Original Article

Repeatability and Reproducibility of a Modified Lekholm and Zarb Bone Quality Classification Based on Cone Beam Computed Tomography

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Abstract

Aim: We propose a modified Lekholm and Zarb classification that considers all possible combinations of cortical and cancellous bone to provide parameters that favor greater repeatability and reproducibility. **Materials and Methods:** This observational and analytical study consisted of a sample of 50 cone beam computed tomography (CBCT) scans. Two new types (V and VI), three subtypes to type II (II-A, II-B, and II-C), and two subtypes to type III (III-A and III-B) were added to the original bone quality classification. The new types refer to regenerated bone (type V) and bone with some pathology (type VI). The subtypes are described as type II-A: thick cortical surrounding the abundant cancellous bone with sharp trabeculae throughout the image and presence of small and visible medullary spaces; type II-B: thick cortical surrounding the abundant cancellous bone with predominance of diffuse trabeculae in the basal bone and predominant presence of wide and visible medullary spaces; type II-C: thick cortical surrounding the abundant cancellous bone with predominance of very thick and sharp trabeculae in the basal third as well as presence of small and visible medullary spaces; type III-A: thin cortical surrounding the abundant cancellous bone with sharp trabeculae throughout the image and presence of small and visible medullary spaces; type III-B: thin cortical surrounding the abundant cancellous bone with predominance of diffuse trabeculae and presence of diffuse medullary spaces. Five dental specialists were trained in the use of the modified classification and were provided with CBCT-sectioned images of edentulous jaws for classification. Each specialist classified the images twice at a 7-day interval. The strength of intra-examiner and inter-examiner agreement was measured with Cohen's and Fleiss' kappa index, respectively. In addition, the agreement between both classifications was analyzed. All data were analyzed at a 95% confidence level, considering a P-value <0.05. **Results:** According to the modified Lekholm and Zarb classification, an almost perfect intra-examiner agreement was significant ($P < 0.05$) in all five specialists, with the kappa index [k] ranging from 0.91 [95% confidence interval (CI): 0.82–0.99) to 0.95 (95% CI: 0.89–1.00). Furthermore, substantial inter-examiner concordance (k=0.76; 95% CI: 0.73–0.79) was significant ($P < 0.05$). **Conclusion:** The high repeatability and reproducibility of the modified Lekholm and Zarb classification on CBCT suggest

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Access this article online	
Quick Response Code:	**Website:** www.jispcd.org
	DOI: 10.4103/jispcd.JISPCD_291_21

How to cite this article: Rosas-Díaz JC, Córdova-Limaylla NE, Palomino-Zorrilla JJ, Guerrero ME, Carreteros R, Cervantes-Ganoza LA, *et al.* Repeatability and reproducibility of a modified Lekholm and Zarb bone quality classification based on cone beam computed tomography. J Int Soc Prevent Communit Dent 0;0:0.

its applicability to distinguish between the various combinations of cortical and cancellous bone and help to define treatment appropriately to optimize results.

Received : 11-10-21
Revised : 15-11-21
Accepted : 03-12-21
Published : 11-07-22

Keywords: *Bone quality, Cohen's kappa index, concordance, cone beam computed tomography, Fleiss' kappa index, Lekholm and Zarb classification, repeatability, reproducibility*

Introduction

In dental implant treatment, the bone tissue must be evaluated in order to properly diagnose and predict success or failure. Early and long-term success depends considerably on the quantity and quality of alveolar bone, as poor alveolar bone quantity and quality could be considered a risk factor for biological complications, associated with lack of primary stability and impaired healing/osseointegration, which can lead to early implant loss.[1-4]

Bone quality refers to the quantity and topographic relationship of cortical and cancellous bone, involving characteristics such as mineral density, thickness, trabecular microarchitecture, bone metabolism, cells, intercellular matrix, vascularization, among other factors.[5,6] Bone density is one of the parameters of bone quality, being a key factor for the initial stability of the implant and for its success, varying according to gender, age, jaw site, and the patient's systemic condition.[1,5,6]

