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Anterior Maxillary Labial Bone Thickness on Cone Beam Computed Tomography

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ABSTRACT

Aim: The objective of this research was to measure the labial bone thickness (LBT) in relation to the 6 anterior maxillary teeth at different levels along the long axis and the distance between cementoenamel junction and bone crest (CEJ-BC) based on cone beam computed tomography (CBCT) scans retrieved from patients of Arab ethnicity and identify any association with patients' characteristics.

Materials and methods: A total of 100 CBCT scans were evaluated by one calibrated examiner. The thickness of the labial bone was measured perpendicular to the long axis of the tooth at 1, 3, and 5 mm from the alveolar crest (LBT-1, LBT-3, and LBT-5, respectively) and CEJ-BC using a medical imaging viewer.

Results: CBCT scans of 58 female patients and 42 male patients with a mean age of 39.7 ± 9.5 years were included. A high variation of CEJ-BC was observed (range, 0.55-3.90 mm). Statistically significant higher CEJ-BC values were associated with men and increased age (>50 years). The overall means of LBT-1 were 0.76 ± 0.26, 0.79 ± 0.26, and 0.83 ± 0.37 mm; LBT-3: 0.92 ± 0.36, 1.05 ± 0.46, and 1.03 ± 0.48 mm; LBT-5: 1.17 ± 0.52, 0.80 ± 0.45, and 0.81 ± 0.40 mm for central incisors, lateral incisors, and canines, respectively. The LBT was <1 mm in 74.2% of all maxillary anterior teeth, with central incisors showing the highest predilection (85% with LBT <1 mm). No significant association between LBT and patient characteristics was observed.

Conclusions: The CEJ-BC distance is greater in men and increases with age, particularly in those aged 50 years and older. The LBT in the 6 maxillary anterior teeth is predominantly thin (<1 mm) and has no correlation to age or sex. An increased LBT was observed at a 3-mm level when compared with LBT-1 and LBT-5. Such variability should be taken into consideration when planning for implant placement.

Introduction

Over the past 5 decades, replacement of missing teeth with dental implants has become a treatment of choice with long-term survival and predictability.[1-3] The presence of adequate hard and soft tissue volume at the time of implant placement, however, is crucial for optimal outcomes in terms of function and aesthetics.[4] In this context, alveolar ridge resorption after tooth extraction is of great concern, particularly in the aesthetic zone.[5] It has been demonstrated that two-thirds of alveolar ridge changes occur within the first 3 months after tooth extraction, with 50% loss in ridge width after 12 months.[6] An average of 40% to 60% loss of the original alveolar bone height and width after tooth extraction has also

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been reported, with the greatest loss occurring within the first 2 years.[5] These alterations in soft and hard tissue volume after tooth extraction have been attributed to histologic and morphologic changes taking place during the socket healing process, resulting in tissue collapse and a ridge deficiency.[7]

It has been suggested that the presence of an inadequate buccal plate prior to tooth extraction could be a significant predictor of hard tissue defects (ie, fenestrations or dehiscences) or soft tissue recessions.[8] These deficiencies become highly critical at the time of implant placement, particularly in the highly aesthetic anterior maxillary region.[5] The unpredictable dimensional changes and wide range of anatomical variations of the anterior maxilla could be very challenging for clinicians contemplating a prosthetically driven implant placement. For example, majority of the anterior maxillary teeth have thin labial bone thickness (LBT) of <1 mm, with almost half presenting LBT of <0.5 mm.[9] Such thin LBT could increase the likelihood of peri-implant tissue recession at the time of immediate implant placement.[10] It is essential, therefore, to consider the morphologic characteristics of the anterior maxilla prior to tooth extraction or implant placement for optimum diagnosis and treatment planning.

The 2 most commonly used methods to measure the thickness of buccal bone are calipers and cone beam computed tomography (CBCT). Of particular interest is the use of CBCT as a noninvasive diagnostic tool to assess the morphologic features of the alveolar bone in the anterior maxilla.[8,9,11] CBCT has been shown to have less radiation exposure and time compared with conventional computed tomography whilst presenting superior image quality, even at the submillimeter levels, making this diagnostic method an indispensable tool for clinicians planning for implant therapy.[11,12]

Several studies have used CBCT to measure LBT of the maxillary anterior teeth,[8,13,14] and average values in different age groups were reported in a recent systematic review.[15] Other well-designed studies evaluating LBT of the anterior maxilla in specific ethnic groups are still lacking.[15] In addition, a recent systematic review was carried out to comprehensively evaluate the LBT and distance between cementoenamel junction to coronal alveolar crest (CEJ-BC) for maxillary anterior teeth in various ethnic groups and highlights the heterogeneity encountered whilst conducting meta-analysis.[19] Hence, the main objective of this retrospective radiographic investigation was to report on the LBT and CEJ-BC for maxillary anterior teeth in a unique population in the United Arab Emirates (with an Arab ethnicity).

