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Original Research

Analysis of Blood Metal Ion Levels in Patients with Dental Implants

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ABSTRACT:

Aim: to assess serum metal ion levels in patients with dental implants**. Materials and methods:** The study included 50 patients aged 18 to 50 years who required dental implants in either jaw. Eligibility criteria included patients with missing teeth aged 18 to 50 years, while those with underlying medical conditions, corticosteroid or other medication use, or a history of orthopedic or dental implants were excluded. Demographic data, including age and gender, were recorded. A comprehensive oral examination was conducted, followed by CBCT imaging to assess bone quality, anatomical structures, and any pathologies. A 5 ml venous blood sample was collected to measure titanium and aluminium ion levels. All patients underwent implant placement and were followed up at 4 weeks, 6 months, and 1 year for ion level assessment. Statistical analysis was performed, using SSPS software. **Results:** Out of 50 patients, 30 (60%) were male, and 20 (40%) were female. Preoperatively, the mean titanium ion level was 1.67 mg/dL (SD: 0.11) with a p-value of 0.20. At 4 weeks postoperatively, the mean level declined to 1.52 mg/dL (SD: 0.16), followed by a further reduction at 6 months to 1.40 mg/dL (SD: 0.14). By the 1-year follow-up, the titanium ion level had decreased to 1.29 mg/dL (SD: 0.19). Similarly, the mean aluminium ion level preoperatively was 3.91 mg/dL (SD: 0.11) with a p-value of 0.27. At 4 weeks postoperatively, it decreased to 3.62 mg/dL (SD: 0.17), followed by a further reduction at 6 months to 3.49 mg/dL (SD: 0.12). However, by the 1-year follow-up, a slight increase was noted, with the mean aluminium ion level rising to 3.64 mg/dL (SD: 0.21). **Conclusion:** Patients who received dental implants showed no significant changes in blood titanium and aluminium ion levels.

Keywords: Aluminium, Titanium, Ions

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INTRODUCTION

Over the past two decades, dental implants have become the leading treatment for edentulism, playing a crucial role in prosthetic tooth replacement. The biocompatibility of an implant material is closely linked to its resistance to corrosion. Titanium (Ti) has been the preferred choice for dental implants due to its exceptional corrosion resistance and favorable mechanical properties. Traditionally, noble alloys were believed to be chemically inert within the body, particularly in the oral environment, and were not considered susceptible to corrosion. However, corrosion is a process characterized by the gradual degradation of materials through electrochemical reactions.[1,2,3]

The biocompatibility of metal and metal alloy dental implants depends on their resistance to corrosion, mechanical strength, and interaction with host tissues. Common implant alloys primarily consist of titanium, vanadium, and aluminium. To enhance mechanical properties, modern dental implants are often alloyed with aluminium and vanadium. However, the extent to which these metals are released into the bloodstream and their potential clinical implications remain insufficiently explored. Therefore, the present study aims to assess serum metal ion levels in patients with dental implants.[4,5]

MATERIALS AND METHODS

The study enrolled 50 patients aged 18 to 50 years who required dental implants in either jaw. The inclusion criteria consisted of patients with missing teeth and those aged between 18 and 50 years, while exclusion criteria included individuals with underlying medical conditions, those taking corticosteroids or other medications, and those with a history of orthopedic or dental implants.

Demographic details such as name, age, and gender were recorded. A thorough oral examination was conducted; followed by CBCT imaging of the recipient site to evaluate bone quality, including height, width, anatomical structures, bone type, and any pathologies. A 5 ml venous blood sample was collected to measure titanium and aluminum ion

levels. All participants underwent dental implant placement, and postoperatively, they were recalled at 4 weeks, 6 months, and 1 year for ion level assessment. Statistical analysis was performed, using SSPS software.

RESULTS

Table 1: Distribution of patients

Gender	Male	Females
Number	30 (60%)	20 (40%)

Table 1 presents the distribution of patients based on gender. Out of the total participants, 30 (60%) were male, while 20 (40%) were female.

Table 2: Comparison of titanium ions level

	Mean(mg/dl)	SD	P
Pre operatively	1.67	0.11	0.20
4 weeks	1.52	0.16	
6 months	1.40	0.14	
1 year	1.29	0.19	

Table 2 presents the comparison of titanium ion levels at different time points. Preoperatively, the mean titanium ion level was 1.67 mg/dl with a standard deviation (SD) of 0.11, and the p-value was 0.20. At 4 weeks postoperatively, the mean level decreased to 1.52 mg/dl with an SD of 0.16. A further decline was observed at 6 months, with a mean of 1.40 mg/dl and an SD of 0.14. By the 1-year follow-up, the mean titanium ion level had decreased to 1.29 mg/dl, with an SD of 0.19.

Table 3: Comparison of aluminium ions level

	Mean(mg/dl)	SD	P
Pre operatively	3.91	0.11	0.27
4 weeks	3.62	0.17	
6 months	3.49	0.12	
1 year	3.64	0.21	

Table 3 presents a comparison of aluminium ion levels at different time points. Preoperatively, the mean aluminium ion level was 3.91 mg/dl with a standard deviation (SD) of 0.11, and the p-value was 0.27. At 4 weeks postoperatively, the mean level decreased to 3.62 mg/dl with an SD of 0.17. Further reduction was observed at 6 months, with a mean of 3.49 mg/dl and an SD of 0.12. However, at the 1-year follow-up, the mean aluminium ion level slightly increased to 3.64 mg/dl, with an SD of 0.21.