Bone quality is believed to be one of the most important etiological factors in predicting early implant failure. To achieve this purpose, it is common to use the Lekholm and Zarb classification that allows evaluating bone quality in cone beam computed tomography (CBCT) scans in four types: type I, compact or cortical bone completely homogeneous; type II, thick layer of compact bone surrounding the dense trabecular bone; type III, thin layer of compact bone surrounding the dense trabecular bone; and type IV, thin layer of compact bone surrounding the dense trabecular bone with poor density.[7,8] In this regard, it has been reported that, on average, the survival rate of dental implants placed in the jaws with bone types I, II, III, and IV was 97.6%, 96.2%, 96.5%, and 88.8%, respectively.[9] In addition, it has been reported in some clinical studies that implants placed in the mandible had higher survival rates compared with those placed in the maxilla, especially in the posterior zone.[1,4,9-11]

Generally, jaw bone condition is determined by measuring cancellous bone density and cortical or compact bone thickness. Additionally, it is known that cancellous bone density is highest in the anterior mandibular region followed by the anterior maxillary region, posterior mandibular region, and posterior maxillary region.[1] In contrast, it has been reported that cortical bone tends to be thickest in the posterior mandibular region, followed by the anterior mandibular region, anterior maxillary region, and finally the posterior maxillary region.[12]

It is very important to determine the bone quality of the jaws during treatment planning, as it is crucial to diagnose and recognize the condition of the bone site before implant placement in order to make decisions based on the information obtained and properly define the treatment to optimize results.[1,8-11] In this sense, CBCT is considered one of the best radiographic methods for the morphological and qualitative analysis of residual bone, as it allows the identification of anatomical boundaries, evaluation of bone morphology, volume, and quality,[13] as well as being a valuable verification tool to assess the distribution of cortical and cancellous bone in the jaws.[1,4] Therefore, the usefulness of CBCT during preoperative planning phase is based on the need to evaluate the patient's specific anatomy in detail, the requirement for more advanced surgical techniques such as grafting, zygomatic implants, among others. If this preliminary analysis concludes that the conditions are appropriate for implant placement, the patient can be scheduled immediately.[4]

Classification systems for the planning and placement of dental implants are necessary to provide an orderly, applicable, and scientific scheme for diagnostic purposes. The Lekholm and Zarb classification is used to evaluate bone quality and is the most referenced and widely used.[1,3,5,8,14-16]

Due to the subjectivity, lack of precision, and low inter-examiner agreement of the bone quality classification proposed by Lekholm and Zarb in 1985, some modifications have been proposed to improve the assessment of bone quality, taking into account all possible combinations of cortical and cancellous bone to provide guidelines for increasing the reproducibility of the classification.[8,17] However, these proposals have not yet included important characteristics such as number and visibility of bone trabeculae and size of the medullary spaces, which are of vital importance for identifying bone density and morphometric parameters of trabecular bone. Furthermore, in order to reduce the subjectivity when analyzing bone density on CBCT under the Lekholm and Zarb classification, it is practical to add and redefine the bone types considered by this classification.

Therefore, the purpose of this study was to propose a modified Lekholm and Zarb classification that takes into consideration all possible combinations of cortical and cancellous bone, in order to provide parameters that favor greater repeatability and reproducibility of the classification in CBCT.

Materials and Methods

Type of study

An observational, retrospective, and analytical study was conducted.

Population and sample selection

The total population was 154 CBCTs taken at the CEDIMAX® Maxillofacial Diagnostic Center in Lima, Peru, during the months of February to October 2020. The sample size consisted of 50 CBCT scans and was calculated using a formula for frequency estimation with known sampling frame (n = 154), considering P = 0.95 and 0.05 error. The sampling technique was simple random without replacement, and the sample was selected by a radiology specialist who did not participate in the calibration. The selection criteria were as follows.

Inclusion criteria

1. CBCT scans of patients who signed an informed consent form in order to process their data for research purposes.
2. CBCT scans of patients from the same geographic area.
3. CBCT scans of edentulous maxillary or mandibular bone.

