

# Risk Factors Associated with Mini-Implant Failure: A Retrospective Study <sup>†</sup>

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**Abstract:** This study aimed to evaluate the failure rate of mini-implants used at the orthodontic external clinic, Egas Moniz School of Health and Science. A retrospective cross-sectional investigation was performed. This included the insertion of 232 TADs into 125 consecutive patients and was always performed with an immediate loading protocol. The examined variables were: gender, age, Angle's classification, presence of pathologies, medication, smoking, receiving jaw, placement side, and insertion site. Descriptive statistics were used and inferential analysis was performed, revealing the six-month failure rate of the used TADs to be 25%. A significant association was found between being a smoker, the failure rate ( $p = 0.036$ ), and the placement site ( $p = 0.003$ ).

**Keywords:** miniscrew; orthodontic; mini-implant; skeletal anchorage; temporary anchorage device

## 1. Introduction

Anchorage management is an essential component of planning a successful orthodontic treatment. A reliable anchorage system can ensure predictable tooth movement accordingly [1]. Over the past century, numerous intra-oral and extra-oral anchorage techniques have been utilized to secure adequate anchorage. Traditionally, maximum anchorage control was mainly obtained using extraoral devices. This was carried out with or without intraoral auxiliary appliances, such as elastics and transpalatal arches [1–3]. A paradigm shift occurred when new bone-anchoring devices were developed for orthodontic purposes. Mini-implant (MI) evolution in the past two decades has enabled clinicians to perform challenging orthodontic treatment procedures that were previously considered inconceivable when relying on conventional anchorage devices. Generally, MI stability for more than six months is considered a success. However, a wide range of success rates were reported in the literature, ranging from 55.6% to 100% [4]. This wide discrepancy might be due to the multiple contributing factors that may cause MI failure, such as factors related to the implant, related to the patient, related to location, and related to orthodontics and implant maintenance. Identifying these factors is crucial to avoiding MI loss during treatment, which might compromise the planned orthodontic treatment outcome. Numerous studies have examined the factors that cause failures in MIs, as evidenced by previous research [5–8]. A recent systematic review and meta-analysis found that success rates varied across studies due to inconsistent factors. Another review established a correlation between the failure rate of MIs and specific factors, while a separate investigation restricted the assessment of success or failure to the placement area of the MI. This underscores the scarcity of studies that comprehensively analyze all contributing factors collectively,



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indicating a need for more research. Therefore, the objective of this study was to investigate the failure rate of MIs and all associated factors that contribute to such failures.

### 2. Materials and Methods

The present study was a retrospective investigation that evaluated the rate of success of MI when integrated with fixed orthodontic treatment between January 2017–December 2019. The investigation was undertaken at the orthodontic clinic, Egas Moniz School of Health and Science University clinic. Ethical approval was obtained from the Ethics Committee of the same school, and the participants granted their informed consent. The sample comprised 232 MIs. These were inserted into 125 consecutive orthodontic patients (mean age 23.4, SD = 11.7 years) by the same operator. A titanium Ti-6Al-4V MI was positioned at all the insertion sites (Osstem Implant Biofisa Ø1.8xH10xG/H1.5): infra-zygomatic, buccal shelf, anterior and posterior inter-radicular space, retromolar area, and the tuberosity zone. Insertion was always performed using an immediate loading protocol. Failure referred to the detection of an expected loss or the presence of mobility requiring the replacement of the MI in the used prior six months. The IBM Package for Social Science (SPSS, V26) was used for the analysis. The overall MI failure rate and the failure rate of each variable were determined. The chi-square test was used to evaluate a possible association between each variable and the MI failure level. The Mantel–Haenzel odd ratio (OR) and 95% confidence interval (CI) were calculated at a significance level of 5%.

### 3. Results

The six-month failure rate of the used MI was 25%. A significant association existed between being a smoker and a failure rate at  $p = 0.036$  (Figure 1). Furthermore, the placement site significantly determined the stability of the MI, where the interradicular region had the highest success rate at 84.4% ( $p = 0.003$ ). In contrast, there was a similar association ( $p > 0.05$ ) between the following variables and the level of MI failure: gender, presence or absence of pathologies, whether the patient was medicated or non-medicated, type of malocclusion, recipient jaw, and direction of movement aided by the MI.

