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ORIGINAL ARTICLE

Dimensional changes of periodontal soft tissues after intrasulcular incision

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Abstract In maxillofacial surgery, intrasulcular incisions are often used. This prospective case series was established to evaluate the detrimental effects of intrasulcular incisions on periodontal structures. In 35 patients, measurements of probing depth and crown length before and 10 months postoperatively were performed to calculate changes of attachment level and gingival recession. In a subgroup, surgically treated sites were compared with untreated control sites. A nonparametric test was applied for longitudinal and split-mouth comparisons. Overall, intrasulcular incisions did not induce significant attachment loss. The frequency of sites losing ≥2 mm of attachment was 5.0%, 2.6%, and 4.7% at mesial, buccal, and distal sites, respectively. Intrasulcular incisions caused only a slight increase in gingival recession by 0.4±0.5, 0.2±0.3, and 0.3±0.4 mm at mesial, buccal, and distal sites, respectively. Within the limitations of the study design, it can be concluded that intrasulcular incisions without additional vertical incisions do not impose a serious risk for attachment loss and/or gingival recession.

Keywords Intrasulcular incision · Gingival recession · Periodontal attachment · Probing pocket depth · Oral and maxillofacial surgery

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Introduction

In oral and maxillofacial surgery, various modes of incision are applied to get access to the bone and a sufficient visibility, e.g., intrasulcular, paramarginal, and semilunar incisions. Each type of incision is associated with risks, such as gingival recessions, that the surgeon must be aware of [13]. Gingival recessions due to oral and maxillofacial surgery are a serious concern of many patients, which is reflected by the high number of people who seek periodontal plastic surgery for cosmetic correction of this mucogingival problem [10].

An intrasulcular incision provides excellent access and visibility as well as good vascular supply to the reflected tissues [13]. Upon intrasulcular incision, the scalpel is in direct contact with the tooth and the crestal bone, separating the sulcular epithelium and gingival connective tissue fibers from the tooth. Subsequently, a full-thickness flap, which consists of gingival and mucosal tissue as well as periosteum, is raised. It is thought that an intrasulcular incision will result in gingival recessions and, therefore, compromise the esthetic outcome, especially if the surgical procedure is carried out on teeth with restorations in the maxillary anterior region. However, such a possible detrimental effect on the level of the free gingival margin, if clinically relevant at all, might also depend on whether an

intrasulcular incision is combined with vertical releasing incisions.

As an alternative approach for recession-free healing, a paramarginal incision has been suggested [5]. This kind of incision leaves the marginal gingiva untouched and does not expose the crestal bone. It is often recommended in a situation where a sufficient band of attached gingiva is still present and the lesion will not extend to the incision line. However, a paramarginal incision can severely impair the vascular supply of the gingival tissues coronally to the incision line so that scar formation and gingiva shrinkage are possible complications caused by this kind of incision [3, 13]. Therefore, clinical prospective studies are warranted to evaluate if an intrasulcular incision without vertical releasing incisions indeed causes a noticeable degree of recession.

Since extensive shrinkage of interproximal papillae may cause esthetic, functional, or phonetic problems, the impact of a sulcular full-thickness flap and papilla base flap on the postsurgical loss of papilla height has been recently investigated [14–17]. Whereas the papilla base flap allowed rapid and predictable recession-free healing, a marked loss of papilla height was caused by complete mobilization of the papilla. These studies provided strong evidence that an intrasulcular incision can result in loss of gingival tissues in interproximal regions. While patients pay strong attention to gingival recessions, an esthetic problem that can easily be assessed by patients themselves, they are much less concerned about changes of the attachment level. However, high probing pocket depths (PPD) and increased attachment levels may confer a higher risk for further bone and attachment loss [4, 6, 7, 9]. Therefore, clinical studies that evaluate the impact of surgical incisions on gingival tissues under special consideration of the attachment level are fundamental. The objective of this prospective study was to determine if an intrasulcular incision without vertical releasing incisions will result in loss of probing attachment and/or clinically relevant gingival recession.