Exclusion criteria

1. CBCT scans of patients with signs of asymmetries and/or marked craniofacial alterations.
2. CBCT scans of patients with signs of traumatic sequelae in the maxillary or mandibular region analyzed.

Lekholm and zarb classification

This classification takes into account bone quality according to the amount of cortical (compact) and trabecular (cancellous) bone evaluated tomographically as follows [Figure 1]:

- Type I: completely homogeneous compact bone.
- Type II: thick layer of compact bone surrounding the dense trabecular bone.
- Type III: thin layer of compact bone surrounding the dense trabecular bone.
- Type IV: thin layer of compact bone surrounding the low-density trabecular bone.

Modified lekholm and zarb classification

This proposal is based on the evaluation of bone quality in relation to the thickness of the bone cortical layer, the number of visible trabeculae, and the size of the medullary spaces in the cancellous bone [Figure 2]:

- Type I: Predominant cortical bone surrounding sparse cancellous bone with sharp trabeculae throughout the image and presence of small and visible medullary spaces.
- Type II-A: Thick cortical bone surrounding abundant cancellous bone with sharp trabeculae throughout the image and presence of small and visible medullary spaces.
- Type II-B: Thick cortical bone surrounding abundant cancellous bone with predominance of diffuse trabeculae in the basal bone and predominant presence of wide and visible medullary spaces.
- Type II-C: Thick cortical bone surrounding abundant cancellous bone with predominance of

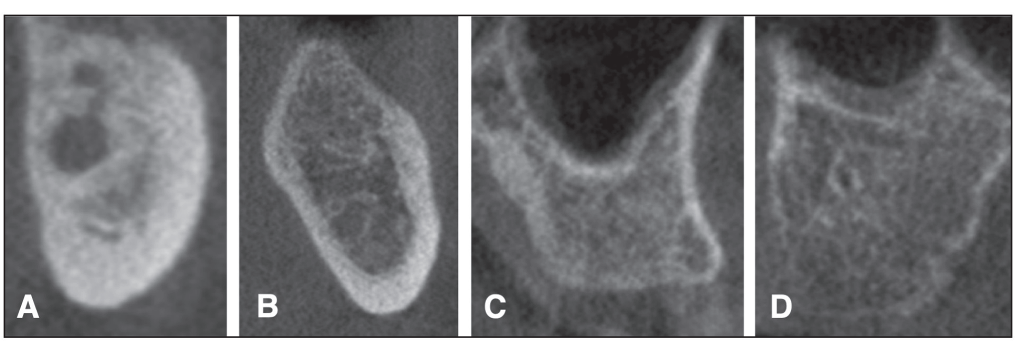

Figure 1: Bone quality according to the original Lekholm and Zarb classification, (A): Type I, (B): Type II, (C): Type III, (D): Type IV