DISCUSSION

Dental implants have become the preferred solution for replacing missing teeth, offering durability, functionality, and aesthetic benefits. Titanium and its alloys are widely used in implantology due to their excellent biocompatibility, mechanical strength, and corrosion resistance. However, concerns have been raised regarding the potential release of metal ions, such as titanium, aluminium, and vanadium, into the bloodstream over time.[6,7]

Metal ion release from implants may result from corrosion, mechanical wear, or biological interactions within the oral environment. While some studies suggest minimal systemic effects, others indicate potential risks associated with prolonged exposure to these ions. Understanding the levels of metal ions in the blood of patients with dental implants is crucial for assessing their long-term biocompatibility and potential health implications.[8,9] This study aims to analyze blood metal ion levels in individuals with dental implants to evaluate possible systemic exposure and its clinical significance. Findings from this research could provide valuable insights into the safety of implant materials and guide future advancements in implantology.

In our study, among the total participants, 30 (60%) were male, and 20 (40%) were female. Preoperatively, the mean titanium ion level was 1.67 mg/dL (SD: 0.11) with a p-value of 0.20. At 4 weeks postoperatively, the mean level declined to 1.52 mg/dL (SD: 0.16), followed by a further reduction at 6 months to 1.40 mg/dL (SD: 0.14). By the 1-year follow-up, the titanium ion level had decreased to 1.29 mg/dL (SD: 0.19). Similarly, the mean aluminum ion level preoperatively was 3.91 mg/dL (SD: 0.11) with a p-value of 0.27. At 4 weeks postoperatively, it decreased to 3.62 mg/dL (SD: 0.17), followed by a further reduction at 6 months to 3.49 mg/dL (SD: 0.12). However, by the 1-year follow-up, a slight increase was noted, with the mean aluminum ion level rising to 3.64 mg/dL (SD: 0.21).

A study by Saini, R et al.[10] evaluated serum metal ion levels in 20 subjects undergoing dental implant therapy for mandibular first molar replacement. Blood samples were collected at baseline, 8 weeks, and 6 months, and metal ion levels were analyzed using an auto-analyzer. All implant procedures were performed by skilled implantologists, and data analysis was conducted using SPSS software. The mean serum titanium concentrations at baseline, 8 weeks, and 6 months were 2.39 mg/dL, 2.35 mg/dL, and 2.38 mg/dL, respectively, while mean serum aluminum concentrations were 4.19 mg/dL, 4.16 mg/dL, and 4.18 mg/dL, respectively. Statistical analysis revealed no significant differences in metal ion levels over time, leading to the conclusion that serum metal ion levels remain unaffected in patients undergoing dental implant therapy.

In the study by Jain R et al.,[11] the preoperative and postoperative serum levels of titanium, cobalt, and aluminium were assessed to evaluate the release of these ions and the potential risk of toxicity following dental implant placement. The results showed a very slight increase in the serum concentrations of these ions 12 months after implant placement compared to preoperative levels, but the increase was statistically non-significant. The study concluded that the use of dental implants did not pose any risk of metal ion toxicity, as the changes in serum levels of titanium, aluminium, and cobalt were minimal and not significant after 12 months.

Marathe et al et al.[12] enrolled 30 patients who underwent dental implant therapy and 30 healthy individuals as a control group. Clinical and demographic details were recorded for all participants. Dental implant procedures were performed by skilled and experienced implantologists. One month postoperatively, salivary samples were collected from both the implant group and the control group to assess salivary titanium levels. The results showed that the mean salivary titanium concentration was 158.2 µg/L in the implant group and 239.8 µg/L in the control group. A statistically significant difference was observed when comparing salivary titanium levels between the two groups. relate and contradict my study and other studies

Our study generally aligns with prior research in observing minimal long-term systemic impact from dental implants, but it contradicts findings by Saini et al. and Jain et al. by demonstrating a clear decline in titanium ion levels over time. The slight increase in aluminum levels at the 1-year mark in our study introduces a potential point of interest for further research. Additionally, Marathe et al.'s findings on salivary titanium levels highlight the need for future studies to explore the correlation between serum and salivary metal ion concentrations.

One limitation of our study is the relatively small sample size of 50 patients, which may affect the generalizability of the findings. A larger sample would enhance the study's statistical power, improving the ability to detect subtle but potentially meaningful changes in metal ion levels. Expanding the cohort size would also strengthen the validity of the results, allowing for more definitive conclusions regarding the long-term effects of dental implants on metal ion concentrations and potential toxicity risks. Additionally, a larger study population could better account for individual variations in response to implant materials and corrosion byproducts, providing a more comprehensive understanding of their clinical significance.

CONCLUSION

Patients who received dental implants showed no significant changes in blood titanium and aluminum ion levels.

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