Materials and methods

Sample collection

This study was reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations.[16] Ethical approval was obtained from Mohammed Bin Rashid University of Medicine and Health Sciences (MBRU-IRB-2020-010) and Abu Dhabi Health Authority Institutional Review Boards (MF2467-2020-5) to conduct this retrospective study. All participants consented to have CBCT scans taken for the purpose of diagnosing various oral pathologic conditions (cysts, tumors, etc), impacted dentition, or implant treatment planning. The scans were obtained between January 2017 and December 2018 via Planmeca ProMax CBCT scanner (Planmeca Oy). All scans were acquired by the same technician and using the same settings (field of view [FOV] = 16 × 11 cm; tube peak potential = 85 kvp; tube current= 7 mAs; time = 8.9s; voxel size= 0.15 mm). One hundred CBCT scans were randomly selected and exported in Digital Imaging and Communication in Medicine (DICOM) format. The determination of the sample size needed was based on adopting a significance level of 5% with 90% power using G*Power software, version 3.1.9.4.[17] A representative sample size of 90 participants was required to detect a mean difference of 0.5 mm and standard deviation of 0.8 mm in buccal bone thickness between groups. To account for possible exclusions, a total of 100 participants were selected.

Inclusion and exclusion criteria

The following inclusion criteria were considered:

- Age 18 years and older.
- Presence of 6 pristine maxillary central incisors, lateral incisors, and canines.
- Absence of peri-apical pathology.
- Absence of radiographic horizontal bone loss.
- Good-contrast CBCT scans.

Exclusion criteria were as follows:

- Crowded teeth/improper teeth alignment or previous history of orthodontic treatment.
- Root canal–treated teeth
- Scattered or unclear CBCT scans.
- Generalised bone loss across all teeth that can be indicative of bone loss due to periodontal reasons.
- Any tooth/teeth associated with localised bony defects.
- Presence of implants in the maxillary anterior area.

Radiographic evaluation

All CBCT scans were assessed by one calibrated examiner (F.A.). To analyse reliability, intraclass coefficient was measured by examining 10 CBCT scans on 2 separate occasions, 2 weeks apart. Scans were assessed on an iMac computer (27-inch screen size with Retina 5 k display; resolution = 5120 × 2880; supports 1 billion colours; brightness = 500 nits; Apple) using medical imaging viewer Horos© viewer (v3.3.6#, www.horosproject.org) in a sagittal slice. For each of the 6 maxillary anterior teeth, LBT measurements were taken perpendicular to the long axis of the tooth at 1, 3, and 5 mm from the alveolar crest (LBT-1, LBT-3, and LBT5, respectively). In addition, the distance of CEJ-BC was also measured, based on a similar protocol previously published in other studies[14,18] (Figure 1).

Statistical analysis

Statistical analysis was performed using Statistical Package for Social Sciences SPSS (version 24.0, IBM for Mac). Intraclass coefficient was used to measure the intra-examiner agreement. Descriptive statistics were reported as mean