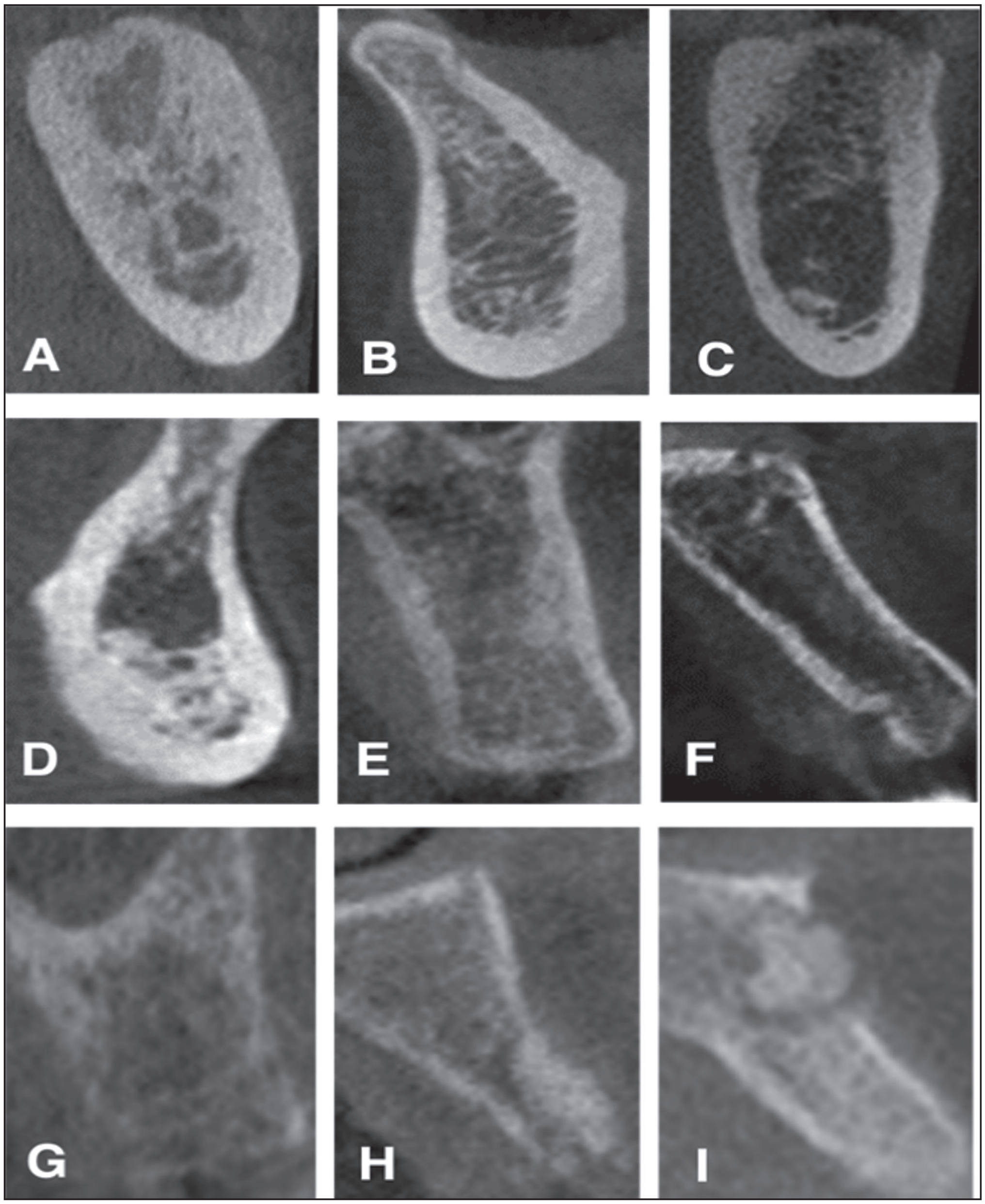

Figure 2: Bone quality according to the modified Lekholm and Zarb classification, (A): Type I, (B): Type II-A, (C): Type II-B, (D): Type II-C, (E): Type III-A, (F): Type III-B, (G): Type IV, (H): Type V, (I): Type VI

very thick and sharp trabeculae in the basal bone, with presence of small and visible medullary spaces.

- Type III-A: Thin cortical bone surrounding abundant cancellous bone with sharp trabeculae throughout the image and presence of small and visible medullary spaces.
- Type III-B: Thin cortical bone surrounding abundant cancellous bone with predominance of diffuse trabeculae and presence of diffuse medullary spaces.
- Type IV: Diffuse cortical bone surrounding abundant cancellous bone with predominance of diffuse trabeculae and presence of diffuse medullary spaces.
- Type V: regenerated bone; trabeculae and medullary spaces with variable visibility and quantity.
- Type VI: bone with pathology; trabeculae and medullary spaces with variable visibility and quantity.

