alloys. Thus, there are differences of opinion among the various authors, regarding the optimal sprue design and its mode of attachment to the pattern for casting base metal alloys. Success in dental casting restorations depends also on the castability. Castability is described as the ability of an alloy to faithfully reproduce sharp detail and fine margins of a wax pattern. The goal of a prosthodontist is to provide the patient with restorations that fit precisely [13, 14].

Base metals have a wide use in casting methods. Sometimes they are reused in laboratories which may have an adverse effect on the restoration marginal integrity. Using 100% recasted alloy is not recommended [15].

The micro- and macrostructure of dental alloys are dependent on the manufacturing technique employed. Given the differences in microstructural properties among
the tested groups, further differences in their clinical behaviour are anticipated [16-18].

Selecting the appropriate casting techniques to obtain the desired alloy properties is important [19].

Conclusions

Selecting the appropriate casting techniques for each alloy and dental restoration and accurate following of the technological steps are essential to avoid casting defects. Detecting of the casting defects and imperfections requires detailed examination. The possible causes of imperfections have to be identified in order to avoid considerable trouble and loss of time due to repairs or making new restorations.

References


Manuscript received: 3.11.2014