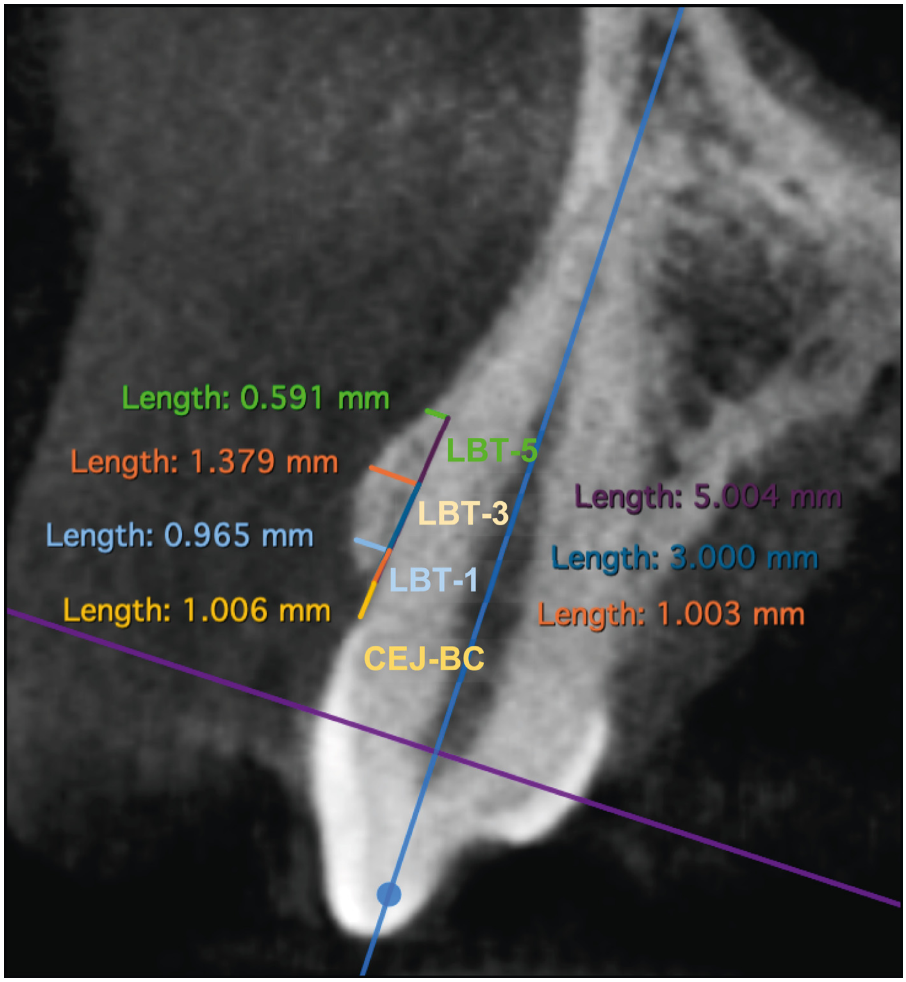

Fig. 1 – Cone beam computed tomography (CBCT) image of maxillary right canine region demonstrating the labial bone thickness (LBT) at 1, 3, and 5 mm from the bone crest and the distance from cementoenamel junction to bone crest (CEJ-BC).

and standard deviation (SDs) with a 95% confidence interval (CI). The mean differences in LBT were assessed for demographic characteristics (ie, age and sex) using independent t test and analysis of variance. Bonferroni post hoc test was used to measure the differences between different pairs. Chi-square test was performed to measure the strength of association between the LBT of ≥1 mm and demographic characteristics (ie, age and sex). The level of significance was set at $P < .05$.

Results

A total of 100 CBCT scans (58 women and 42 men) were included in the analysis, with a mean patient age of 39.7 ± 9.5 years (range, 18-68). An intraclass coefficient of 0.94 across all measurements indicated an "almost perfect" agreement. For further analysis, the participants were divided into 3 age groups: <25 years, 25-50 years, and >50 years.

The CEJ-BC distance demonstrated a wide range between 0.55 and 3.90 mm (Table 1). The overall means and SDs (combined right and left sides) for CEJ-BC were 1.80 ± 0.62, 1.85 ± 0.61, and 1.91 ± 0.66 mm for central incisors, lateral incisors, and canines, respectively. The LBT means and SDs (combined right and left sides) measured at LBT-1 were 0.76 ± 0.26, 0.79 ± 0.26, and 0.83 ± 0.37 mm and at LBT-3 were 0.92 ± 0.36, 1.05 ± 0.46, and 1.03 ± 0.48 mm for central incisors, lateral incisors, and canines, respectively. The corresponding numbers at LBT-5 were 1.17 ± 0.52, 0.80 ± 0.45, and 0.81 ± 0.40 mm for central incisors, lateral incisors, and canines, respectively. Men had significantly higher CEJ-BC values at all maxillary anterior teeth than women (Table 2), whilst there were no statistically significant differences between men and women in LBT-1, LBT-3, and LBT-5. Bonferroni post hoc test showed that patients older than 50 years had significantly larger CEJ-BC measurements for maxillary right and left canines and maxillary left central incisors compared to other age groups (Table 2). Central incisors exhibited a higher prevalence of LBT-1 of <1 mm (85%) compared to lateral incisors (79%) and canines (71.5%) (Figure 2). Likewise, LBT-5 showed similar prevalence with 82% of central incisors, 75% of lateral incisors, and 79% of canines having LBT-5 of <1 mm. On the other hand, LBT-3 of ≥ 1 mm was observed in 35%, 46%, and 41% of the measured sites at central incisors, lateral incisors, and canines, respectively. No significant association between LBT and sex or age was detected (Table 3).