Procedure

Four dental specialists in radiology and implantology (two with more than 20 years of experience in radiology and the other two with more than 15 years of experience in implantology) participated in the development of the new (modified) proposal by Lekholm and Zarb. Once the new classification was defined, it was evaluated qualitatively by a panel of three expert blinded dental specialists in radiology, external to the present investigation, with more than 10 years of experience. These experts evaluated the modified Lekholm and Zarb classification modification, according to the criteria of clarity, objectivity, timeliness, organization, sufficiency, intentionality, consistency, coherence, and methodology, using an ordinal scale, whose final values were: poor (0–0.20), fair (0.21–0.40), good (0.41–0.60), very good (0.61–0.80), and excellent (0.81–1.00). At the end of the evaluations, an average of excellent acceptance was obtained (Aiken's $V = 0.93$).

Subsequently, five investigators, previously trained in the new proposed classification, participated in the intra-examiner and inter-examiner calibration by analyzing 50 CBCT scans that a sixth investigator (who did not participate in the calibration) randomly shared with them in real time on the Microsoft Teams® virtual platform at two different times with an interval of 7 days. At each time point, the five investigators individually diagnosed bone quality according to the two classifications: original Lekholm and Zarb and the proposed modification. It should be noted that none of the 50 CBCT scans was used to elaborate the proposed classification.

All data were stored by the sixth researcher who coded the names of the participants and tabulated their results. The researcher then handed the data to a statistician in a single-blinded way for analysis of the results.

All CBCT scans were taken with the same Sirona XG 5 model, Galaxis® Software, Berlin, Germany.

Table 1: Assessment of the kappa index

Kappa index	Concordance strength
0.00	Poor
0.01–0.20	Slight
0.21–0.40	Fair
0.41–0.60	Moderate
0.61–0.80	Substantial
0.81–1.00	Almost perfect

Statistical analysis of repeatability and reproducibility

Data were stored in an Excel 2019 spreadsheet (Microsoft, Redmond, WA, USA) and subsequently imported into the statistical package SPSS (Statistical Package for the Social Sciences Inc., IBM, NY, USA) 24.0. For the analysis of intra-examiner agreement (repeatability), as well as to evaluate agreement between instruments, Cohen's kappa index was applied, considering the ordinal scale used most frequently to qualitatively express the strength of agreement (kappa), ranging from poor to almost perfect according to Landis and Koch[18,19] [Table 1]. This scale was also used to analyze the strength of inter-examiner agreement (reproducibility) according to the Fleiss kappa index [Table 1]. For all statistical analysis, a P-value< 0.05 was considered significant.

Bioethical considerations

This research respected the bioethical principles of medical research of the Declaration of Helsinki,[20] related to confidentiality and nonmaleficence. In addition, it was exempted from review by an Institutional Research Ethics Committee (No.56–2020–DFE-UIGV), as the study was performed on secondary data obtained from CBCT scans, which did not pose any risk to human life.

Results

According to the analysis of the intra-examiner observation of five specialists, in the classification proposed by Lekholm and Zarb, an almost perfect concordance could be appreciated significantly ($P < 0.05$) in each of them, being the minimum and maximum values of Cohen's kappa index 0.87 (CI: 0.75–0.99) and 0.94 (0.87–1.00), respectively [Table 2].

According to the analysis of the intra-examiner observation of the five specialists, in the proposed classification (modified Lekholm and Zarb), an almost perfect concordance could be appreciated significantly ($P< 0.05$) in each one of them, being the minimum and maximum values of Cohen's kappa index, 0.91 (CI: 0.82–0.99) and 0.95 (0.89–1.00), respectively [Table 3].

Table 2: Intra-examiner concordance, according to the original Lekholm and Zarb classification

Examiners	CBCT	*k*	SE	95% CI		*P*-value
				LL	UL	
Examiner 1	50	0.92	0.05	0.83	1.00	0.000
Examiner 2	50	0.87	0.06	0.75	0.99	0.000
Examiner 3	50	0.94	0.04	0.87	1.00	0.000
Examiner 4	50	0.88	0.06	0.76	0.99	0.000
Examiner 5	50	0.94	0.04	0.87	1.00	0.000

