INTRODUCTION

Neurosensory deficit (NSD) is a commonly reported complication following a Le Fort 1 osteotomy (LF1O)[1] with a highly variable incidence reported in the literature ranging from 9 - 85%[2–4]. The long-term outcomes have not been comprehensively reported, especially relating objective and subjective outcomes[2,4–6]. It is essential we have sufficient information on material risks to offer our patients as part of the informed consent process[7].

Previous studies have added to the evidence base in this field but suffer from shortcomings related to brief follow-up periods[4,8,9], limited sample size[8], absent anatomical sites[3,4,8–12], lack of baseline assessment[8], variability in assessment protocols and only including either objective or subjective outcomes[2,9,13]. In addition, no consensus exists on somatosensory protocol capturing infraorbital changes[14]. Furthermore, most research in oro-facial NSD reports on inferior alveolar nerve recovery[1].

New approaches in orthognathic surgery including use of piezoelectric instrumentation have been reported to improve outcomes for NSD[15]. Fundamentally, the piezoelectric saws utilise low-frequency vibrations to aid cutting of bone with more precision and safety[16]. Originally introduced to help reduce the shortcomings of traditional bone instrumentation with maxillary sinus surgery its use has widen to include orthognathic surgery[17]. Amongst its major advantages, piezoelectric surgery has shown to reduce soft tissue trauma. This in turn has a positive impact on reduction of blood loss with better field of view during surgery[18,19,20,21,22], improved osteotomy segmentation[22], reduced post-operative swelling[23] and a reduction in NSD incidence[19,24,25].

However, most of the studies carried out with piezoelectric surgery have been on mandibular surgical procedures and they have shown positive improvements in reduction of inferior dental nerve injuries[21,23,24,25]. Although there are few clinical trials with sufficiently high-quality evidence to systematically review; a recent meta-analysis has shown a pooled difference of severe NSD in favour of using piezoelectric over conventional instrumentation [26].

Another interesting aspect of NSD is the subjective analysis of patient perceptions. Objective assessment is an effective method of identifying the extent of NSD. However, research has identified that the context of such results should be assessed alongside subjective reporting by the patient[13]. In medical literature, subjective and objective assessments have been shown to correlate with each other in assessment of trigeminal nerve repair[27]. Accordingly, subjective outcomes are more conclusive when analysed in conjunction with objective outcomes[13,27]. However, the link between objective and subjective reporting is complicated with the literature reporting differences among which objective testing methods correlate best with subjective reporting[28].

This study intends to bridge the gap by undertaking a comprehensive subjective and objective assessment of NSD including both intra-oral and extra-oral sites with a prolonged follow-up period.

SPECIFIC AIMS AND OBJECTIVES

The primary objectives of the study were to assess the incidence and pattern of recovery of neurosensory deficit following Le Fort 1 osteotomy. Secondary objectives were to investigate the relationship between age, gender and extent of surgical movement on NSD and to explore the relationship between subjective and objective outcome measures of NSD.

MATERIALS AND METHODS

Trial design and any changes after commencement

This study was a prospective longitudinal cohort study. Ethical approval was obtained from the National Research Ethics Service, Queens Square London (14/LO/1605) and the Joint research management office for Barts and the London School of Medicine and Dentistry.

Participants, eligibility criteria, sample selection and setting

Participants were recruited at the Institute of Dentistry, Barts and The London School of Medicine and Dentistry, London, UK from July 2014 to October 2016. Data collection was undertaken by two postgraduate orthodontic trainees (AD and NB). The following criteria were applied:

Inclusion Criteria

1. Patients undergoing a LF1O as part of their treatment at Barts Health NHS Trust, UK.
2. Adult male and female patients (aged 18 and above).

Exclusion Criteria

1. Patients who present with pre-existing medical conditions affecting neurosensory function or neurosensory deficits.
2. Patients who have had previous orthognathic treatment, treatment for facial deformity or any other form of facial surgery.
3. Administration of medications that affect neurosensory perception and recovery.
4. Patients from vulnerable groups (given the nature of the intervention and concerns over the ability to understand, consent and /or partake in the research study).

All patients meeting the criteria were invited to participate. An expected sample size of 30 patients was identified from previous studies. A convenient consecutive sample of 31 patients were recruited.