Materials and methods

The participants of this case series were patients who had been referred to the Department of Oral and Maxillofacial Surgery at the University Hospital Schleswig-Holstein, Campus Kiel, for surgical treatment. In all patients, an intrasulcular incision was required to provide access during the surgical procedure. Patients with diagnosed or already treated marginal periodontitis, systemic diseases known to be associated with periodontal diseases, medications that can induce periodontal diseases as a side effect, and orthodontic appliances were excluded from the study. Patients scheduled for treatment with dental restoration that were expected to change tooth morphology were also not eligible to take part in this trial. Forty-one patients gave their informed consent and participated in the study that was approved by the ethics committee. Out of these patients, thirty-five (25 women and 10 men) appeared for reevaluation and could be used for data analysis. The age of these patients ranged between 21 and 53 years (mean age 32.1 years).

In total, crown length (CL) and PPD were measured on 547 teeth (306 teeth on which an intrasulcular incision was performed and 241 control teeth). Fifty-three out of these 306 teeth were maxillary and mandibular first molars. Oral and maxillofacial surgery was carried out 19, 18, 17, and 18 times in the first, second, third, and fourth quadrant of the oral cavity, respectively. The intrasulcular incision was applied during the following surgical procedures: removal of gentamicin-impregnated polymethylmethacrylate beads or osteosynthesis plates, cystectomy in the maxillary sinus region, surgical removal of dislocated and/or impacted third molars, LeFort 1 maxillary osteotomy, sagittal splitting of the mandible, and placement of dental implants. Prior to surgery, patients rinsed with an antimicrobial povidone iodine solution (Betaisodona, Mundipharma, Germany) for 1 min. Subsequently, an intrasulcular incision without vertical releasing incisions was performed with a scalpel blade (#15, Aesculap, Germany) in close contact to the tooth and bone and with gentle mobilization of the vestibular part of the papilla. When a tension-free mobilization of the mucoperiosteal flap could not be achieved, the intrasulcular incision was extended in mesial or distal direction. If necessary, a releasing incision was performed on the ascending ramus of the mandible or on the maxillary tuber. At the end of the surgical procedure, the wound closure was performed with interdental single knot and sling sutures of an atraumatic material, i.e., monophile polyamide (Ethilon, Ethicon, Germany, 3-0). Until removal of sutures, i.e., 7 to 10 days following surgery, patients refrained from oral hygiene procedures at surgical sites and rinsed twice daily with 0.2% chlorhexidine.

The clinical parameters, i.e., PPD, CL, bleeding on probing (BOP), and plaque index (PI), were recorded in outpatients 2 h before surgery and in inpatients 1 day prior to the surgical procedure. The reevaluation was performed 6–12 months (average 10.1 months) following surgery. PPD was measured with a force-controlled electronic probe (Peri-Probe®, Vivadent, Ellwangen, Germany) at three defined sites (mesial, buccal, and distal) on the labial aspect of front teeth, premolars, and molars. BOP and PI were dichotomously evaluated. At sites where PPD was measured intraorally, CL was determined on casts by a sliding caliper. Alginate impressions (Xantalgin, Bayer, Germany) were taken and poured in dental stone cast material (Vel-Mix Stone, Kerr, Germany) within 1 h.

CL was defined as the longest distance between incisal edge and cuspid tip that served as a fixed reference point and free gingival margin. ΔCL, the change of crown length/recession, was calculated by subtraction of postsurgical CL from presurgical CL values. In order to determine the relative attachment level (RAL), CL was added to PPD. ΔRAL, the change of attachment, was assessed by subtraction of postsurgical RAL from presurgically measured RAL. Positive ΔRAL values indicated attachment gain whereas negative values represented loss of probing attachment. In 18 of the 35 study participants, sites where an intrasulcular incision (95 teeth) was performed and control sites located in the contralateral quadrant (114 teeth) were compared. ΔΔRAL, the difference of attachment change between teeth on which an intrasulcular incision was performed and contralateral control teeth, was determined by subtracting ΔRAL of surgical sites from ΔRAL of control sites. Mean, SD, median, and quartiles for PPD, CL, RAL, ΔCL, ΔRAL, and ΔΔRAL at mesial, buccal, and distal sites were determined. To test for significant differences between presurgical and postsurgical CL and RAL as well as for significant differences of attachment changes between teeth with an intrasulcular incision and contralateral control teeth, the Wilcoxon rank–sum test ($p < 0.05$) was applied.

