

Original Research

Analysis of serum metal ion levels in dental implant patients

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ABSTRACT

Background: this study was carried out to analyze serum metal ion levels in subjects with dental implants.

Materials & methods: 100 subjects were enrolled and had their serum samples taken at following time intervals, baseline and postoperatively one month. Using inductively coupled plasma optical emission spectrometry, these samples' amounts of titanium as well as aluminium were examined. Employing the paired t-test, the variation between preoperative as well as postoperative serum concentrations was quantified as well as statistically examined. Software called SPSS had been used to evaluate the outcome.

Results: The concentrations of titanium and aluminium were somewhat different postoperatively (2.86 and 5.11 mg/dl) compared to preoperatively (2.76 and 5.22 mg/dl), however this difference was numerically insubstantial. The serum metal ion concentrations prior to as well as after implant insertion were not significantly different.

Conclusion: While there exists a slight elevation in aluminium as well as titanium ion concentrations following implant insertion, there seems to be no discernible variation in serum metal ion concentrations prior to and following the procedure.

Introduction:

Dental implantation is a surgical process of the jaw bone to support a crown, bridge, denture, and facial prosthesis. The basis of modern dental implantations is called osseointegration, it is the direct structural and functional connection between living bone and the surface of a load-bearing implant. Osseointegrated implants have been used to treat various condition ranging from edentulism to head and neck reconstruction. Dental implants are used to facilitate retention of auricular mandibular, maxillary, nasal, and orbital implants, and for bone-anchored hearing aids. The implant fixture is first placed so as to osseointegrate, and then a dental prosthesis is added. A variable amount of healing time is required for osseointegration before a crown, denture, or abutment is placed which will hold a dental prosthesis.¹

Dental implants became a scientific cornerstone after the serendipitous invention of Dr. Branemark who helped in the evolution of the concept of osseointegration (direct,

rigid attachment of the implant to the bone without any intervening tissue in between two implants).²

Co-Cr alloy is one of the commonly used implant materials which has excellent mechanical property and corrosion resistance. It has been used in dental prosthodontics since 1929. The Co-Cr alloy is biocompatible and has osteoconductive properties that promote rapid osseointegration.³ However, in the oral environment, the long-term use of Co-Cr alloy leads to the release of cobalt and chromium ions.⁴ Hence, in order to evaluate the serum metal ion concentrations in participants having dental implants, this investigation was carried out.

Materials & methods:

The present study was conducted for evaluating the serum metal ion concentrations in participants having dental implants. 100 subjects were enrolled and had their serum samples taken at following time intervals, baseline and postoperatively one month. Using inductively coupled plasma optical emission spectrometry, these samples'

amounts of titanium as well as aluminium were examined. Employing the paired t-test, the variation between preoperative as well as postoperative serum concentrations was quantified as well as statistically examined. Software called SPSS had been used to evaluate the outcome. Statistics are deemed significant at P value of less than 0.05.

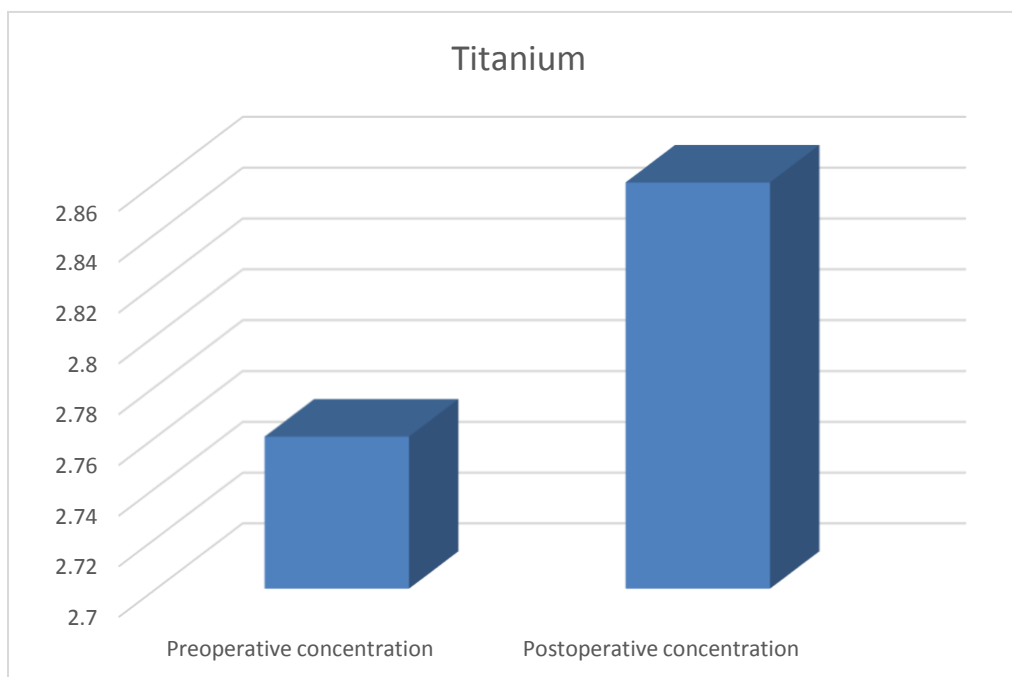
Results:

There was a numerically negligible variation between the titanium as well as aluminium concentrations in the

