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Original article

Attributable fractions, modifiable risk factors and risk stratification using a risk score for peri-implant pathology

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ABSTRACT

Purpose: This study aimed to estimate the impact of risk factors for peri-implant pathology, to identify potentially modifiable factors, and to evaluate the accuracy of the risk algorithm, risk scores and risk stratification.

Methods: This retrospective case–control study with 1275 patients (255 cases; 1020 controls) retrieved a model according to the predictors: history of Periodontitis, bacterial plaque, bleeding, bone level, lack of passive fit or non-optimal screw joint, metal-ceramic restoration, proximity to other implants/teeth, and smoking habits. Outcome measures were the attributable fraction; the positive and negative likelihood ratios at different disease cut-off points illustrated by the area under the curve statistic.

Results: Six predictors may be modified or controlled directly by either the patient or the clinician, accounting for a reduction in up to 95% of the peri-implant pathology cases. The positive and negative likelihood ratios were 9.69 and 0.13, respectively; the area under the curve was 0.96; a risk score was developed, making the complex statistical model useful to clinicians.

Conclusions: Based on the results, six predictors for the incidence of peri-implant pathology can be modified to significantly improve the outcome. It was possible to stratify patients per risk category according to the risk score, providing a tool for clinicians to support their decision-making process.

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1. Introduction

Peri-implant pathology represents a group of multifactorial situations that may affect negatively the successful outcome of implant supported restorations: The biological and biomechanical factors seem to play a significant role in the pathogenesis of this condition [1]. Peri-implant pathology is currently suggested to be considered as a separate pathological entity from Periodontitis based on the differences of genetic expression [2,3]. Furthermore, current considerations for peri-implant pathology include different theories that waive the purely infection-driven mechanism as the only causal component: Several authors proposed marginal bone loss to be dependent on different mechanisms such as a complication of a dis-balanced foreign body reaction that could be followed by a secondary biofilm-mediated infection [4,5]; or the combination of numerous background factors, including patient characteristics together with poorly constructed implants placed by untrained clinicians [6]. Compromised implants due to peri-implant pathology can manifest different features on the clinical aspect, including inflammatory signs of the soft tissue, marginal bone resorption, probing pocket depths higher than 4 mm, suppuration, bleeding on probing, or hyperplasia [7–10], with these signs occurring alone or in combination, sometimes with absence of symptomatology [11,12]. Other pathological features in compromised implants are related to a traumatic process [13–15] such as a radiographic evidence of periapical or marginal bone destruction (through micro fractures that lead to a bone defect) with absence of inflammation at least in an initial stage [7,16]. These manifestations of peri-implant pathology are not to be mistaken with implant failures, that usually present clinical mobility, inflammatory signs, bleeding on probing, peri-implant pockets over 4 mm, and fibrous encapsulation or radiological bone loss present in its apical third (visible at a radiological level) [17–21].

These potential different features together with the multifactorial origin may represent a challenge for clinicians to correctly diagnose and acknowledge the risk that a patient is for developing peri-implant pathology. Moreover, it is important to disclose the specific impact of each risk factor, especially the risk factors that can be modified or prevented, in order to increase the probability of a good outcome.

The attributable fraction (AF) consists in an epidemiological tool (an impact measure of effect) to attest the percentage of situations that could be prevented if the exposure to the risk factor was eliminated [22]. For peri-implant pathology, the importance of controlling risk factors for the incidence of the condition can be illustrated through the estimation of AF of the cases exposed regarding the risk factors, as some risk factors may be possible to be controlled either by the clinician or the patient, and this way decrease risk.

The existence of risk algorithms for disease modeling assumes an important role in modern Medicine, representing an important tool for clinicians [23] in the diagnosis and decision process, furthermore when risk stratification strategies are included. The evaluation of these models can be performed through the application of a receiver operating characteristic curve (ROC curve) [24,25] and provides a pure index of accuracy, by demonstrating the limits of a test's ability to discriminate between alternative states of health over the complete spectrum of operating conditions.

The aims of this study were: (1) to estimate the impact for each variable identified as a risk factor for the incidence of peri-implant pathology; (2) to identify factors potentially modifiable by the clinician or the patient; (3) to evaluate the accuracy of the risk algorithm, risk scores and risk group stratification.

2. Materials and methods (method of research)

This retrospective case–control study was approved by the National Commission of Data Protection (Portugal) and the Faculty of Medicine-University of Lisbon Ethical Board (Process 2237/09, Authorization 1976/2009). Informed consent was provided by the participants.

2.1. *Participants, setting and context*

The study population consisted of patients over 18 years, of both sexes, rehabilitated with dental implants from the Nobel Biocare system at the Center for Implantology and Fixed Oral Rehabilitation – Malo Clinic Lisbon.

The participants were selected from a defined list of 346 patients with peri-implant pathology and 1417 patients without peri-implant pathology. From these, there were 66 cases and 317 controls excluded due to incomplete or missing records and refusal to participate; 10 cases and 20 controls were included in a pilot study and excluded from the main study, and 15 cases and 60 controls excluded in the analytical phase due to bone level localized on the implants' apical third. The sample where the risk algorithm originated, consisted of 1275 individuals of both genders, with 255 patients with peri-implant pathology (cases) and 1020 patients with healthy peri-implant complex (controls), matched for age (2 years range), gender, and follow-up time of implant placement (2 months range). Peri-implant pathology was defined as the presence of peri-implant pockets $\geq$5 mm; bleeding on probing; concurrent presence of vertical bone loss visible in the periapical radiograph compared to the previous evaluation; attachment loss $\geq$2 mm compared to the previous evaluation [26–30]. Healthy patients were defined per denial of peri-implant pathology. The unit of analysis was the patient, and in the situation of more than one implant respecting the inclusion criteria, the implant was selected using a random sequence generator from www.random.org. The dental implants inserted in this study were from the Nobel Biocare system (Brånemark system, NobelSpeedy, Nobel Biocare AB, Gothenburg, Sweden).

This study is part of a series of exploratory studies for predictors of peri-implant pathology [26–30]: Patient enrolment took place between January and July 2009, the preliminary inferential studies [26–29] took place between July 2009 and October 2012, and the final multivariable studies between October 2012 and February 2015 with the development and publication of the risk model [30] using conditional logistic

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