Table 1 Mean PPD±SD for mesial, buccal, and distal sites of 306 teeth, as measured prior to (pre) and on average 10 months following (post) surgery

Quadrant	Site	Time	Mean	SD
First quadrant	Mesial	Pre	2.41	0.54
		Post	2.30	0.35
	Buccal	Pre	1.74	0.32
		Post	1.69	0.35
	Distal	Pre	2.54	0.57
		Post	2.45	0.60
Second quadrant	Mesial	Pre	2.53	0.45
		Post	2.46	0.58
	Buccal	Pre	1.70	0.38
		Post	1.70	0.36
	Distal	Pre	2.71	0.68
		Post	2.88	0.81
Third quadrant	Mesial	Pre	2.59	0.54
		Post	2.45	0.71
	Buccal	Pre	1.56	0.33
		Post	1.70	0.78
	Distal	Pre	2.44	0.59
		Post	2.62	0.99
Fourth quadrant	Mesial	Pre	2.49	0.43
		Post	2.42	0.55
	Buccal	Pre	1.56	0.29
		Post	1.73	0.56
	Distal	Pre	2.40	0.44
		Post	2.44	0.75

Results

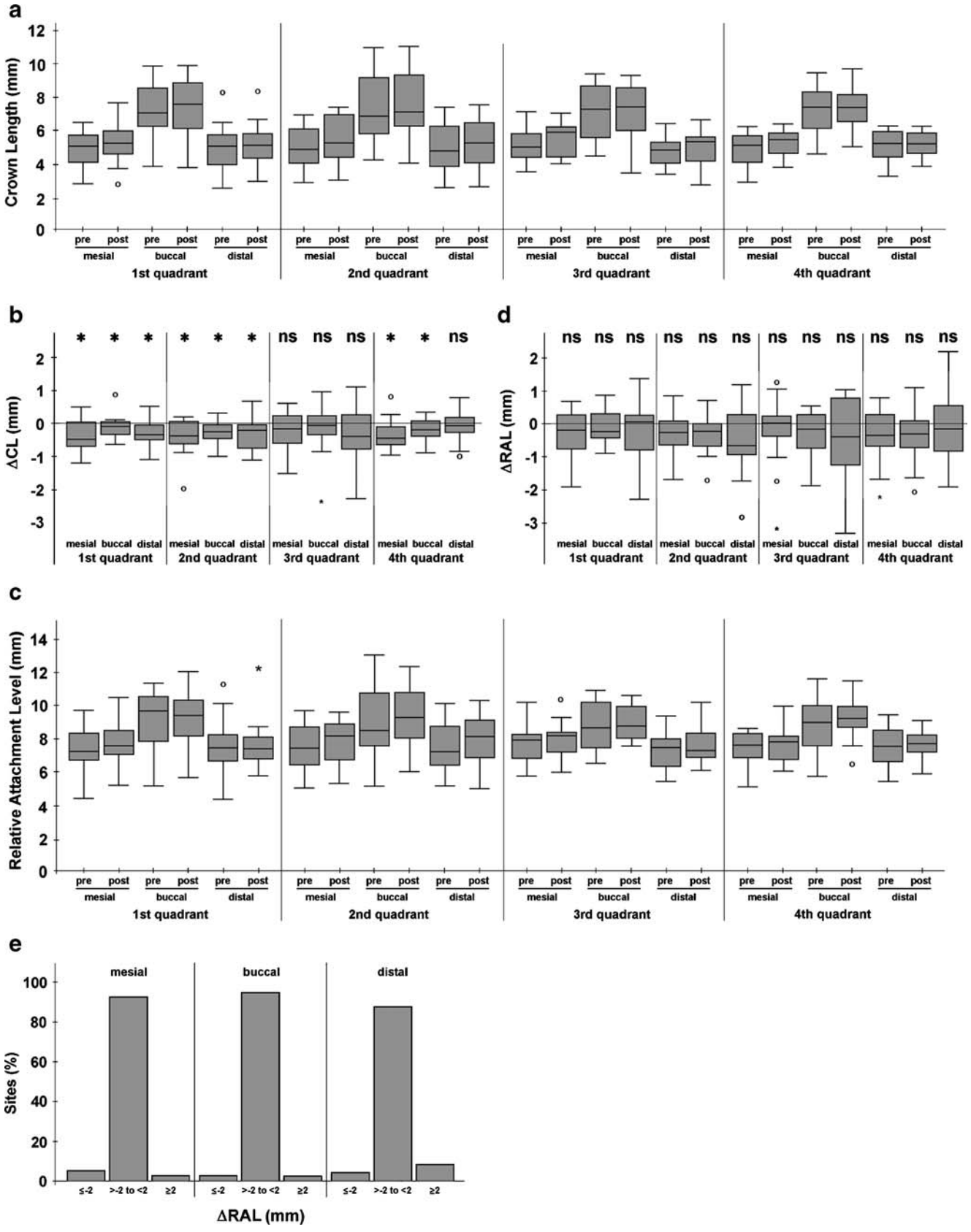
Mean PI, BOP, PPD, and CL were determined prior to and on average 10 months following surgery. During the study period, mean PI dropped from 10.7% to 4.7% and mean BOP from 28.9% to 19.2%. Mean PPD of teeth where an intrasulcular incision was performed was <3 mm at all sites and in all quadrants, presurgically and postsurgically (Table 1). Differences between presurgical and postsurgical PPD were not significant.

