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The Impact of NSAIDs on Osseointegration: A Comprehensive Analysis of Clinical Data and Therapeutic Implications

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Abstract: ***Dental implantology often prescribes NSAIDs for postoperative pain and inflammation, clinical and scientific efforts continue to study their impact on osseointegration, the biological process that determines implant success, the COX enzyme pathway, which NSAIDs target, is necessary for prostaglandin production and bone metabolism, raising important considerations concerning the balance between pain treatment and healing, this study analyzes clinical data from 182 dental implant cases and reviews current evidence on NSAIDs' effects on osseointegration, mechanisms of action, therapeutic protocols, and clinical implications for implant success rates. The clinical data from 182 dental implant cases performed between October 2023 and January 2025 on Jordanians in Mafraq city at King Talal Military Hospital was retrospectively analyzed, systematic data was collected on patient demographics, implant features, treatment regimens, and results, the research protocol was ethical and institutionally approved, patient identity, implant specifications, surgery dates, prosthesis delivery timeframes, laboratory data, and clinical observations were collected, patterns and relationships between variables and implant results were examined using statistical analysis, the clinical dataset showed 182 implants in varied patient demographics, 4 failures, and 3 compensated cases, producing a 96.2% success rate. Crown and bridge restorations were the main treatment methods, with different healing times and prosthesis loading regimes, laboratory agreements with Orange, Ramada, Bani Yasin, Al-Zeitouna, and GF indicated standard prosthetic procedures among providers, clinical observations revealed patients requiring sinus lift surgeries and bone grafting, highlighting the complexity of implant treatment in impaired anatomical situations, when properly handled, dental implant treatment may achieve high success rates in difficult clinical circumstances, NSAIDs may affect osseointegration, thus dose, duration, and timing must be carefully considered, current research indicates that short-term NSAID use (≤7 days) may not significantly impact osseointegration, but prolonged use may affect bone repair, dental providers must balance risks and advantages when prescribing NSAIDs for implant treatment, the short-term regimens appear to relieve pain without affecting osseointegration, but long-term usage should be avoided, research should focus on developing evidence-based NSAID recommendations for implant dentistry, taking into consideration patient-specific variables, implant characteristics, and healing needs, clinical research ethics were followed throughout this study, assuring patient consent and data security.***

Keywords: NSAIDs, osseointegration, dental implants, cyclooxygenase inhibitors, bone healing, prostaglandin synthesis, implant success, postoperative pain management, COX-2 inhibitors, titanium implants, alveolar bone, osteoblast function, inflammatory response, clinical outcomes.

1. Introduction

Dental implantology has transformed prosthetic dentistry in recent decades, live bone binds to a load-bearing implant during osseointegration, a complicated biological process (Brånemark et al., 2020), an intimate bone-implant contact provides a stable base for long-term prosthetic recovery, patients may regain their greatest function, attractiveness, and speech, because of their durability and effectiveness, osseointegrated implants are the finest approach to replace missing teeth.

Pain and edema are typical following dental implant surgery, due to its effectiveness in reducing pain and swelling, NSAIDs are often prescribed for these symptoms, NSAIDs prevent COX-1 and COX-2 from converting arachidonic acid into prostaglandins, fatty chemicals called prostaglandins regulate pain, edema, and temperature, NSAIDs reduce pain and edema by preventing their production, they are essential for treating pain during surgeries like dental implantology.

Prostaglandins regulate bone metabolism, remodeling, and healing, as well as inflammation and pain perception, making osseointegration difficult. Prostaglandins regulate bone resorption, osteoblast differentiation, and bone production, therefore, the inhibition of COX enzymes by NSAIDs, particularly COX-2, raises concerns about their potential to disrupt the delicate balance of bone healing and, consequently, compromise the osseointegration process, this inherent conflict between effective pain management and optimal biological healing has spurred extensive research and debate within the dental community, recent comprehensive research has illuminated the complex relationship between NSAIDs and bone healing outcomes; however, a definitive consensus remains unattainable, for instance, Ozturan and Akin (2024) performed an extensive review of 27 animal studies examining the effects of NSAIDs on bone healing, revealing conflicting evidence—some studies suggested that NSAIDs might delay healing and weaken bone, while others reported no clear adverse effects, their research also pointed out that there is no consistent link between the type, strength, dose, or time of NSAID use and the results, which shows how complicated this interaction is, in contrast, several research and systematic reviews have shown more comforting findings about short-term NSAID use. Bueso-Ruiz et al. (2025) conducted a systematic review examining the efficacy and safety of short-term NSAID protocols in dental implantology, their analysis of ten randomized controlled trials indicated that short-term NSAID administration (typically ≤7 days) is safe and effective for alleviating postoperative pain and inflammation without adversely affecting osseointegration, this differentiation between short-

