**Table 3:** Implant positions (n = 20)

| Teeth | 16 | 15 | 14 | 24 | 25 | 26 |
|---|---|---|---|---|---|---|
| Implants | 4 | 4 | | 1 | 2 | 9 |

**Table 4:** Life table analysis for all implants, groups I and II

| | Implants | Failed implants | Cumulative survival rate % |
|---|---|---|---|
| All implants | | | |
| Implant placement prosthesis delivery | 20 | | 100 |
| Prosthesis delivery 6 months | 20 | | 100 |
| 6 months 1 years | 20 | | 100 |
| 1 years 3 years | 18 | | 100 |

## DISCUSSION

When inadequate subantral bone height is available and implant-supported restorations are indicated, sinus floor elevation procedures are considered. There is controversy regarding what is considered to be adequate bone height, and, thus, when sinus oor elevation is indicated.

Moreover, selection of an appropriate sinus oor elevation procedure is complex and lacks consensus in the literature. The choice is mainly based on residual vertical bone height, marginal bone width, local intra-sinus anatomy, and the number of teeth to be replaced, although other factors, such as surgical training and experience, may have an impact.[21]

It is proposed that a TSFE approach could be the rst choice for single-tooth gaps in situations where there is su cient width for implant placement and the intended elevation height does not exceed the height of the available residual bone, i.e., a residual bone height of at least 5 mm.[21] The lateral sinus oor elevation is indicated when <5 mm of bone is available.[21]

With regard to the time of implant placement, the two-stage technique results in a higher percentage of new-bone formation which gives it a biological advantage.[22] However, similar implant survival rates have been reported and, therefore, the one-stage technique is preferred provided that careful case planning and meticulous surgical techniques must be used, and, thus, su cient primary stability can be achieved.[23]

The advantages of the one-stage technique, such as shorter treatment time and a fewer surgical procedures, are obvious.

Selection of the appropriate implant length depends on the residual bone height and the choice of technique. During transcrestal sinus oor elevation procedures, it was proposed to place implants of 8 12 mm length. Longer implants may pose a risk for accidental perforation and collapse of the membrane, and, thereby, impair bone formation in the tented space, or iatrogenic migration of the graft material into the sinus antrum.[24]

With the two-stage lateral sinus oor elevation technique, the height of the augmentation after healing dictates the length of the implants. It is recommended to place implants of at least 10 mm lengths to ensure an e ective tenting e ect.[25]

The necessity of placing a lling material for sinus elevation procedures has been questioned. Boyne et al. showed, in a study on primates, that sinus membrane elevation and implant insertion with the apical part protruding in the sinus cavity under the elevated mucosa result in spontaneous bone formation.[26] In a clinical histologic study, Johansson et al. found no di erences when comparing lateral sinus oor elevation, with and without autogenous bone grafts, regarding bone formation and bone implant contacts.[27]

An interesting aspect of sinus membrane elevation is the healing mechanism and role of the sinus membrane on bone formation during the early healing phase. Several authors have demonstrated the osteogenic potential of the maxillary sinus membrane.[28,29]

Surface-modi ed oxidized implants showed a stronger bone response than machined implants.[30]

With regard to short dental implants, <10 mm, their reported cumulative survival rate was 99.1% after a follow-up period of 3.2 ± 1.7 years. Even 5 mm implants had an estimated survival rate of 93.1% after 2 years.[19]

To minimize short implant failure rates and compensate for the reduction in implant length, modi cations to the micro and macro designs of dental implants, for example, increasing implant diameter, thread depth, surface treatment, and decreasing thread pitch, have been made[19] (Figs 1 and 3).

These measures were made so that short implants can be used predictably, especially in nonideal clinical situations and when the patient declined advanced bone-grafting procedures because of the associated morbidity, increased cost, and treatment time.[31]

A higher survival rate was reported with short dental implants placed in the mandible than those placed in the maxilla.[32] This phenomenon could be attributed to an increase in bone density, improved mechanical properties of the implant bone interface, and reduced stress concentration in the bone,[33] therefore, facilitating primary stability and early osseointegration, which compensated for the reduction in implant lengths. However, the evaluation of the e cacy of short implants in either the mandibular or maxillary arches separately was not possible because of the shortage of studies reporting success of implants placed only in one arch.[19] Our study ndings are in agreement with the results achieved by two recent meta-analyses.[34,35]

Panoramic and intraoral radiography can provide su cient information when a TSFE procedure is considered for a minor augmentation, often limited to replacement of one or two teeth. At present, cone-beam computed tomography (CBCT) is the preferred radiographic technique as it provides high-quality images in three dimensions using low doses of irradiation compared with conventional computed tomography.[36] The CBCT examination can reveal information about the thickness of the lateral bone wall, presence of septa, at vs oblique sinus oor, status of the Schneiderian membrane, and width of the sinus, and, in addition,

**Fig. 3:** Design parameters enhancing short dental implant survival

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