CL was determined on stone casts. In the first quadrant, CL was significantly increased at mesial, buccal, and distal sites following surgery. Likewise, a significantly increased CL, i.e., recession, was found at all sites in the second quadrant postsurgically. Although postsurgical CL levels were also higher than presurgical values in the third quadrant, the differences were not significant. In the fourth quadrant, there was also increase in CL at all sites following surgery but the differences were only significant for mesial and buccal sites (Fig. 1a, b). When data were analyzed for all quadrants together, the intrasulcular incision caused a slight but significant increase in gingival recession by 0.4±0.5, 0.2±0.3, and 0.3±0.4 mm at mesial, buccal, and distal sites, respectively.

Overall, the change of attachment was not significant even if a number of sites experienced loss of probing attachment to some extent. In the first quadrant, RAL was slightly increased at mesial and buccal sites whereas RAL at the distal site was diminished after surgery. However, no significant differences between presurgical and postsurgical RAL were found for any site. RAL was also slightly enhanced at mesial, buccal, and distal sites in all other quadrants except the mesial site in the third quadrant where a small reduction was observed after surgery. Like the first quadrant, presurgical and postsurgical attachment levels did not significantly differ (Fig. 1c, d). In addition, the study revealed that only few sites experienced a noticeable attachment loss. The frequency of sites losing ≥2 mm of probing attachment was 5.0%, 2.6%, and 4.7% at mesial, buccal, and distal sites, respectively; 2.6% of mesial, 2.3% of buccal, and 8.0% of distal sites gained ≥2 mm of attachment. All other sites experienced a change of attachment <2 mm (Fig. 1e).

A subanalysis of the presurgical and postsurgical attachment levels was performed for the first molars (Fig. 2a). Like in total teeth, postsurgical RAL did not significantly differ from presurgical levels at any site or in any quadrant (Fig. 2b). Furthermore, only a few sites lost or gained ≥2 mm of attachment when presurgical and postsurgical RAL were compared (Fig. 2c).

