Preoperative assessment of labial bone perforation for virtual immediate implant surgery in the maxillary esthetic zone

A computer simulation study

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For the past several decades, the successful use of osseointegrated implants has evolved into an integral treatment option for patients who are partially and completely edentulous.[1] Traditionally, the presence of sufficient bone volume is the most important prerequisite for dental implant placement; therefore, to provide state-of-the-art dental implant treatment, clinicians should suggest that patients wait for months after tooth extraction to ensure adequate alveolar bone healing and remodeling.[2,3] On the other hand, to meet the increased demands for maximizing esthetic results and minimizing treatment procedures, some investigators have reported that placing a 1-stage implant into a fresh socket immediately after tooth extraction may be possible for various indications.[2,4]

In recent years, investigators have reported the results of studies addressing the healing dynamics between soft and hard tissues around dental implants, the rapid advancement of grafting materials, and the refinement of surgical and restorative techniques to allow for improved predictability and prognosis for immediate

ABSTRACT

Background. In this computer simulation study, the authors investigated the frequency distribution of labial bone perforation (LBP) between various sagittal root position (SRP) classes with respect to the anterior maxillary osseous housing and evaluated the associated factors correlated with a higher risk of LBP when performing a virtual immediate implant surgery in the esthetic zone.

Methods. The authors analyzed cone-beam computed tomography (CBCT) images from 285 qualified study participants (1,449 teeth) to determine the probability of LBP when associated with selected variables, such as tooth type, SRP class, and morphologic parameters. The authors examined associated factors and analyzed the adjusted odds ratios by means of multiple logistic regression analysis.

Results. The overall probability of LBP was 81.7%, which presented statistically significant differences between each specific tooth type and SRP class (all $P < .001$). After adjusting for other factors, the authors found that the maxillary central incisor was 2.37 times more likely to have LBP than the canine. SRP class I was 4.9 times more likely to be associated with LBP when compared with SRP class IV.

Conclusions. When a clinician performs an immediate implant in the anterior esthetic zone, he or she should be aware that the specific tooth type, SRP class, and morphologic features of fossa concavities are associated with a risk of experiencing LBP.

Practical Implications. Presurgical cross-sectional images can be analyzed to identify anatomic features relative to LBP in the maxillary esthetic region, and this can avoid unpleasant complications, specifically when performing immediate implant procedures.

Key Words. Cone-beam computed tomography; dental implants; maxilla; dental esthetics; risk assessment; dental implantation.

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implants placed into fresh extraction sockets.[2,4] However, it should be emphasized that immediate implant placement and restoration in the maxillary esthetic zone is still critical and challenging.[1,3] This is mainly because of the limited volume of hard tissue in this zone, the unfavorable biotypes of soft tissue, inadequate implant position, poor primary stability, and gaps between implant and socket, among other issues, that may lead to difficulty in achieving the primary stability of the implant, an unsatisfactory esthetic outcome, and a high rate of implant failure.[2,5]

An insufficient or thin wall of labial bone in the maxillary anterior teeth is prone to perforation, dehiscence, or both, after a clinician places an immediate implant in the esthetic zone.[6,7] In a clinical scenario, the clinician usually positions immediate implants along the palatal slope of the extraction socket. However, unintentional slipping of dental implants positioned toward thin labial bone frequently leads to the perforation or fracture of the labial plate.[7] Consequently, the clinician should consider augmenting the hard or soft tissue in the site of the implant. Stringent case selection, comprehensive assessment, and proper treatment planning before surgery are suitable ways to reduce surgical accidents and complications such as labial bone perforation (LBP) in the esthetic zone.[6] However, there is a paucity of information about how a clinician should assess the risk of labial plate perforation and other morphologic parameters in the esthetic zone of an anticipated extraction site.

The amount of information that a clinician can glean from a 2-dimensional (2-D) dental radiograph is substantial.[8] However, traditional radiographs cannot always provide sufficient information, and clinicians using traditional radiographs note that radiographs may have some limitations associated with performing preoperative assessment and postsurgical evaluation, such as determining the localization and amount of bone volume in a labiopalatal direction in an anterior esthetic zone. Consequently, using an imaging modality with 3-dimensional (3-D) capability—for example, cone-beam computed tomography (CBCT)—is essential to enhance diagnosis and treatment planning while performing an immediate implant placement.[9]

The purpose of this computer simulation study was to investigate the frequency distribution of LBP and fenestration between various sagittal root position (SRP) classes with respect to the anterior maxillary osseous housing and to evaluate the associated factors that are correlated with having a higher risk of experiencing LBP when a clinician performs an immediate implant surgery in the anterior esthetic zone.

TABLE 1

Reliability of intra- and interobservations for nominal variables measurement.

INTRAOBSERVATION	FREQUENCY	κ
Perforation (Yes Versus No)	1/50	0.913
SRP* Classification (Class I, II, III, IV)	1/50	0.912
INTEROBSERVATION		
Perforation (Yes Versus No)	1/50	0.923
SRP Classification (Class I, II, III, IV)	1/50	0.922

* SRP: Sagittal root position.

TABLE 2

Reliability of intra- and interobservations for continuous variables measurement.

INTRAOBSERVATION	FIRST OBSERVATION, MEAN (SD*)	SECOND OBSERVATION, MEAN (SD)	MEASUREMENT ERRORS, MEAN (SD)	ICC†	CRONBACH α
Concavity Angle (Degree)	147.21 (8.21)	147.32 (8.03)	1.29 (0.12)	0.982	0.991
Tooth-Ridge Angle (Degree)	13.49 (4.41)	12.93 (4.33)	0.86 (0.821)	0.98	0.99
Residual Labial Bone Thickness (mm‡)	−1.38 (0.99)	−1.35 (0.97)	0.134 (0.015)	0.985	0.993
INTEROBSERVATION	**OBSERVER 1, MEAN (SD)**	**OBSERVER 2, MEAN (SD)**	**MEASUREMENT ERRORS, MEAN (SD)**	**ICC**	**CRONBACH α**
Concavity Angle (Degree)	147.21 (8.21)	147.58 (8.35)	1.182 (0.18)	0.989	0.989
Tooth-Ridge Angle (Degree)	13.49 (4.14)	13.01 (4.39)	0.71 (0.82)	0.992	0.992
Residual Labial Bone Thickness (mm)	−1.38 (0.99)	−1.36 (0.93)	0.132 (0.144)	0.992	0.992

* SD: Standard deviation.
† ICC: Intraclass correlation coefficient.
‡ mm: Millimeters.

ABBREVIATION KEY. **2-D:** 2-dimensional. **3-D:** 3-dimensional. **CA:** Concavity angle. **CBCT:** Cone-beam computed tomography. **LBP:** Labial bone perforation. **RLBT:** Residual labial bone thickness. **SRP:** Sagittal root position. **TRA:** Tooth-ridge angle.