Intervention, assessment protocol and outcomes

Intervention

Subjects were consented to participate in the study. Two experienced oral and maxillo-facial surgeons carried out the surgical interventions involving the use of a reciprocating saw and mini-plate fixation. A standardised surgical protocol, in keeping with the department's normal procedure, was adopted for the surgical phase including the pre-operative work-up and post-operative surgical care. No surgical complications necessitating repeat surgery were encountered.

Assessment protocol

Patients were assessed in a supine position with eyes-closed limiting the use of non-spatial information to minimise bias. Objective and subjective assessment were carried out at the following time points: baseline readings prior to surgery (T0); at 1-week (T1), 1-month (T2), 3-months (T3), 6-months (T4) and 12-months (T5) post-surgery. The assessment methods were standardised to limit intra-and inter-operator variability.

Extra-oral sites assessed included the skin overlying the infra-orbital region under the lower eyelid (marked red), over the alar cartilage (marked blue), above the upper lip vermillion border (marked black) and overlying the cheeks (marked yellow) (Figure 1). Intra-oral sites assessed included the vestibular and palatal mucosa adjacent to the first permanent molar, the first premolar and the central incisor (Figure 2). Teeth sensibility testing was conducted in the maxillary dentition from the first permanent molar to the permanent central incisor (Figure 2). Missing, root treated or prosthetically restored teeth were omitted without substitution.

Objective assessments included pin-prick (PP), static light touch (SLT), static two-point discrimination (STPD) and electronic pulp testing (EPT) (Figure 3). Nociception was assessed with pin-prick using a dental probe placed perpendicular to the surface until blanching was detected[14,29] (Figure 3). A verbal response was recorded from the patient to a positive or

negative sensation. Static light touch was assessed using a calibrated filament (NeuroPen®, Owen Mumford Ltd.) placed perpendicular to the site of interest. The filament bowed once to provide an accurate, reliable force of 10g[30] and was left for 1-2 seconds[14]; the patient responded verbally whether a positive or negative stimulation was felt. The use of both pin prick and static light touch allowed for assessment to both sharp painful stimuli and blunt stimuli.

Assessment of peripheral nerve density was undertaken using STPD[31]; a calliper with a set distance determined at T0 for individual patients (Figure 3). Once set, the calliper was placed on the test sites, with both points touching equally and perpendicular to the skin surface. Enough pressure was applied until the surface skin blanched. If the patient did not feel the two points separately, at the minimum distance, this was recorded as a negative reading.

Pulp sensibility testing in the maxillary dentition was conducted using an EPT machine due to its documented reliability[32,33]. The tip was placed on the surface with closest proximity to the pulp chamber[32] using a conducting medium (Figure 3). Patients responded verbally at the onset of a warming or tingling sensation. A negative response was tested twice to ensure true negatives. To limit cross-talk, no conducting medium nor the EPT tip touched any of the metallic brackets[32].

Visual analogue scales (VAS) were used for subjective assessment. Patients rated how much the numbness 'bothered' them from 'not at all' (0mm) to 'extremely' (100mm); extra-oral and intra-oral scores were recorded separately. Patients were not given access to their previous scores at the assessments.

Outcomes

The primary outcome measures were the incidence and the recovery of NSD following Le Fort I osteotomy over the study duration from baseline to 12 months. Secondary outcomes included the relationship between age, gender, extent of surgical movement on the incidence of NSD and the relationship between subjective and objective outcome measures of NSD.

Data Analysis

Data was analysed with a combination of descriptive and analytical statistics using JMP® Version 14 Pro (SAS Institute Inc., Cary, NC, 1989-2020). Data for pin prick, static light touch, static two-point discrimination and vitality was structured such that the unit of analysis was a measurement nested within a person repeated over time. Therefore, a mixed-effects repeated measures ANCOVA was chosen. Using the random coefficients, this approach allowed for multiple error structures to represent the nested nature of the data without violating the independency assumption. Implementing the restricted maximum likelihood (REML) approach better balances the weight of the observations with respect to variance across the hierarchical structure. For detailed comparisons between categories the Šidák correction for multiple post hoc t-tests was used. Subjective outcomes were calculated as a percentage mean measurement from the VAS using Wilcoxon tests. Cohen's Kappa (κ) statistics were used to assess the reliability of the two assessors. For the categorical outcome, Maxillary dentition NSD, a multiple mixed logistic regression was utilised. The level of significance was set at $p < 0.05$.