In a subgroup of study participants, sites where an intrasulcular incision was performed were compared with


a
Crown Length (mm)
pre post pre post pre post
mesial buccal distal
1st quadrant
2nd quadrant
3rd quadrant
4th quadrant
b
ΔCL (mm)
* * * * * * ns ns ns * * ns
mesial buccal distal
d
ΔRAL (mm)
ns ns ns ns ns ns ns ns ns ns ns ns
c
Relative Attachment Level (mm)
e
Sites (%)
mesial
buccal
distal
≤-2
>-2 to <2
≥2
ΔRAL (mm)

◀ **Fig. 1** Intrasulcular incisions were performed on 306 teeth in 35 patients. Clinical crown length (*CL*) and relative attachment level (*RAL*) were determined at mesial, buccal, and distal sites prior to (*pre*) and on average 10 months following (*post*) surgery. **a** Presurgical and postsurgical CL levels. **b** ΔCL, the change of crown length/recession, was calculated by subtraction of postsurgical CL from presurgical CL values. *$p<0.05$, significant difference between presurgical and postsurgical CL levels (Wilcoxon rank–sum test); *ns*, nonsignificant difference. **c** Presurgical and postsurgical RAL. **d** ΔRAL, the change of attachment, was calculated by subtraction of postsurgical RAL from presurgical RAL values. *$p<0.05$, significant difference between presurgical and postsurgical RAL values (Wilcoxon rank–sum test); *ns*, nonsignificant difference. **e** Percentage of sites with ΔRAL ≤−2 mm, >−2 mm to <2 mm, and ≥2 mm

control sites located in the contralateral quadrant. Neither surgical nor control sites did experience a significant change of attachment, as shown in Fig. 3a, b. In addition, the study did not reveal a significant difference of attachment change between surgical and control sites (Fig. 3c). In summary, no significant differences of RAL were found when presurgical levels were compared with postsurgical levels at surgical sites. Furthermore, no significant differences of attachment change were observed when surgically treated sites were compared with contralateral control sites.

Discussion

The present investigation mainly aimed at evaluating if raising a mucoperiosteal flap by using an intrasulcular incision would result in iatrogenic damage of the attachment apparatus (loss of probing attachment), which has not been analyzed so far. In this prospective study, no significant loss of probing attachment was found at sites where an intrasulcular incision was performed. This strongly suggests that an intrasulcular incision does not impose a serious risk for attachment loss in periodontally healthy conditions. This finding is fundamental because loss of attachment and increased PPD may confer a