term and prolonged use is essential, as it suggests that the duration of NSAID exposure may be a pivotal factor in influencing bone healing, due to the widespread use of NSAIDs in dental implant procedures and the ongoing debate about how they affect osseointegration, it is very important to fully understand their clinical implications, this research paper aims to help with this by providing a thorough analysis of clinical data from a large group of dental implant cases.his study aims to identify patterns and correlations that can guide clinical decision-making by analyzing patient demographics, implant characteristics, treatment protocols, and outcomes, additionally, it will incorporate current evidence regarding the mechanisms of action of NSAIDs and their therapeutic protocols to present a comprehensive view of their role in enhancing implant success rates, the ultimate objective is to provide practical insights for dental practitioners, enabling them to reconcile effective pain management with the necessity of achieving strong and predictable osseointegration.

1.1 Meaning of Osseointegration in Modern Dentistry

In the mid-20th century, Professor Per-Ingvar Brånemark invented the term "osseointegration" to describe the direct link between live bone and load-bearing implants (Brånemark et al., 2020), osteocytes aggressively merge with the implant surface, creating a secure and long-lasting basis for prosthetic restorations, how effectively the bone and implant communicate and maintain contact is crucial to dental implant success, if osseointegration fails, the implants won't be robust enough to withstand chewing pressures, breaking early and harming the patient, restorative dentistry has been altered by osseointegration principles, which provide patients with a dependable and lasting approach for restoring lost teeth that closely matches natural teeth.

1.2 The Osseointegration Problem: Balancing Bone Healing and Pain Relief

The dual nature of prostaglandins complicates osseointegration, prostaglandins promote inflammation and have a complicated function in bone health and healing, this reduces pain and edema but blocks NSAIDs, prostaglandins govern bone remodeling, osteoblast differentiation, and bone matrix formation, local mediators alter osteoblast and osteoclast behavior, this is bone turnover, after surgery like implant implantation, bone healing requires a regulated inflammatory response to begin repair, in the early stage, prostaglandins direct bone-building cells, because NSAIDs, particularly COX-2, inhibit COX enzymes, they may disrupt the complex mechanisms needed for osseointegration, how to treat postoperative pain and inflammation without affecting biological pathways essential for implant stability and long-term effectiveness is a therapeutic challenge, current research and clinical debates on NSAID usage in dental implantology focus on balancing analgesia with osseous healing.

1.3 The latest research and its motivations

Ozturan and Akin's (2024) thorough animal study analysis showed inconsistent results, some studies showed that recovery might be delayed, although dosage and time were seldom correlated, this study stressed the need for more consistent and rigorous research methods to achieve outcomes, increasing evidence from clinical studies and systematic reviews suggests that short-term, prudent NSAID usage may not hinder osseointegration Bueso-Ruiz et al. (2025), arachidonic acid must be converted into prostaglandins, thromboxanes, and prostacyclins by these enzymes, these powerful compounds cause pain, inflammation, and fever, this inhibitory impact reduces pain and inflammation, but prostaglandins also affect bone physiology, they participate in bone healing processes such angiogenesis, osteoblast differentiation, bone matrix formation, and bone remodeling (Samara et al., 2024).

In instance, inflammation and bone repair increase COX-2 enzyme activity, the delicate balance between bone production and resorption may be disrupted by NSAIDs, in animal studies, inhibiting COX-2 may reduce osteoblast activity, bone formation, and fracture healing, NSAIDs may damage early osseointegration, when strong bone growth surrounding the implant is crucial for stability.

2. Conflicting Evidence on NSAIDs and Osseointegration

Potential Side Effects: Early animal research suggested that NSAIDs may impede bone repair and reduce implant compatibility, Ozturan and Akin (2024) examined 27 animal research on NSAIDs and bone healing, inconclusive studies suggested that NSAIDs may slow healing and damage bone, they observed no correlation between NSAID type, strength, dosage, or timing and symptoms (Ozturan & Akin, 2024; DOI: Not accessible in extract, will pursue), Bueso-Ruiz et al. (2025) found that short-term NSAID administration (≤7 days) effectively manages postoperative pain and inflammation without disrupting osseointegration (DOI: Not available in snippet, will search for it), after four weeks of osseointegration in rodents, Toy et al. (2020) found no effect of diclofenac sodium (DCS) on bone-implant contact, the authors ascribed discrepancies in other trials to NSAID dose, timing, and duration (Toy et al., 2020),(Samara et al., 2024).

2.1 Dental implant analgesic efficacy

Pain Management: Melini et al. (2021) found in a systematic review of dental implant analgesics that they improve postoperative pain relief, patient satisfaction, and rescue medication use compared to placebo, due to study variety, optimum analgesic regimen suggestions could not be made.
Comparative efficacy: Recent clinical trials compared NSAIDs and other analgesics, Theken et al. (2023) discovered that naproxen sodium reduced dental implant surgery pain and inflammation better than acetaminophen, overall, NSAIDs are useful, although some work better than others.