RESULTS

Participant Flow

From the 31 patients recruited 3 were lost during follow-up. One patient moved abroad and the other two patients chose not to continue citing complexity in organising suitable appointments. Therefore, data for 28 patients that completed the study are presented.

Baseline Data

The total sample consisted of 28 participants with a mean age of 24.5 years (SD, 7.4) comprised of 12 males (M = 23.3, SD = 5.1) and 16 females (M = 25.4, SD = 8.8) . Seventeen patients (60.7%) underwent a maxillary advancement only, 4 (14.3%) had a maxillary impaction only and 7 (25.0%) underwent a combination of the aforementioned movements.

The mean minimum distance perceptible by patients at baseline (T0) for the STPD assessment was 11.4mm (SD, 2.5). No patient reported any pre-existing NSD at T0. All teeth included in the analysis responded positively to sensibility testing at T0.

Objective assessement

Table 1 and 2 illustrates the number to patients with NSD at any given time point and the results of objective testing by site over the 12 month period . One week post-surgery (T1), the highest incidence of NSD is reported in 24 (85.7%) of the sample . At 6 months (T4), the incidence is at its lowest level with 5 (17.9%) of the sample assessed positive for NSD . At 12 months (T5), the overall incidence is the same as at T4 with 5 (17.9%) presenting with NSD. Subjects exhibited 100% recovery with the PP test, whereas the SLT and STPD elicited NSD in 1 (3.6%) and 4 (14.3%) subjects respectively (Table 1). The pattern of recovery of NSD is illustrated in Figure 4. There is a reduction in NSD from 85.7% at T1 to 17.9% at T5 with the majority of recovery in terms of overall incidence of NSD occurring between one (T2) to 6 (T4) months after surgery.

There is clearly a significant loss of sensitivity immediately after the operation, especially at intra-oral sites, and recovery starts with a diminishing trend over time up to the 12 months' time point (Table 1 and 2). Results for pin prick, static light touch, static 2 point discrimination and electric pulp test are presented.

<u>Pin prick, Static light touch and Static 2 point discrimination</u>

Figure 5a and 5b illustrate the results for mean pin prick and static light touch for all sites and at different intra and extra-oral sites over time. Once broken down by site, it is clear that the main loss of sensitivity is in the intra-oral sites, namely, the palatal and the Vestibular mucosa rather than extra-oral sites.

The mixed ANCOVA estimation for pin prick reveals time ($F_{(5, 135)}$=28.57, p<0.0001), site ($F_{(5, 135)}$=22.23, p<0.0001) and their interaction ($F_{(25, 675)}$=14.43, p<0.0001) are significant (table 3). Differences between sides were not found to be significant. The Šidák corrected post-hoc test shows the 1-week timepoint is significantly lower than all others (M=2.55). No significant differences were found between the baseline (M=3.00), 3-months (M=2.96), 6-months (M-2.99) and 12-months(2.99). Therefore, recovery, defined by insignificant difference from the baseline is achieved by 3-months. In relation to anatomical site, the palatal at one week is significantly less sensitive compared to all other sites at any time (M= 1.46). The vestibular region at 1-week (M=2.30) was also significantly less sensitive than all other time points, recovering by 1-month (M=2.80).

Similarly, the estimation for static light touch produced the following significant effects: time ($F_{(3, 135)}$=26.79, p<0.0001), site ($F_{(5, 135)}$=19.75, p<0.0001) and time*site ($F_{(25, 675)}$=15.12, p<0.0001) with no significant differences found between sides (Table 4). Furthermore, as with the pin prick test, the post hoc test indicates that at 1-week the sensitivity is significantly lower than at any other time (M=2.54) and the palatal at 1 week (M=1.33) is significantly less sensitive than all other sites at any time. All intra-oral sites (palate and vestibule) are insignificantly different from baseline readings at six months, illustrating numbness is concentrated to intra-oral sites and takes up to six months to recover.