CBCT = cone beam computed tomography; k = Cohen's kappa index; SE = standard error; 95% CI = 95% confidence interval; LL = lower limit; UL = upper limit; *χ^2, P-value< 0.05 (significant association)

Table 3: Intra-examiner concordance, according to the modified Lekholm and Zarb classification

Examiners	CBCT	*k*	SE	95% CI		**P*-value
				LL	UL	
Examiner 1	50	0.93	0.04	0.86	1.00	0.000
Examiner 2	50	0.91	0.04	0.82	0.99	0.000
Examiner 3	50	0.95	0.03	0.89	1.00	0.000
Examiner 4	50	0.93	0.04	0.85	1.00	0.000
Examiner 5	50	0.95	0.03	0.89	1.00	0.000

CBCT = cone beam computed tomography; *k* = Cohen's kappa index; SE = standard error; 95% CI = 95% confidence interval; LL = lower limit; UL = upper limit; *χ^2, *P*-value< 0.05 (significant association)

Table 4: Inter-examiner concordance, according to the original Lekholm and Zarb classification

Lekholm and Zarb	*n*	*k*	SE	95% CI		**P*-value
				LL	UL	
I	22	0.58	0.04	0.49	0.66	0.000
II	81	0.58	0.04	0.49	0.67	0.000
III	99	0.46	0.04	0.38	0.55	0.000
IV	48	0.47	0.04	0.38	0.56	0.000
Total	250	0.52	0.03	0.46	0.57	0.000

n = number of concordances; *k* = Fleiss kappa index; SE = standard error; LL = lower limit; UL = upper limit; 95% CI = 95% confidence interval; *χ^2, *P*-value< 0.05 (significant association)

Table 5: Inter-examiner concordance, according to the modified Lekholm and Zarb classification

Modified Lekholm and Zarb	*n*	*k*	SE	95% CI		**P*-value
				LL	UL	
I	13	0.72	0.04	0.63	0.80	0.000
II-A	40	0.79	0.04	0.70	0.88	0.000
II-B	30	0.85	0.04	0.76	0.94	0.000
II-C	17	0.87	0.04	0.79	0.96	0.000
III-A	42	0.74	0.04	0.65	0.83	0.000
III-B	30	0.64	0.04	0.55	0.73	0.000
IV	25	0.64	0.04	0.56	0.73	0.000
V	26	0.79	0.04	0.70	0.87	0.000
VI	27	0.79	0.04	0.70	0.88	0.000
Total	250	0.76	0.02	0.73	0.79	0.000

n = number of concordances; *k* = Fleiss kappa index; SE = standard error; LL = lower limit; UL = upper limit; 95% CI: 95% confidence interval; *χ^2, *P*-value<0.05 (significant association)

According to the analysis of the inter-examiner observation of five specialists in the classification I, II, III, and IV proposed by Lekholm and Zarb, a moderate concordance could be appreciated significantly ($P < 0.05$), being the minimum and maximum values of the Fleiss kappa index equal to 0.46 (CI: 0.38–0.55) and 0.58 (CI: 0.49–0.67), respectively. Overall, the classification proposed by Lekholm and Zarb presented a moderate concordance [*k*=0.52 (CI: 0.73–0.79)] significantly ($P < 0.05$) [Table 4].

According to the analysis of the inter-examiner observation of five specialists for the proposed classification I, II-A, III-A, III-A, III-B, IV, V, and VI (Lekholm and Zarb modified), a substantial concordance could be appreciated in a significant way ($P < 0.05$), being the minimum and maximum values of the Fleiss kappa index equal to 0.64 (CI: 0.55–0.73) and 0.79 (CI: 0.70–0.88), respectively. Furthermore, for the II-B and II-C classification, an almost perfect concordance was obtained significantly ($P < 0.05$), the Fleiss kappa index being equal to 0.85 (CI: 0.76–0.94) and 0.87 (CI: 0.79–0.96), respectively. Overall, the proposed modified Lekholm and Zarb classification presented substantial concordance [*k*=0.76 (CI: 0.73–0.79)] significantly ($P < 0.05$) [Table 5].