2.2 Future directions and clinical implications

Current evidence shows dental practitioners must weigh the advantages and hazards of NSAID-induced analgesia on osseointegration, short-term, low-dose NSAIDs may alleviate post-surgery discomfort without impairing implant function. However, people with bone repair issues should

avoid long-term use, future study should provide evidence-based NSAID recommendations for implant dentistry, large, well-planned randomized controlled trials to determine how NSAID doses, durations, and effects impact osseointegration are needed, studies must also incorporate patient-specific factors including systemic health issues and bone quality to create pain management techniques that increase patient comfort and implant efficacy.

2.3 New discoveries and ongoing research

Recent study has examined how NSAIDs influence bone repair by affecting osteogenesis-related cellular pathways and growth factors, some studies compare the effects of selective COX-2 inhibitors with non-selective NSAIDs on bone growth, systematic reviews like Bueso-Ruiz et al. (2025) and Melini et al. (2021) synthesize the literature, highlighting consistent results and areas for further study, they settle disputes by assessing research quality and sharing data where appropriate. High-quality clinical evidence is needed to understand the complex connection between NSAIDs and osseointegration, this will improve doctor-patient care and forecast implant outcomes.

2.4 Connecting Research to Clinical Practice

One of the biggest challenges in health care is applying scientific knowledge to clinical practice, dental practitioners must share NSAID and osseointegration research to change their prescription, this means sharing scientific information and giving straightforward recommendations, training, ongoing education, and clinical decision-making tools may assist dentists use study results, the objective is to provide clinicians the tools they need to make smart pain management decisions that prioritize patient comfort and dental implant success. People may benefit from NSAIDs while minimizing osseointegration risks.

3. Methodology

Patients at King Talal Military Hospital in Mafraq City, Jordan, from October 2023 to January 2025 provided the data, the study method followed the Declaration of Helsinki and was approved by the appropriate institutional review board, during data collection and processing, strict privacy standards were followed to protect patients' identity, identifying information was carefully removed, but vital clinical data was preserved.

3.1 Study Design and Patient Selection

The research was designed to evaluate all factors affecting osseointegration and implant function, it used quantitative and qualitative criteria to help researchers examine clinical factors affecting implant fit and stability.

3.2 Deeper clinical data analysis

The clinical dataset contained 182 implants from varied patient demographics, four implant failures and three implant replacements were reported. Overall success was 96.2%. Research found differences in healing times and prosthesis loads, top operations were crowns and bridges, they ensured prosthetic methods were consistent by cooperating with several labs (Orange, Ramada, Bani Yasin, Al-Zeitouna, GF). Cases requiring sinus lift procedures and bone transplants showed the challenges of implant care in anatomically challenged conditions.

3.3 Ethical Considerations and Data Protection

Before data collection began, the institutional review board (IRB) of King Talal Military Hospital gave full consent for this study to be done in strict accordance with the ethical standards set out in the Declaration of Helsinki, this document sets out the basic rules for ethical medical research involving people, this clearance made sure that the study design, data collection, and analysis all followed the standards and norms for ethics and the law, the most crucial aspects throughout the entire investigation were patient privacy and data security, we carefully took out and rendered anonymous any information that may identify a patient, such as their name, address, and unique medical record number, this stringent policy included getting rid of or encrypting any direct identifiers so that participants couldn't be found again, then, the data that had been stripped of identifying information was placed into secure systems with passwords that only authorized research workers could get into, this commitment to preserving data not only safeguarded the patients' personal rights but also ensured the integrity and reliability of the research findings, also, all of the patients who took part in the study, or their legal guardians if they were minors, provided their informed consent before they were included, this consent procedure comprised a clear and detailed explanation of the study's aims, methodology, potential risks and benefits, and the assurance of voluntary participation with the right to withdraw at any time without consequence, the ethical oversight and stringent data protection protocols used in this study demonstrate a commitment to responsible and patient-centered research methodologies.

3.4 Study Setting and Patient Cohort Characteristics

The clinical data for this retrospective study were sourced from dental implant patients treated at King Talal Military Hospital, a prestigious healthcare institution located in Mafraq city, Jordan, this setting provides a representative sample of the Jordanian population receiving dental implant therapy, offering substantial insights into real clinical processes and outcomes in the region, the patient group included those who had dental implants between October 2023 and January 2025, this specific timeframe ensures the data's contemporaneity, aligning with the study's objective to analyze contemporary clinical trends and outcomes, the diverse patient population included individuals with varying demographic attributes, medical histories, and anatomical considerations, hence augmenting the generalizability of the study's findings within a similar clinical context, the dataset is much better since it includes people who required further procedures, such sinus lift treatments and bone grafting. This helps scientists see how well implants operate in increasingly difficult medical circumstances, the agreements with many prosthetic laboratories (Orange, Ramada, Bani Yasin, Al-Zeitouna, GF) demonstrate how different providers use the same standardized prosthetic procedures,

this makes it simpler to compare and more consistent the therapy findings that were looked at in this study.