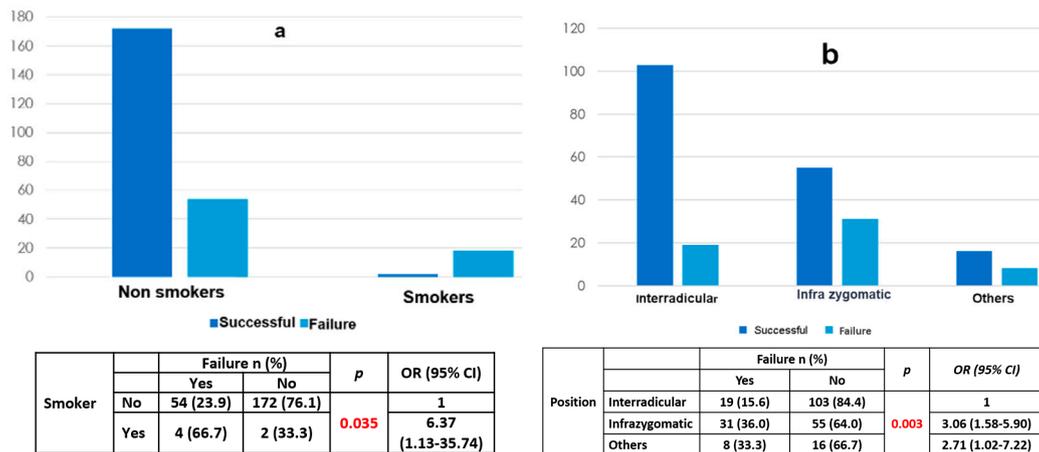


Figure 1. (a) The number and the percentage of succeeded and failed mini-implants (MI) associated with smoking habit (a) and position of insertion (b) with the confidence interval and the p value.

### 4. Discussion

This was a retrospective observational study that evaluated the failure rate and the factors contributing to the failure of MI after its integration into fixed orthodontic treatment. Similar studies categorized the causes of MI failure to host-related and implant-related factors [4–8]. The MI used in this study had the same characteristics and were placed by the same clinician. Therefore, the following discussion includes only the host-related factors.

This study revealed a significant association between MI failure and smoking. Numerous investigations reported the same findings [9–12]. Several complications that might compromise the MI survival time are associated with smoking. This includes such issues as peri-implantitis and mucositis, leading to MI loosening [9]. Bayat and Bauss [10] reported a deleterious effect for the heavy smoking, which is the consumption of >10 cigarettes/day, on the success rate of MI. However, they did not notice significant discrepancies in the success rate between light smokers and non-smokers. In our study, the patients were categorized only into two groups according to their self-reporting; smokers and non-smokers, without any discrimination made being between the smoking intensity. It is recommended that researchers undertake prospective studies to refine the methodology and categorization of the investigation.

## 5. Conclusions

Based on the results obtained in the present study, it is possible to conclude that the failure rate of MI, used as orthodontic anchorage in the orthodontic external clinic at the Egas Moniz School of Health and Science, was 25%. MI that had been inserted into the infra-zygomatic region failed the most (36%), and those inserted into the interdental region failed the least (15.6%). Gender, the existence or non-existence of pathologies, use or lack of use of medication and MI-supported tooth movement were the least influential variables. Conversely, the position of MI placement and smoking were the most influential factors contributing to the high MI failure rate.

**Author Contributions:** M.d.F.M.—the principal investigator, collecting study data, taking direct measurements, using the software, validating the measurements, collecting references and writing up the proceeding draft; P.M.P.—Conceptualization, Supervision, co-editing and co-writing up, Revising the final draft of the Proceeding; H.N.C.—Conceptualization revision, co-editing and co-writing up, Revising the final draft of the Proceeding; I.B.—second supervisor, Co-editing and co-writing up the proceeding. All authors have read and agreed to the published version of the manuscript.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** Data is available upon request.

**Conflicts of Interest:** The authors declare no conflict of interest.

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