Discussion

In the present study, according to the proposed classification (Lekholm and Zarb modified), almost perfect and substantial concordance was found in the intra- and inter-examiner observation, respectively. In addition, fair agreement was obtained for the diagnosis of maxillary bones with favorable or unfavorable prognosis for implant stability.

The most commonly used clinical method for evaluating trabecular bone is based on the subjective assessment of inter-trabecular spaces (small to large) and the degree of trabeculation (sparse to dense).[21,22] In implant dentistry, it has been shown that morphometric parameters of trabecular bone are associated with implant stability, indicating their importance for the assessment of bone quality.[21,23]

Bone quality is important not only for the initial stability of the implant but also for its success.[5,6] For this reason, different authors have reported that it is difficult to achieve primary stability in an implant placed in poor quality bone, whereas treatment success has been achieved when the implants were placed in good quality bone.[1-4] To achieve successful osseointegration, it is essential to recognize the type of bone quality on which the implant is being placed; in this sense, according to Lekholm and Zarb, bone quality has been classified into four types: type I, considered the least vascular and most homogeneous; type II, with a thick cortical surrounding a dense trabecular bone; type III, predominantly composed of trabecular bone; and type IV, with a very thin cortical and trabeculae of low density, and generally considered as a bone that cannot support an implant.[24] Clinical studies have demonstrated a high percentage of osseointegration failure in sites with low bone density.[2,5,9] However, other studies have reported a lower survival rate in type I bone quality compared with type II bone quality, possibly as a result of low trabecular bone content leading to inadequate blood supply in the former.[1,25] This was concordant with that reported in the study by Chrcanovic *et al.*,[1] who evaluated the bone sites of different bone qualities according to the Lekholm and Zarb classification and found that the failure rates of the implants were higher in bone quality type I compared with types II and III, and likewise the failures were higher in bone quality type IV compared with types I, II, and III.

In an attempt to improve the reproducibility of the original Lekholm and Zarb classification, it has been proposed to add subclasses to it, in order to take into consideration all possible combinations of cortical and trabecular bone.[8,17] Therefore, Al-Ekrish *et al.*[8] added three subclasses to the original classification in bone quality types II and III, in which they considered type II-B as a thick layer of compact bone surrounding a medium density trabecular bone core, type II-C as a thick layer of compact bone surrounding a low density trabecular bone core, and type III-B as a thin layer of compact bone surrounding a medium density trabecular bone core. However, in this classification proposal, characteristics that are important to analyze, such as the following, were not considered: quantity, visibility of trabeculae, and size of medullary spaces. These would indicate bone density and morphometric parameters of trabecular bone. In addition, poor bone quality at the probable site for implant placement is known to be a risk factor for implant failure, as mentioned earlier.[1,4,8-11] Considering that the combination of bone density and trabecular architecture parameters can predict implant stability with greater confidence, it is important to consider them in clinical diagnosis.[23]