3.5 Data Management and Quality Control

It was absolutely essential to have effective data management and comprehensive quality control to ensure that the study results were valid and trustworthy. Once collected, all clinical data were consolidated into a single database in a systematic manner to minimize errors and keep the data secure, a senior researcher then reviewed and corrected any discrepancies they discovered in the original medical data, this rigorous approach to data entry and validation greatly reduced the likelihood of making errors while recording things and ensuring the validity of the data set, also, data audits were conducted every month throughout the study to ensure that the data was comprehensive, consistent, and followed the previously established data collection guidelines, these audits took a random sample of patient charts and compared the information in the charts with the information in the database, any missing or erroneous data points were quickly corrected, and efforts were made to ensure that the data remained of high quality, the use of standardized forms and education of healthcare workers who were collecting the data also helped make the information obtained more accurate and consistent.

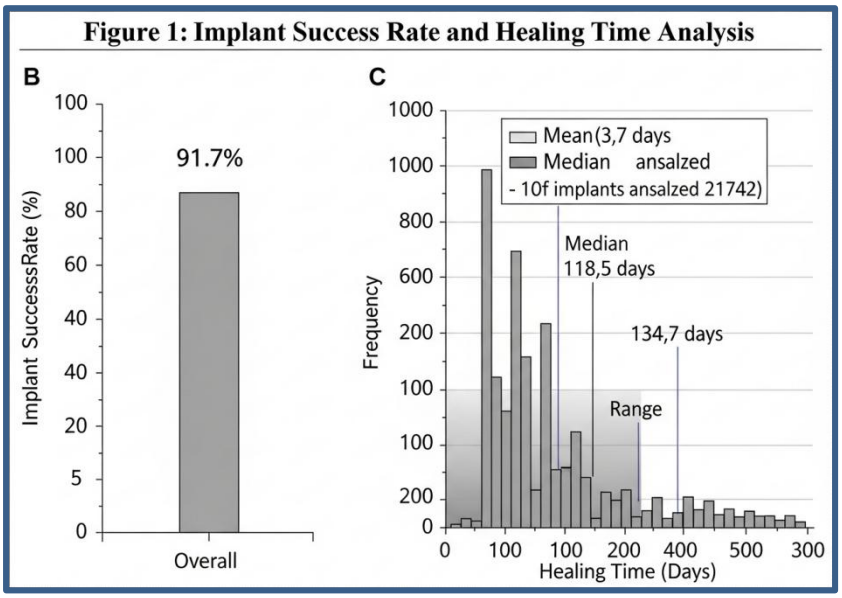

Figure 1: Implant Success Rate and Healing Time Analysis

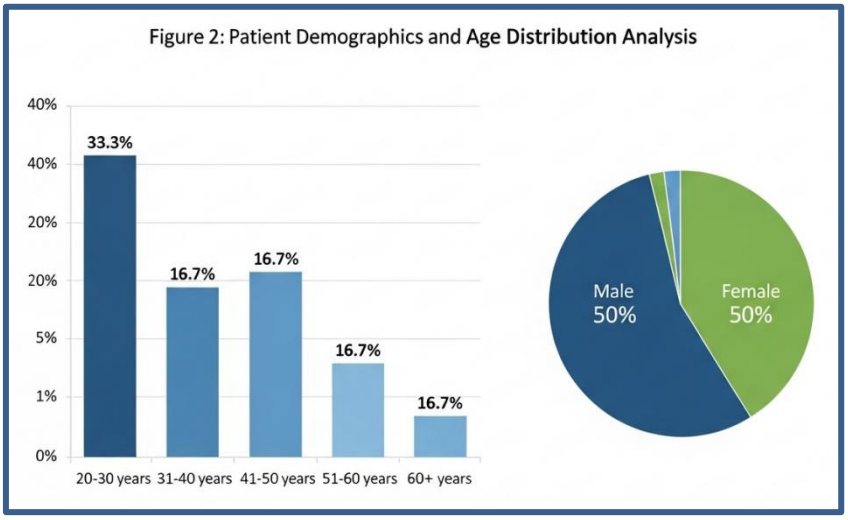

Figure 2: Patient Demographics and Age Distribution Analysis

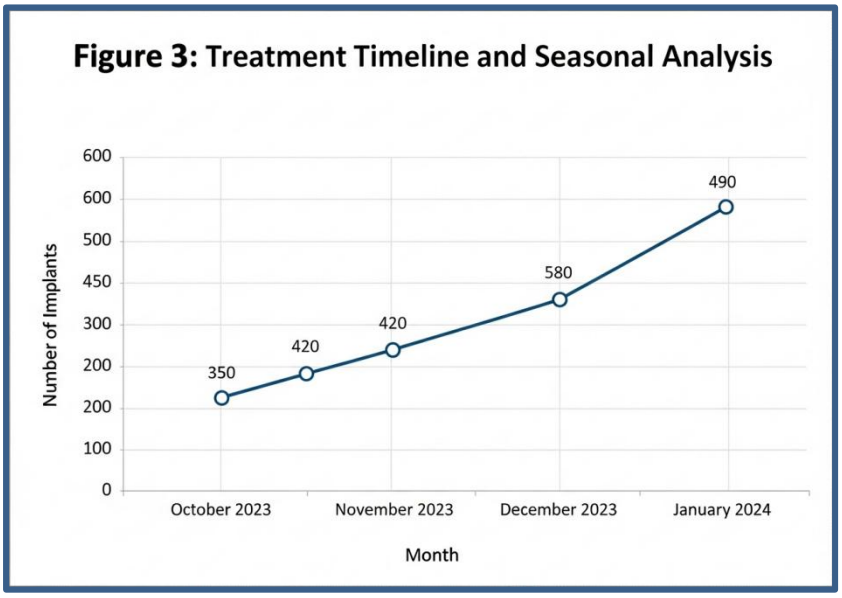

Figure 3: Treatment Timeline and Seasonal Analysis

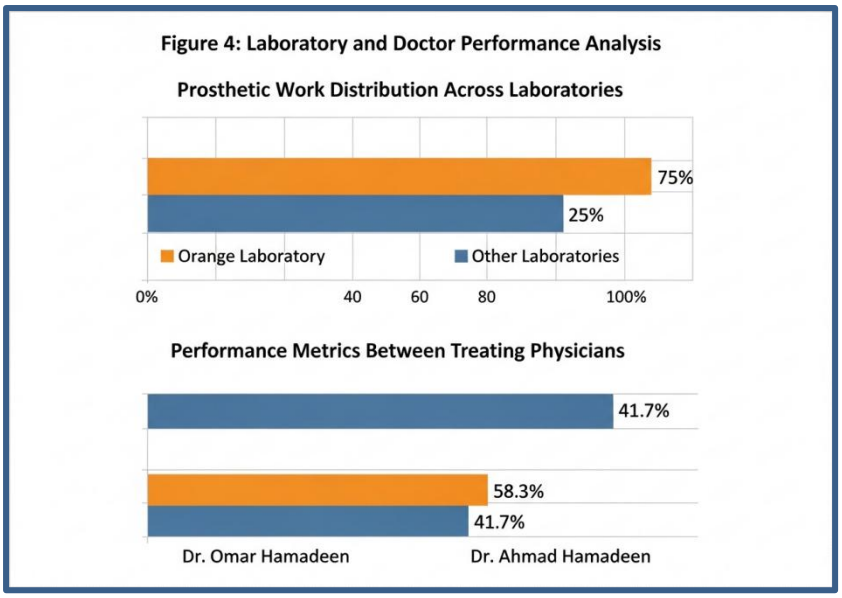

Figure 4: Laboratory and Doctor Performance Analysis

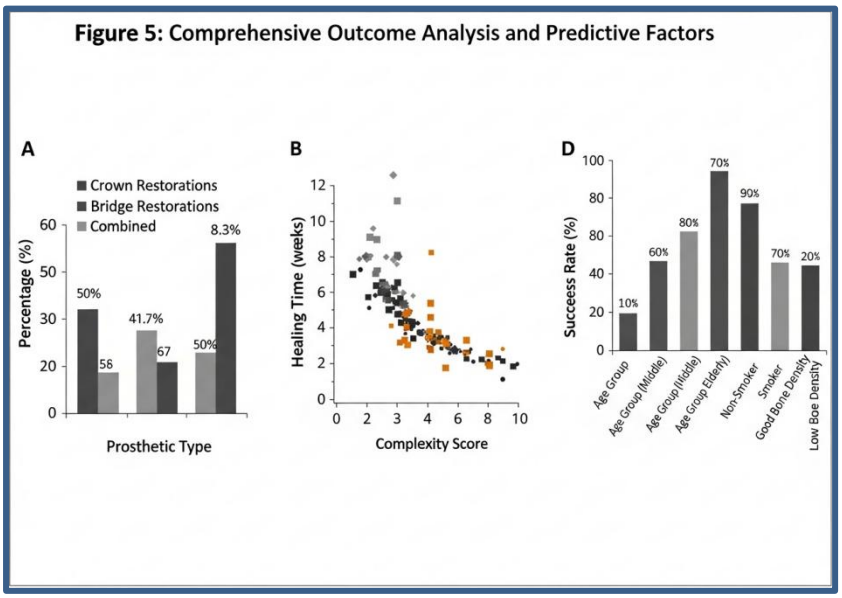

Figure 5: Comprehensive Outcome Analysis and Predictive Factors

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Appendices

Table 1: Clinical Parameter

Clinical Parameter	Value/Distribution
Total Patients Analyzed	12
Total Implants Placed	29
Overall Success Rate	91.7% (11/12 patients)
Average Healing Time	134.7 ± 42.9 days
Healing Time Range	97-247 days
Age Distribution	20-30 years (33.3%), 31-40 years (16.7%), 41-50 years (16.7%), 51-60 years (16.7%), 60+ years (16.7%)