Table 1 – Descriptive statistics of bone measurements.

	Right side Mean ± SD	Left side Mean ± SD	Overall mean ± SD (range)
Maxillary canines			
CEJ-BC	1.95 ± 0.72	1.86 ± 0.74	1.91 ± 0.66 (0.56-3.44)
LBT-1	0.82 ± 0.40	0.84 ± 0.40	0.83 ± 0.37 (0.31-2.12)
LBT-3	0.99 ± 0.49	1.06 ± 0.53	1.03 ± 0.48 (0.35-2.66)
LBT-5	0.75 ± 0.40	0.86 ± 0.50	0.81 ± 0.40 (0.24-2.30)
Maxillary lateral incisors			
CEJ-BC	1.79 ± 0.68	1.91 ± 0.68	1.85 ± 0.61 (0.69-3.27)
LBT-1	0.77 ± 0.29	0.82 ± 0.29	0.79 ± 0.26 (0.34-1.62)
LBT-3	1.03 ± 0.48	1.07 ± 0.51	1.05 ± 0.46 (0.34-2.86)
LBT-5	0.80 ± 0.49	0.80 ± 0.49	0.80 ± 0.45 (0.26-2.27)
Maxillary central incisors			
CEJ-BC	1.72 ± 0.64	1.88 ± 0.69	1.80 ± 0.62 (0.55-3.90)
LBT-1	0.74 ± 0.27	0.77 ± 0.28	0.76 ± 0.26 (0.19-1.64)
LBT-3	0.94 ± 0.39	0.90 ± 0.39	0.92 ± 0.36 (0.25-2.51)
LBT-5	0.79 ± 0.38	0.77 ± 0.38	1.17 ± 0.52 (0.32-3.94)

CEJ, cementoenamel junction; BC, bone crest; LBT-1, labial bone thickness at 1 mm from coronal alveolar crest; LBT-3, labial bone thickness at 3 mm from coronal alveolar crest; LBT-5, labial bone thickness at 5 mm from coronal alveolar crest.

Table 2 – Summary of bone measurements by sex and age.