Because of the above, the proposed modified Lekholm and Zarb classification given in this study incorporates three subtypes of bone quality type II (II-A, II-B, and II-C) and two subtypes of bone quality type III (III-A and III-B) in the original classification, taking into consideration the thickness of the cortical bone and the characteristics of the trabecular bone. This proposal took into account the study by Nicolielo *et al.*,[21] who separated trabecular bone into three bone types: sparse, related to bone with large medullar spaces containing few trabeculae; intermediate, related to bone with medium-to-large trabecular spaces; and dense, related to a massive bone area with little space between trabeculae. They also concluded that intermediate bone types seem to be more favorable for implant survival, as opposed to very dense or very sparse ones. In contrast, a type V bone quality was also added to the original classification, taking into consideration the regenerated bone, as bone augmentation is frequently performed to improve the esthetic result and the contours of the alveolar ridge, allowing a better anchorage of dental implants. This is in agreement with what was reported by Karl *et al.*,[26] as they found a series of favorable factors in the mechanical properties of regenerated bone, determinant for primary stability. Finally, type VI bone quality was added to the original classification, as it represents bone with some pathology, which should be taken into consideration during treatment planning. In this sense, the type VI proposed is important for refining the diagnosis, in order to establish the feasibility of implant placement in bone sites with some pathology, always under appropriate surgical protocols, or to establish the need for pretreatment and therefore postpone treatment. However, several scenarios can be presented in this regard, such as immediate implant placement in periapically infected extraction sockets, which may be feasible after thorough debridement and use of appropriate surgical protocols.[27,28] It has also been reported that immediate dental implant placement is possible after removal of a complex odontoma, as this is a non-contaminated pathology.[29] In contrast, in malignant tumors of the craniofacial region, the treatment protocol with radiotherapy together with surgical excision is generally recommended, as it has been reported that the success rate of dental implant placement in irradiated bone is 70%, highlighting that hyperbaric oxygen therapy in irradiated patients prior to implant treatment increases the success rate.[30] Therefore, due to the possible pathologies that may be present in maxillary bones, and given the importance of their approach to establish a suitable treatment plan, it was considered useful to include this bone type VI in the proposed classification.

In the present investigation, intra-examiner and inter-examiner evaluations were performed in order to obtain more accurate results about the repeatability and reproducibility of the proposed classification, unlike Al-Ekrish *et al.*[8] who performed only an intra-examiner evaluation of their proposal. However, it should be noted that the results of the intra-examiner analysis for both proposals were almost perfect. The high repeatability and reproducibility of the modified Lekholm and Zarb CBCT classification proposed in this study suggest its applicability to distinguish between the various combinations of cortical and cancellous bone and to decide on the correct treatment, optimizing the results.

One of the limitations of the present study was that it could not evaluate the sensitivity and specificity of the modified Lekholm and Zarb classification for predicting optimal bone quality for implant placement, because clinical information confirming the success or failure of implants placed in the bone evaluated on CBCT was not available.

It is advisable to conduct studies to investigate the association between the types of bone quality proposed and tactile sensation during osteotomies, as well as with primary stability and implant failure rate. In addition, it is suggested to evaluate the predictive ability of the proposed classification on a larger sample of CBCT, taking into consideration a sensitivity and specificity analysis. Additionally, it would be important to compare in future studies the intra-examiner and inter-examiner calibration between novice and experienced dental specialists when making CBCT readings using the modified Lekholm and Zarb classification proposed in the present research.

Conclusions

Considering the limitations of this research, it can be concluded that the high repeatability and reproducibility of the modified Lekholm and Zarb classification in CBCT suggest its applicability to distinguish between the various combinations of cortical and cancellous bone, allowing to adequately define the treatment and optimize results.

Acknowledgements

We thank the San Juan Bautista Private University, School of Stomatology, Lima, Peru, for their constant support in the preparation of this manuscript.

Financial support and sponsorship

No funding was available for this study.

Conflicts of interest

None to declare.

Authors contributions

They conceived the research idea (JCR-D), elaborated the manuscript (NEC-L, CFC-R, LAC-G), collected, tabulated the information (NEC-L, CFC-R, JJP-Z), carried out the bibliographic search (LAC-G, JCR-D, MEGA, RC), interpreted the statistical results and helped in the development from the discussion (CFC-R, JCR-D), he performed the critical revision of the manuscript (JCR-D, NEC-L, JJP-Z, MEGA, RC, LAC-G, CFC-R). All authors approved the final version of the manuscript.

Ethical policy and institutional review board statement

This research respected the bioethical principles of medical research of the Declaration of Helsinki, related to confidentiality and nonmaleficence. In addition, it was exempted from review by an Institutional Research Ethics Committee (No. 56-2020–DFE-UIGV), since the study was performed on secondary data obtained from cone-beam computed tomography scans, which did not pose any risk to human life.

Patient declaration of consent

Not applicable.

Data availability statement

The data that support the study results are available from the author (Dr. José Carlos Rosas-Díaz, e-mail: josecarlos.rosas@upsjb.edu.pe) on request.

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