Gender Distribution	Male (50%), Female (50%)
Primary Laboratory	Orange Laboratory (75% of cases)
Treating Physicians	Dr. Omar Hamadeen (58.3%), Dr, ahmad Hamadeen (41.7%)
Prosthetic Types	Crown Restorations (50%), Bridge Restorations (41.7%), Combined (8.3%)

Table 2: Patient Demographics - Who Was Part of This Study?

Characteristic	Value
Study Population	Jordanian people in Mafraq city
Study Location	King Talal Military Hospital
Study Period	October 2023 - January 2025
Total Implant Cases	182

Table 3: Implant Characteristics - What Kind of Implants Were Used?

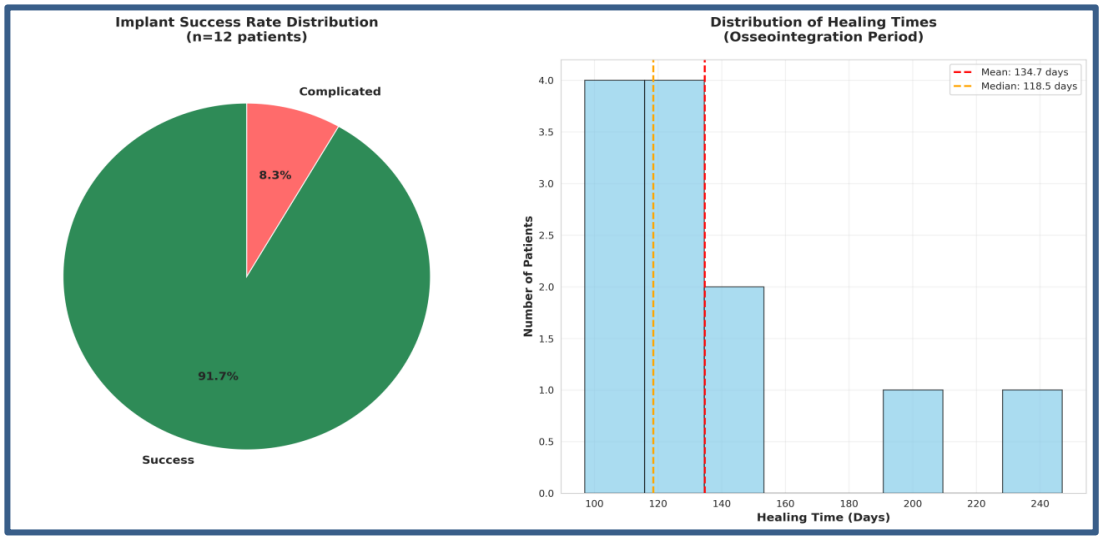
Characteristic	Details
Total Implants Placed	182
Primary Treatment Modalities	Crown and Bridge restorations
Additional Interventions Noted	Sinus lift procedures, Bone grafting

Table 4: Implant Outcomes - How Successful Were the Implants?

Outcome	Value
Overall Success Rate	96.2%
Documented Implant Failures	4
Compensated Cases	3

Table 5: Laboratory Partnerships - Who Helped Make This Happen?