	Measurements by sex				Measurements by age				
	Female (n = 58) Mean ± SD	Male (n = 42) Mean ± SD	Mean difference and 95% CI	*P* value*	<25 years (n = 4) Mean ± SD	25-50 years (n = 83) Mean ± SD	>50 years (n = 13) Mean ± SD	*F* (*df*)	*P* value†
Tooth #13									
CEJ-BC	1.81 ± 0.69	2.15 ± 0.71	0.34 (0.06 to 0.62)	.02‡	1.34 ± 0.67	1.92 ± 0.72	2.38 ± 0.51	4.03 (2, 97)	.02‡
LBT-1	0.79 ± 0.39	0.86 ± 0.42	0.07 (−0.09 to 0.23)	.4	0.77 ± 0.24	0.86 ± 0.41	0.58 ± 0.31	2.93 (2, 97)	.06
LBT-3	0.95 ± 0.50	1.06 ± 0.48	0.11 (−0.09 to 0.31)	.29	0.69 ± 0.27	1.03 ± 0.50	0.84 ± 0.50	1.65 (2, 97)	.2
LBT-5	0.72 ± 0.41	0.80 ± 0.37	0.07 (−0.09 to 0.23)	.37	0.56 ± 0.26	0.77 ± 0.38	0.71 ± 0.50	0.64 (2, 97)	.53
Tooth #12									
CEJ-BC	1.60 ± 0.61	2.07 ± 0.67	0.47 (0.21 to 0.72)	<.0001‡	1.14 ± 0.28	1.82 ± 0.69	1.86 ± 0.59	2.02 (2, 97)	.14
LBT-1	0.78 ± 0.30	0.75 ± 0.28	−0.02 (−0.14 to 0.09)	.68	0.88 ± 0.21	0.78 ± 0.29	0.63 ± 0.27	2.09 (2, 97)	.13
LBT-3	1.02 ± 0.49	1.05 ± 0.46	0.03 (−0.17 to 0.22)	.79	1.08 ± 0.45	1.04 ± 0.49	1.00 ± 0.42	0.06 (2, 97)	.94
LBT-5	0.79 ± 0.51	0.80 ± 0.47	0.01 (−0.19 to 0.21)	.9	0.89 ± 0.86	0.77 ± 0.48	0.95 ± 0.47	0.85 (2, 97)	.43
Tooth #11									
CEJ-BC	1.60 ± 0.58	1.88 ± 0.69	0.28 (0.03 to 0.53)	.03‡	1.13 ± 0.35	1.70 ± 0.63	1.98 ± 0.68	2.92 (2, 97)	.06
LBT-1	0.77 ± 0.27	0.70 ± 0.27	−0.07 (−0.18 to 0.04)	.21	0.75 ± 0.24	0.75 ± 0.28	0.72 ± 0.25	0.07 (2, 97)	.93
LBT-3	0.94 ± 0.41	0.94 ± 0.38	0.004 (−0.16 to 0.16)	.96	0.78 ± 0.32	0.95 ± 0.41	0.92 ± 0.34	0.36 (2, 97)	.7
LBT-5	0.74 ± 0.38	0.85 ± 0.37	0.11 (−0.04 to 0.26)	.16	0.63 ± 0.26	0.80 ± 0.39	0.75 ± 0.35	0.43 (2, 97)	.65
Tooth #21									
CEJ-BC	1.73 ± 0.64	2.09 ± 0.72	0.36 (0.09 to 0.63)	.009‡	1.46 ± 0.39	1.81 ± 0.67	2.44 ± 0.62	6.00 (2, 97)	.003‡
LBT-1	0.82 ± 0.28	0.71 ± 0.28	−0.10 (−0.22 to 0.009)	.07	0.80 ± 0.27	0.77 ± 0.30	0.78 ± 0.20	0.02 (2, 97)	.98
LBT-3	0.93 ± 0.44	0.87 ± 0.31	−0.05 (−0.21 to 0.10)	.52	0.70 ± 0.86	0.90 ± 0.40	0.96 ± 0.35	0.73 (2, 97)	.49
LBT-5	0.76 ± 0.41	0.78 ± 0.32	0.02 (−0.13 to 0.17)	.81	0.60 ± 0.13	0.77 ± 0.39	0.80 ± 0.31	0.47 (2, 97)	.63
Tooth #22									
CEJ-BC	1.78 ± 0.63	2.09 ± 0.72	0.31 (0.05 to 0.58)	.02‡	1.59 ± 0.50	1.87 ± 0.70	2.31 ± 0.47	2.92 (2, 97)	.06
LBT-1	0.82 ± 0.30	0.81 ± 0.27	−0.01 (−0.12 to 0.11)	.87	0.91 ± 0.20	0.83 ± 0.29	0.73 ± 0.24	0.88 (2, 97)	.42
LBT-3	1.06 ± 0.54	1.08 ± 0.49	0.03 (−0.18 to 0.23)	.81	0.87 ± 0.43	1.09 ± 0.53	1.00 ± 0.45	0.44 (2, 97)	.65
LBT-5	0.80 ± 0.56	0.78 ± 0.38	−0.02 (−0.21 to 0.18)	.86	0.66 ± 0.52	0.80 ± 0.49	0.79 ± 0.48	0.15 (2, 97)	.86
Tooth #23									
CEJ-BC	1.72 ± 0.70	2.04 ± 0.76	0.32 (0.03 to 0.61)	.03‡	1.00 ± 0.41	1.82 ± 0.73	2.36 ± 0.59	6.53 (2, 97)	.02‡
LBT-1	0.85 ± 0.38	0.82 ± 0.44	−0.03 (−0.20 to 0.13)	.69	0.93 ± 0.31	0.87 ± 0.42	0.60 ± 0.21	2.73 (2, 97)	.07
LBT-3	1.07 ± 0.56	1.05 ± 0.49	−0.02 (−0.23 to 0.19)	.86	1.06 ± 0.48	1.10 ± 0.56	0.82 ± 0.17	1.60 (2, 97)	.21
LBT-5	0.86 ± 0.55	0.88 ± 0.44	0.02 (−0.18 to 0.22)	.86	0.85 ± 0.34	0.89 ± 0.54	0.68 ± 0.24	1.03 (2, 97)	.36

CI, confidence interval; CEJ, cementoenamel junction; BC, bone crest; LBT-1, labial bone thickness at 1 mm from coronal alveolar crest; LBT-3, labial bone thickness at 3 mm from coronal alveolar crest; LBT-5, labial bone thickness at 5 mm from coronal alveolar crest.