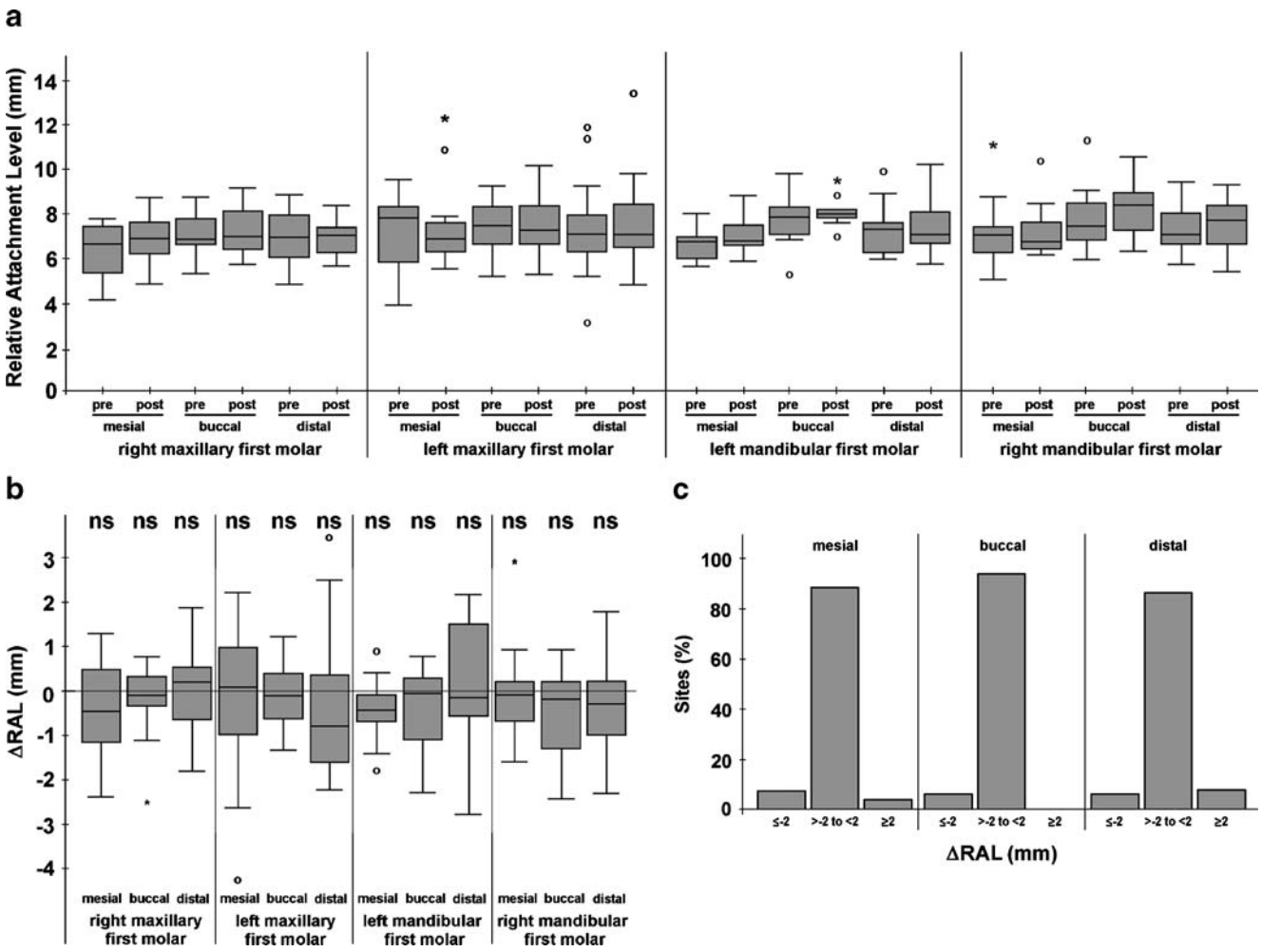


Fig. 2 A subanalysis of the presurgical and postsurgical attachment levels was performed for the 53 first molars out of the 306 teeth presented in Fig. 1. **a** Presurgical (*pre*) and postsurgical (*post*) relative attachment levels (*RAL*). **b** ΔRAL, the change of attachment, was calculated by subtraction of postsurgical RAL from presurgical RAL values. *ns*, nonsignificant difference between presurgical and postsurgical levels ($p<0.05$, Wilcoxon rank–sum test). **c** Percentage of sites with ΔRAL ≤−2 mm, >−2 mm to <2 mm, and ≥2 mm