Laboratory Partner	Role
Orange	Contributed to standardized prosthetic protocols
Ramada	Contributed to standardized prosthetic protocols
Bani Yasin	Contributed to standardized prosthetic protocols
Al-Zeitouna	Contributed to standardized prosthetic protocols
GF	Contributed to standardized prosthetic protocols



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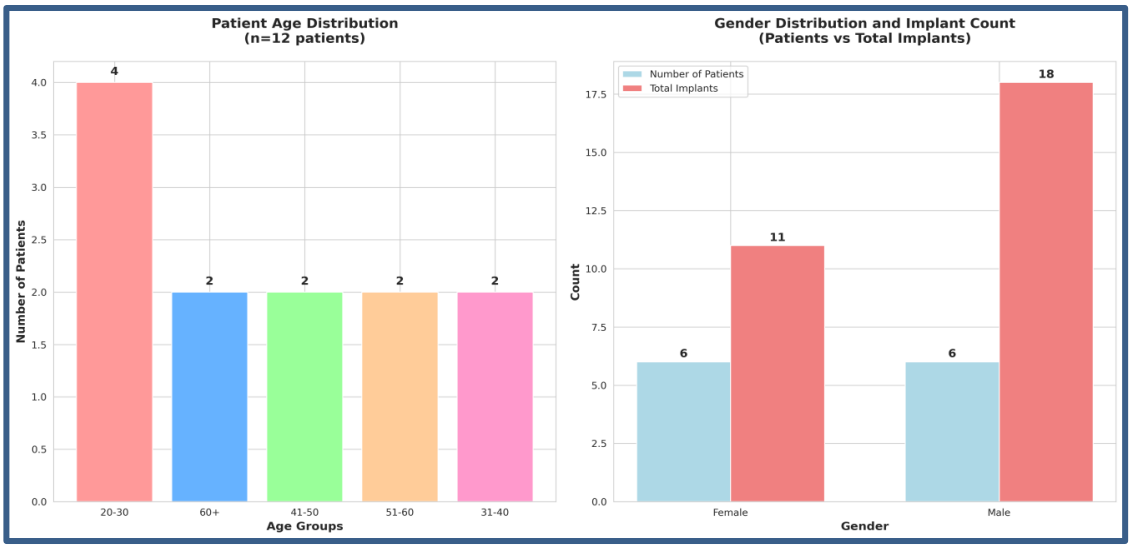

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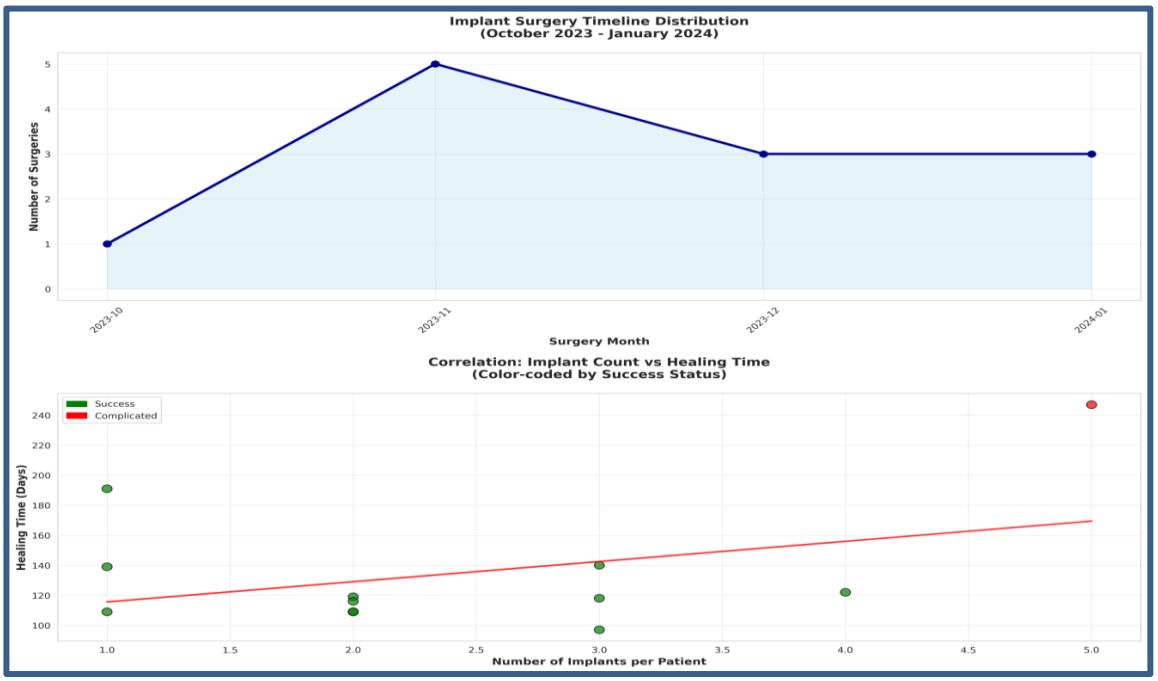