* Independent *t* test.
† Analysis of variance.
‡ Statistically significant ($P < .05$).

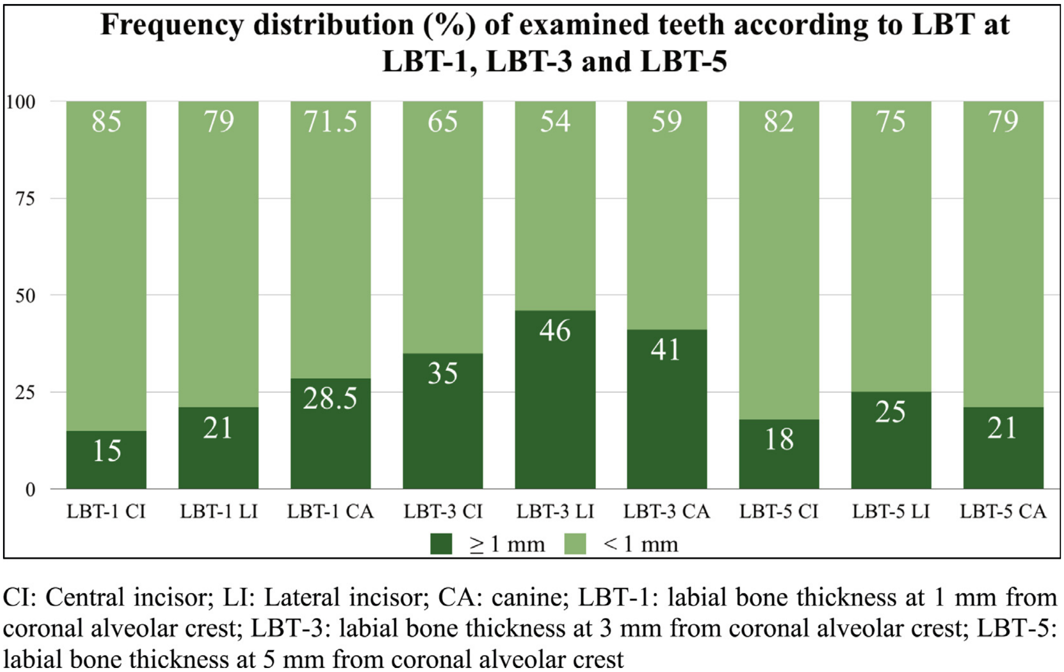

Fig. 2 – Frequency distribution according to labial bone thickness (LBT) at LBT-1, LBT-3, and LBT-5.

CI, central incisor; LI, lateral incisor; CA, canine; LBT-1, labial bone thickness at 1 mm from coronal alveolar crest; LBT-3, labial bone thickness at 3 mm from coronal alveolar crest; LBT-5, labial bone thickness at 5 mm from coronal alveolar crest.

Discussion

The present retrospective study assessed the LBT of the maxillary anterior teeth and CEJ-BC distance in an Emirati population. It is a routine standard of care to evaluate the morphology and bone volume prior to tooth extraction using CBCT to ensure adequate knowledge for future implant placement. This study depicted a statistically significant higher CEJ-BC values with increased age (>50 years) and male participants. These main findings are in accordance with other studies and recent systematic reviews that evaluated CEJ-BC and LBT for maxillary anterior teeth[14,15,18-20] indicating minimal differences between Emirati population and other ethnic groups. The high CEJ-BC values in men were also in agreement with other studies.[15,21] Conversely, one study contradicted this sex-related link whilst evaluating CEJ-BC.[22] The potential influence of an increased CEJ-BC distance on implant placement could result in deep implant placement with subsequent need for long transgingival components connecting the implants to the final prostheses. One other significant trend was increasing CEJ-BC distance with age, particularly for individuals 50 years of age or older. This observation is also consistent with other studies where a correlation between the CEJ-BC distance and age of participants was reflected.[8,15,18,20,22,23] This increase in CEJ-BC was believed to be a result of physiologic bone remodeling associated with aging.[24-28] The correlation between CEJ-BC distance and age, however, has not been substantiated in other studies.[14,29]

Our findings are consistent with those reported in the majority of studies where LBT values of <1 mm in the maxillary anterior region were observed.[8,14,18,30] This phenomenon was further corroborated in a study assessing LBT clinically following tooth extraction.[31] The study showed that more than 80% of sites had an LBT of <1 mm. Moreover, an increased rate of postextraction bone resorption has been associated with 71% of sites with thin labial bone.[32] Other studies[13,23,33,34] showed a similar pattern, with 76% to 89% of sites having an LBT of <1 mm at the maxillary central incisor region—similar to the findings of the present study where 85% of the assessed central incisors had an LBT of <1 mm. This observation reinforces our knowledge regarding anterior maxillary sites exhibiting <1 mm of LBT.