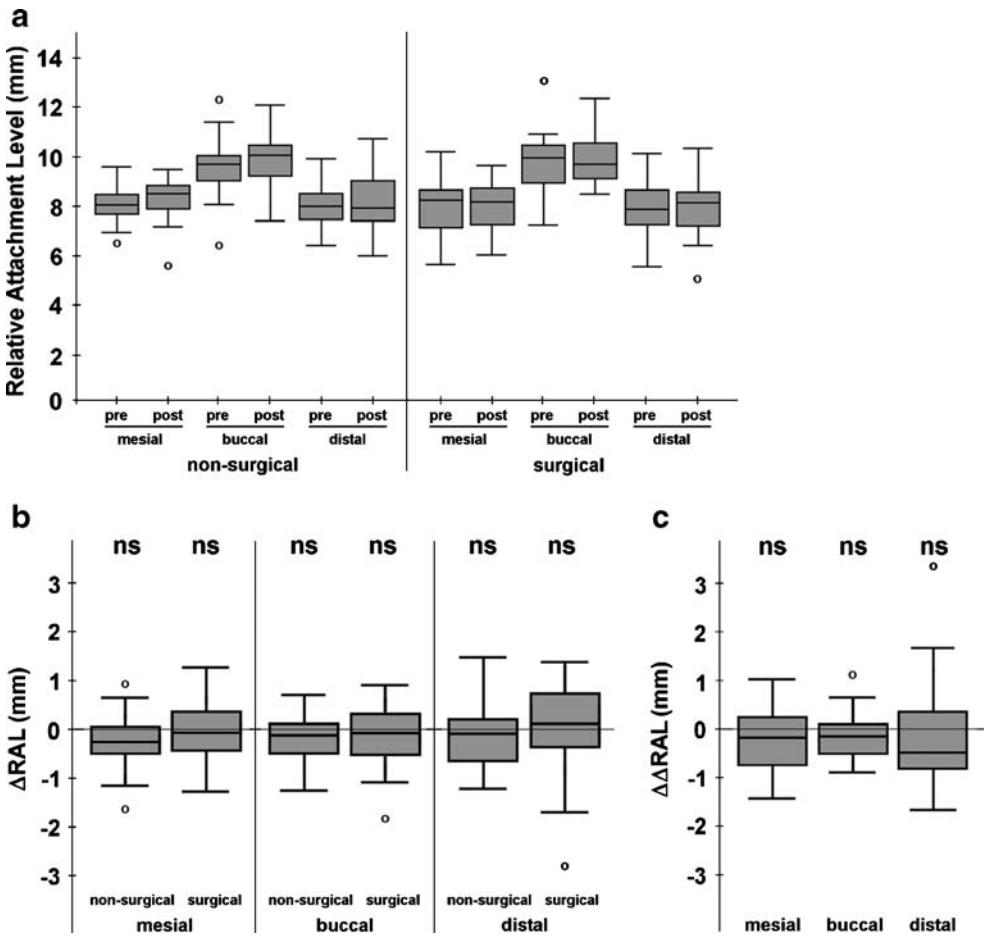


Fig. 3 In 18 out of the 35 study participants, teeth on which an intrasulcular incision was performed (surgical, $n=95$) were compared with control teeth in the contralateral quadrant (nonsurgical, $n=114$). **a** Relative attachment level (RAL) at mesial, buccal, and distal sites of nonsurgical and surgical teeth prior to (*pre*) and on average 10 months following (*post*) surgery. **b** ΔRAL, the change of attachment, at mesial, buccal, and distal sites of nonsurgical and surgical teeth was calculated by subtraction of postsurgical RAL from presurgical RAL values. *ns*, nonsignificant difference between presurgical and postsurgical RAL ($p<0.05$, Wilcoxon rank–sum test). **c** ΔΔRAL, the difference of attachment change between surgical and nonsurgical teeth, was determined by subtracting ΔRAL of surgical sites from ΔRAL of nonsurgical sites. *ns*, nonsignificant difference ($p<0.05$, Wilcoxon rank–sum test)

risk for future bone and attachment loss and, thereby, jeopardize the functional maintenance of teeth [4, 6, 7, 9]. Although patients are usually less concerned about changes of periodontal attachment due to surgical procedures, they pay strong attention to gingival recessions, an esthetic problem that can be easily assessed by the patients themselves. This study demonstrated that an intrasulcular incision causes a significant but only slight increase in gingival recession. Future studies should also focus on how intrasulcular incisions will affect esthetic parameters in front teeth, premolars, and molars.

The observed increase in gingival recession may not solely be due to the kind of incision performed, i.e., intrasulcular incision. Needle size, kind and size of suture material, number of sutures, day of suture removal, kind and size of scalpel blade, use of magnifying glasses or microscopy, etc., will also affect the level of the free gingival margin after surgery [13]. In this study, a thick and firm suture material was applied and sutures were kept in place for 7–10 days. No wound healing complications or dehiscence were noticed. However, it can be assumed that minimally invasive surgery using microblades and 5.0 or 6.0 sutures would have caused even less trauma to the gingiva and attachment apparatus.

An advantage of the intrasulcular incision is the good vascular supply of the mucoperiosteal flap and the lack of scar formation when compared with a paramarginal incision [13]. For better access to the surgical field, an intrasulcular incision is often combined with vertical releasing incisions. Vertical incisions are thought to negatively affect the postsurgical level of the free gingival margin and were, therefore, not applied in our study. When a tension-free mobilization of the mucoperiosteal flap could not be achieved, the intrasulcular incision was extended in mesial or distal direction. Future studies should clarify whether vertical releasing incisions indeed cause a detrimental effect on soft tissue shrinkage if correct paramedian releasing incisions are performed. Considering that vertical releasing incisions allow a good tissue mobilization and the possibility of a coronally advanced flap, the risk of postoperative gingival recessions might also be negligible.