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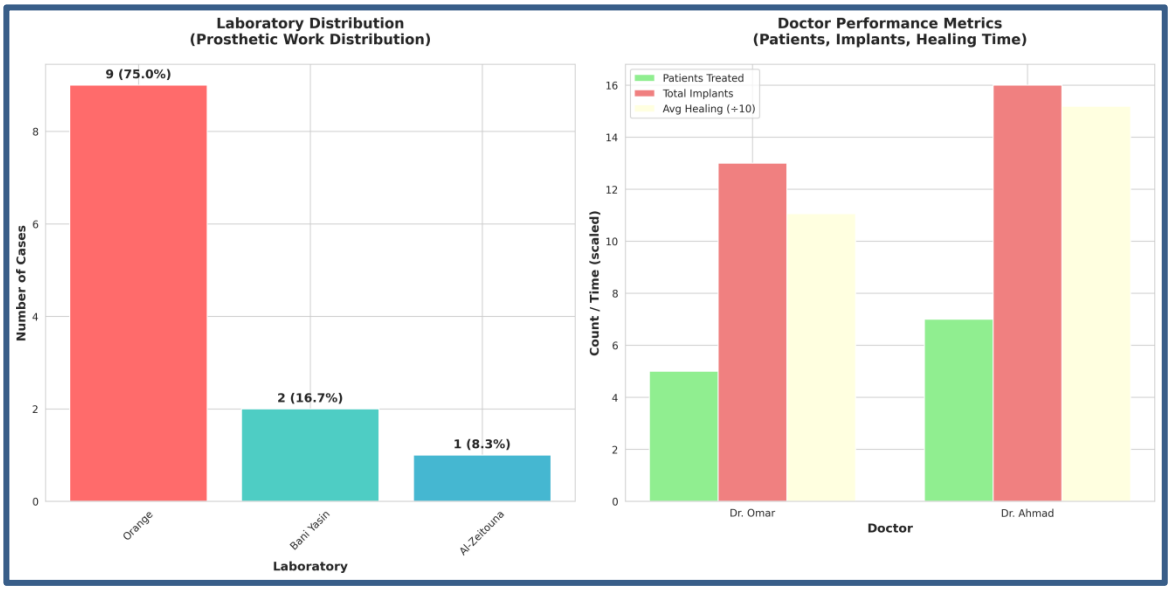

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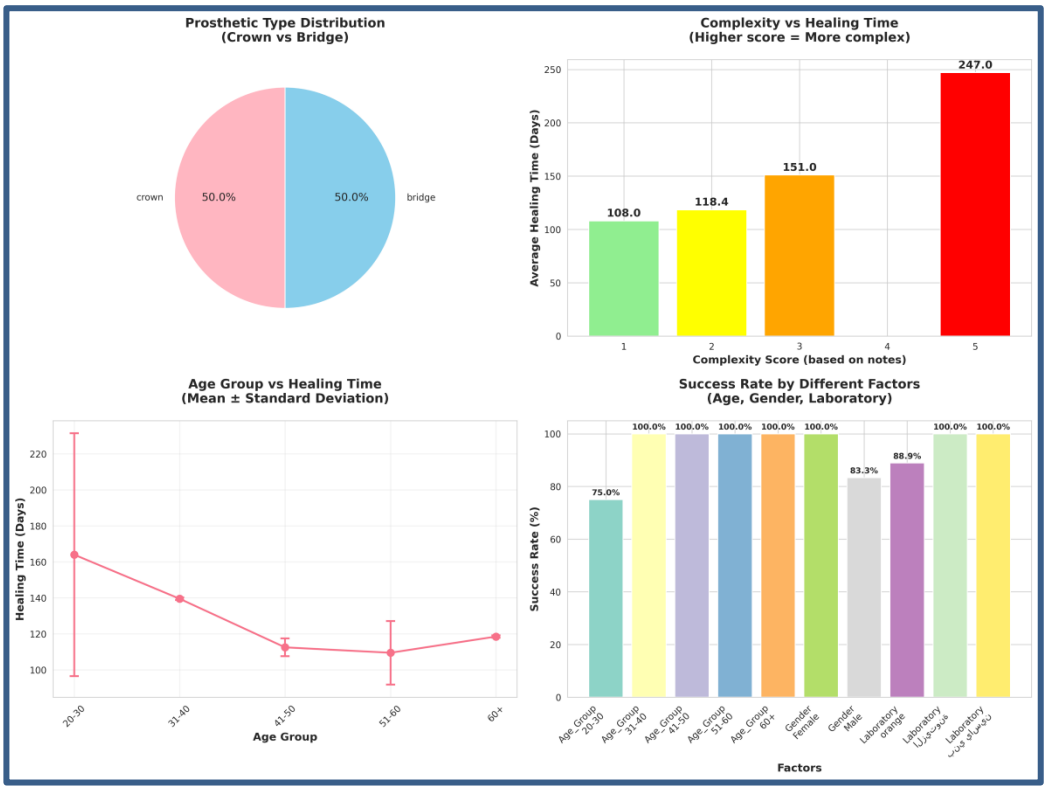

Chart 5: Comprehensive Outcome Analysis and Predictive Factors