Implant placement in the anterior maxillary region can be aesthetically challenging, and the timing of implant placement can be highly influenced by the LBT in the region. A majority of studies have reached a consistent conclusion that immediate implant placement with LBTs <1 mm are associated with progressive loss of buccal plate as well as gingival recession post–implant restoration.[35-37] Hence, it would be prudent to alternatively consider early implant placement or alveolar ridge preservation (ARP) followed by delayed implant placement rather than immediate implant placement when LBT is <1 mm. Even when ARP is considered, baseline LBT of 0.6 mm (<1 mm) is associated with at least 10% loss of bone volume at the time of remodeling.[38]

A further in-depth analysis of our findings demonstrated a trend towards the presence of an increasing thickness at LBT-3 when compared to LBT-1 and -5. Published data have reported a similar trend of increasing thickness at a 3-mm level apical to the alveolar crest.[8,21] The different buccal bone thicknesses around single teeth at various apico-coronal

Table 3 – Characteristics of patients with LBT-1 ≥1 mm.

Tooth #13	N (%) LBT-1 ≥1 mm	N (%) LBT-1 <1 mm	LBT-1 <1 mm relative risk (95% CI)[*]	P value[†]
Sex				
Female	17 (29.3)	41 (70.7)	1.01 (0.79-1.30)	.94
Male	12 (28.6)	30 (71.4)		
Age (y)		3 (75.0)		
<25	1 (25.0)	57 (68.7)	NA	.49
25-50	26 (31.3)	11 (84.6)		
>50	2 (15.4)			
Tooth #12	**N (%) LBT-1 ≥1 mm**	**N (%) LBT-1 <1 mm**	**LBT-1 <1 mm relative risk (95% CI)[*]**	**P value[†]**
Sex				
Female	14 (24.1)	44 (75.9)	1.13 (0.93-1.37)	.22
Male	6 (14.3)	36 (85.7)		
Age (y)				
<25	2 (50.0)	2 (50.0)	NA	.17
25-50	17 (20.5)	66 (79.5)		
>50	1 (7.7)	12 (92.3)		
Tooth #11	**N (%) LBT-1 ≥1 mm**	**N (%) LBT-1 <1 mm**	**LBT-1 <1 mm relative risk (95% CI)[*]**	**P value[†]**
Sex				
Female	11 (19.0)	47 (81.0)	1.09 (0.92-1.29)	.34
Male	5 (11.9)	37 (88.1)		
Age (y)				
<25	1 (25.0)	3 (75.0)	NA	.88
25-50	13 (15.7)	70 (84.3)		
>50	2 (15.4)	11 (84.6)		
Tooth #21	**N (%) LBT-1 ≥1 mm**	**N (%) LBT-1 <1 mm**	**LBT-1 <1 mm relative risk (95% CI)[*]**	**P value[†]**
Sex				
Female	7 (12.1)	51 (87.9)	0.95 (0.80-1.12)	.51
Male	7 (16.7)	35 (83.3)		
Age (y)				
<25	1 (25.0)	3 (75.0)	NA	.79
25-50	11 (13.3)	72 (86.7)		
>50	2 (15.4)	11 (84.6)		
Tooth #22	**N (%) LBT-1 ≥1 mm**	**N (%) LBT-1 <1 mm**	**LBT-1 <1 mm relative risk (95% CI)[*]**	**P value[†]**
Sex				
Female	14 (24.1)	44 (75.9)	1.07 (0.87-1.31)	.54
Male	8 (19.0)	34 (81.0)		
Age (y)				
<25	1 (25.0)	3 (75.0)	NA	.39
25-50	19 (22.9)	64 (77.1)		
>50	2 (15.4)	11 (84.6)		
Tooth #23	**N (%) LBT-1 ≥1 mm**	**N (%) LBT-1 <1 mm**	**LBT-1 <1 mm relative risk (95% CI)[*]**	**P value[†]**
Sex				
Female	18 (31.0)	40 (69.0)	1.11 (0.87-1.41)	.43
Male	10 (23.8)	32 (76.2)		
Age (y)				
<25	2 (50.0)	2 (50.0)		
25-50	25 (30.1)	58 (69.9)		
>50	1 (7.7)	12 (92.3)	NA	.15

LBT-1, labial bone thickness at 1 mm from coronal alveolar crest; CI, confidence interval; NA, not applicable.