In the present study, intrasulcular incisions were applied during various surgical procedures such as removal of osteosynthesis plates and impacted third molars, cystectomy, placement of dental implants, etc. It is conceivable that different surgical procedures may differentially affect wound healing of the raised mucoperiosteal flap and, therefore, also recession and/or attachment levels. Our

study was purposely designed to comprise various surgical procedures as they are routinely performed in oral and maxillofacial clinics. The present study design has some additional limitations with regard to standardization, e.g., various surgeons and different evaluation time points. In addition, the thickness of the gingival tissues was not evaluated and might have been different among patients and sites. Although the surgical procedures were performed by different surgeons, they all followed the same standardized protocol to ensure a high degree of standardization. This study was performed under conditions that clinicians face more likely than extremely well-controlled and standardized conditions. We, therefore, believe that the limitations of this study design might be rather advantageous when it comes to drawing conclusions for a more realistic setting.

Postsurgically, the clinical parameters such as PPD and CL were reevaluated at different time points among patients due to patient- and/or treatment-related factors. Mainly, tissue remodeling has been shown to take place within 6 months [2, 8, 11, 18]. Since the interval between surgery and reassessment of the clinical parameters exceeded this time in all study participants, differences in time of reevaluation seem to be negligible.

In our study, clinical parameters were measured by a single examiner but the surgical procedures, i.e., the intrasulcular incisions, were performed by various oral and maxillofacial surgeons. However, no significant differences between surgeons were found when results were subanalyzed for each surgeon alone (data not shown).

Attachment levels were measured by a constant force electronic probe with an accuracy of ±0.2 mm. The accuracy of the sliding caliper that was used to evaluate the crown length was ±0.03 mm. Therefore, the measurement error was often greater than the changes of attachment observed.

The impact of an intrasulcular full-thickness flap and papilla base flap on postsurgical loss of papilla height has been recently investigated [14–17]. In contrast to the papilla base flap that allowed rapid and predictable recession-free healing, a loss of papilla height was caused by a complete mobilization of the papilla. Although these studies mainly focused on the interproximal region, they provided evidence that an intrasulcular incision can cause loss of gingival tissues, which is in accordance to our study where a slight but significant increase in recession was observed. There is an obvious lack of studies that evaluated the effect of various modes of surgical incisions on attachment level. However, in one study, semilunar flaps were compared with trapezoidal flaps that are created by combining an intrasulcular incision with two vertical releasing incisions [1]. Interestingly, no difference in loss of attachment was found between both flap designs. This study seems to support our finding that an intrasulcular incision does not necessarily lead to attachment loss. Another study compared marginal and paramarginal flaps both combined with vertical releasing incisions when used during impacted third molar surgery [12]. It was found that the PPD on the buccal and distal aspects of the adjacent second molars was significantly increased in marginal flaps at 5 and 10 days following surgery but similar at 3 months. Although no information was given regarding the change of attachment level, the report also suggests that a sulcular incision does not seem to be harmful at least as far as the PPD is concerned.

Gingival recession or vertical attachment loss on molars might be especially harmful by favoring subsequent horizontal attachment loss in furcation areas. Therefore, a subanalysis of presurgical and postsurgical attachment levels of the maxillary and mandibular first molars was performed. Like in total teeth, no significant attachment loss was found, suggesting that an intrasulcular incision does not put molars at risk for furcation involvement.

In a subgroup of study participants, sites where an intrasulcular incision was performed were compared with control sites located in the contralateral quadrant. This split-mouth design did not reveal any significant differences of attachment change between surgically treated and control sites, which supports our findings obtained by comparing the presurgical and postsurgical levels at surgical sites.

Within the limitations of the study design, it can be concluded that intrasulcular incisions without additional vertical incisions do not impose a serious risk for attachment loss and/or gingival recession in healthy periodontal conditions.

Conflict of interest statement The authors declare that they have no conflict of interests.

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