UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT AND VALIDATION OF OMIS: A DEVICE FOR ORTHODONTIC MINI IMPLANT STABILITY MEASUREMENT USING THE OSSTELL ISQ SYSTEM

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ABSTRACT

Orthodontic mini-implants (OMIs) provide reliable skeletal anchorage, but their clinical success depends on achieving optimal primary stability. Although Resonance Frequency Analysis (RFA) using the Osstell ISQ system is well-established in implantology, its application to OMIs is limited by structural incompatibility and the absence of standardised adaptors. This study aimed to develop and evaluate the Orthodontic Mini-Implant SmartPeg (OMIS), a reusable and universal adaptor for assessing OMI stability using the Osstell ISQ system. A mixed-methods study was conducted in two phases: laboratory validation using goat jawbone models and SICace® implants, and clinical usability testing among orthodontic lecturers and postgraduate trainees. OMIS was developed using aluminium alloy 6061 with a claw-end magnetic coupling design. Its performance was compared to standard Osstell SmartPegs, and its compatibility was tested with four commercial OMI brands. User perception was assessed using a validated 17-item questionnaire. OMIS demonstrated good inter-device reproducibility but exhibited poor test-retest reliability (ICC < 0.5) and weak, non-significant correlations with SmartPeg ISQ values (Spearman's r = 0.21–0.36, p > 0.05). The OMIS attached securely to all four OMI systems and produced consistent intra-brand ISQ measurements despite inter-brand differences. Usability feedback indicated high agreement (>80%) on instruction clarity, perceived usefulness, and educational potential, with moderate ratings for intraoral comfort and ease of handling. In conclusion, OMIS shows promising potential as a standardised, reusable tool for OMI stability assessment. Further refinement in calibration accuracy, ergonomic design, and multi-centre clinical validation is recommended to optimise its clinical application.

Keywords: Orthodontic mini-implants, ISQ, SmartPeg, Resonance Frequency Analysis, OMIS, implant stability, clinical usability.

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CHAPTER 1
INTRODUCTION

1.1 Research Background

Orthodontic anchorage refers to the resistance provided by an anatomical structure to prevent undesired tooth movement during orthodontic treatment (Asok et al., 2021). Traditional anchorage methods, such as extraoral headgear and intraoral anchorage devices, often require patient compliance and may result in unwanted side effects. The advent of orthodontic mini-implants (OMIs), shown in Figure 1 has revolutionised orthodontic biomechanics by offering absolute anchorage with minimal side effects and high patient compliance (T. C. K. Lee et al., 2008; Zawawi, 2014). Their widespread use can be attributed to their small size, ease of insertion and removal, cost-effectiveness, the ability to withstand significant orthodontic forces without affecting adjacent teeth, and cost-effectiveness relative to conventional dental implants (Deguchi et al., 2003; Miyawaki et al., 2003a).

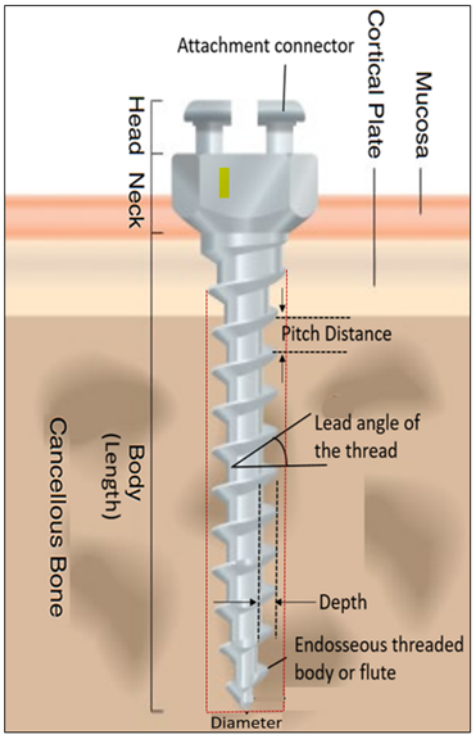

Figure 1.1 Structure and functional components of an OMI