* Computed only for 2 × 2 tables.
† Chi-square test: statistically significant ($P < .05$).

levels can influence postextraction morphologic changes to the bone volume. A study also hypothesised a clinical relevance of this increasing thickness at the 3-mm level by placing implants deep enough to engage the thicker bone apically.[21] Furthermore, more frequent sites with <1 mm were measured at LBT-5, suggesting a possibility for fenestration type defects at the time of implant placement. The minimum LBT at these levels would actually determine the bucco-palatal position of the implant where a more palatal positioning of the implant placement has been suggested.[39] Nonetheless, several studies using the same methodology found minimal variation of LBT measurements at multiple levels.[14,18,40,41] The authors suggested that these disparities could be attributed to the different traits of patients included in these studies as well as the variations in the sample sizes.

In our analysis, sex did not appear to have an impact on the LBT. This seems to be consistent with the findings of other published studies.[18,21,41] Contradicting findings of sex's influence on LBT were also reported where an increased thickness in men was observed in one study,[15] whilst other studies showed higher LBT in lateral incisors in the apical thirds for men compared to higher LBT at the alveolar crest of central incisors in women.[22]

Age did not seem to influence the LBT in our investigation, which is in agreement with the study of Januario et al.[14] However, in several other studies, low values of LBT were associated with increasing age.[13,15,18,20,23,34] This could be related to high prevalence of chronic inflammatory periodontal diseases affecting the supporting structures of the dentition of older patients.[15] Placement of dental implants in treated periodontitis with reduced periodontium may encounter reduced crestal bone levels supporting the teeth and could be considered as a potential aesthetic risk at the time of implant placement in older patients.[34] With the knowledge that only 11 participants in the ≥50 age group were included, our findings in this context must be interpreted with caution. This study also attempts to address the proposition whether geographic location of a population is indeed an "effect modifier" by evaluating variations in LBT and CEJ-BC of maxillary anterior teeth in a unique population with Arab ethnicity. The recent systematic review, which critically analysed data from various populations, observed heterogeneity in the outcomes whilst comparing Asian to European populations.[19]

The present study has several limitations that need to be acknowledged. There was a lack of information on patients' medical and dental history, including systemic conditions or orthodontic treatment that might have influenced the LBT and CEJ-BC distances. Additionally, the study's generalisability is limited due to the small sample size and retrospective design. The study does not consider the overlying gingival biotype, periodontal health status involving these maxillary anterior teeth – that have shown to have the highest influence on the underlying LBT levels in other studies.[19] Furthermore, CBCT scans of labial bone demonstrate a tendency towards overestimation of bone thickness, especially in sites with LBT <1 mm.[42] Finally, image resolution of a CBCT scan can be adversely affected by variations in field of view and voxel size which, in turn, can impact the evaluator's ability to read the scans accurately.[43] However, a voxel size of 0.15 mm produced by a CBCT scanner at the centre aided in minimising these measurement errors.

Conclusions

Within the limitations of this study, CEJ-BC distance is greater in men and increases with age, particularly in those aged 50 years and older. The LBT in maxillary anterior teeth is predominantly thin (<1 mm) and has no correlation to age or sex. There is a trend of increasing thickness at LBT-3 and decreasing thickness at LBT-5. Therefore, immediate implant placement should consider these anatomic variations and be performed judiciously after thorough treatment planning.

Clinical relevance

Scientific rationale for the study

The morphologic variations observed in LBT around maxillary anterior teeth can affect the 3-dimensional placement of dental implants and its long-term outcomes; making it imperative for clinicians to thoroughly examine the LBT prior to tooth extraction.

Principal findings

The distance of CEJ-BC increased, particularly, in men and with increasing age (>50 years). Generally, the LBT was observed to be predominantly thin (<1 mm) in the maxillary anterior region.

Practical implication

It is crucial to evaluate morphologic variations in the LBT using CBCT prior to surgical placement of dental implants to comprehend the need for additional hard and soft tissue augmentation procedures.

Conflict of interest

None disclosed.

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Supplementary materials

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