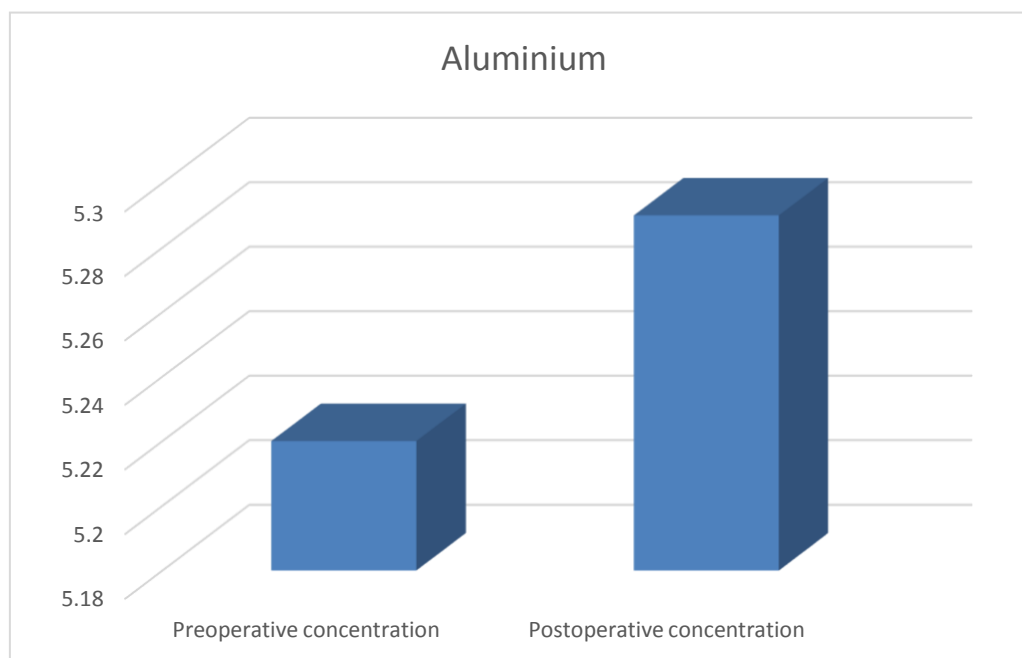
postoperative period as well as the preoperative period. The average serum titanium concentrations did slightly rise, but the variation was not numerically noteworthy. Similar to how the serum aluminium concentrations increased somewhat after implant insertion, the findings were not numerically relevant. The concentrations of titanium and aluminium were somewhat different postoperatively (2.86 and 5.29 mg/dl) compared to preoperatively (2.76 and 5.22 mg/dl), however this difference was numerically insubstantial. The serum metal ion concentrations prior to as well as after implant insertion were not significantly different.

Serum metal ions	Preoperative concentration	Postoperative concentration at one months
Titanium	2.76	2.86
Aluminium	5.22	5.29

Table 1: Preoperative as well as postoperative concentrations of titanium as well as aluminium ions.



Graph 1: Preoperative as well as postoperative concentrations of titanium ions.



Graph 2: Preoperative as well as postoperative concentrations of aluminium ions.

Discussion:

Dental implant materials are biologically safe, resistant to corrosion and have excellent mechanical properties for rapid re-passivation in biological environments.^{5,6} However, changes in the bacterial flora and pH of the oral cavity have pronounced effects on the oral microenvironment.^{7,8,9} These changes make traditional cobalt–chromium alloy and titanium materials highly susceptible to corrosion resulting in many deficiencies in osseointegration and antibacterial properties. The release of exogenous metal ions caused by the long-term use of dental implant materials can also impact the surrounding tissues and affect osseointegration resulting in loosening and loss of implants.^{10,11} These ions may be distributed in distant tissues and organs in the body.

In this study, there was a numerically negligible variation between the titanium as well as aluminium concentrations in the postoperative period as well as the preoperative period. The average serum titanium concentrations did slightly rise, but the variation was not numerically noteworthy. Similar to how the serum aluminium concentrations increased somewhat after implant insertion, the findings were not numerically relevant. The concentrations of titanium and aluminium were somewhat different postoperatively (2.86 and 5.29 mg/dl) compared

to preoperatively (2.76 and 5.22 mg/dl), however this difference was numerically insubstantial. The serum metal ion concentrations prior to as well as after implant insertion were not significantly different.

In the study by Gopi G et al¹², serum samples were collected from 30 patients undergoing dental implant placement preoperatively and postoperatively at intervals of 6 weeks, 3, 6, and 12 months. These samples were analyzed for titanium, aluminium, and vanadium levels using Inductively Coupled Plasma Optical Emission Spectrometry. The difference in preoperative and postoperative serum levels was measured and statistically analyzed using the paired t-test. It was found that there was a slight difference in the postoperative levels of titanium and aluminium (2.30 and 4.07 mg/dl) as compared to the preoperative levels (2.28 and 2.30 mg/dl), which was statistically insignificant ($P > 0.5$). The serum levels of vanadium were too insignificant to be detected by the instrument (<0.0088 mg/dl).

In another study by Smith DC et al¹³, blood levels of titanium, aluminum, and vanadium were measured using an atomic absorption spectrophotometric technique preoperatively and at intervals over a 3-year period for 52 patients (17 men, 35 women), each of whom had three mandibular porous-surface endosseous dental implants. The results showed that there was no evidence of change

from preoperative to long-term values for the three metals measured in the study.

Conclusion:

While there exists a slight elevation in aluminium as well as titanium ion concentrations following implant insertion, there seems to be no discernible variation in serum metal ion concentrations prior to and following the procedure.

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