Figure 6 illustrates the trends for static 2 point discrimination at extra-oral sites over time. The mixed model estimate (Table 5) shows significant fixed effects to be time ($F_{(5, 135)}$= 5.42, p<0.0001), site ($F_{(3, 81)}$= 6.38, p=0.0006) and the interaction between them ($F_{(15, 405)}$= 1.87, p=0.0250). The Šidák corrected post hoc tests reveal that the least sensitive site is the intra orbital at 1-week (M=2.57) improving insignificantly by 1-month (M=2.62) and statistically indifferent from the bassline at the 3-months timepoint (M=2.76). At 1-week, the cheek is at its leased sensitive measurement (M=2.61) significantly different from the bassline.

Nevertheless, by the 1-month measurement (M=2.80) it is statistically indifferent from the bassline (M=3.00). Insignificant differences to baseline values at extra-oral sites are noted between 1-3 months.

Maxillary dentition NSD

The highest incidence of dental NSD is reported at T1 (48%) with a gradual reduction to near pre-treatment values at T5 (Figure 7a). At each time point there is no significant difference in distribution of NSD across the teeth within the arch (Figure 7b, Table 6a). Mixed effects logistic regression confirms all time points are significantly different from the final measurement at 12-Months. (Table 6b).

Subjective assessement

Subjective assessment scores for both extra and intra-oral sites are displayed (Figure 8). From T1 through to T5 the trend is a reduction in mean scores and at T5 the lowest mean scores are recorded at 3.0mm (SD = 5.3) for extra-oral and 6.2mm (SD = 9.4) for intra-oral sites. Estimating the differences between the participants on the subjective assessment at the 12-month time point using a Wilcoxon rank test, no difference was found for extra-oral sites (Table 7). Meanwhile, for intra-oral sites a significant difference emerged between those who actually suffered NSD and those who did not (p=0.031).

Co-variables

The following section describes the results pertaining to the co-variables age, gender and extent of surgical movement undertaken on incidence of NSD.

Age

For pin prick, adding age as co-variate is significant ($F_{(1, 18.35)}$=8.51, p=0.009). Furthermore, detailed parameter analysis shows the interaction Age*1-Week is significant (effect ($F_{(5, 88.63)}$=2.44, p=0.04) as well as the interaction for Age*Site[Palatal] ($F_{(5, 60.84)}$=6.18, p<0.0001).

Similar results were found for static light touch with regards to the influence of age ($F_{(1, 20.99)}$=9.84, p=0.005) with a significant interaction for the Age*Site[Palatal] ($F_{(5, 81.34)}$=6.60, p<0.0001).

Static 2 point discrimination, which was carried out at extra-oral sites only, revealed no significant age related significant effects ($F_{(1, 22.6)}$=0.14, p=0.71). Age at surgery with reference to dental NSD yielded a non-significant effect ($F_{(1, 21.72)}$=3.07, p=0.09). These results indicate that as age rises patients are predicted to have more numbness in general, particularly, intra-orally in the palate during the immediate post-operative phase of recovery. However, at 12 months no significant age related effects are significant.

Gender

Introducing gender to the ANCOVA found no significant difference in the incidence of NSD between males and female for pin prick ($F_{(1, 26)}$=3.91, p=0.06), static light touch ($F_{(1, 26)}$=2.87, p=0.10). , static two point discrimination ($F_{(1, 26)}$=, p=0.65) and dental NSD ($F_{(1, 22.43)}$=1.81, p=0.19).

Extent of surgical movement

To assess the influence of extent of surgical movement on incidence of NSD the patients that underwent Le Fort I advancement (n=24) were separated into 2 groups; those that underwent movement that were ≤5mm (n = 11) and those with >5mm movements (n = 13). No statistical difference in incidence of NSD between the groups is noted for any of the tests: pin prick test ($F_{(1,26)}$=0.46, p=0.50), static light touch ($F_{(1, 26)}$=0.13, p=0.72), static 2 point discrimination ($F_{(1, 20.6)}$=3.86, p=0.06) and dental NSD (($F_{(1, 22.37)}$=0.12, p=0.74). This implies that the numbness impact is fixed to the operation procedure rather than differential to the surgical extent of movement.

Inter-operator reliability

One assessor conducted the objective tests for thirteen participants and the other completed objective tests for fifteen participants. Inter-operator reliability identified either perfect or near perfect agreement between the assessors for 4 repeat readings carried out by both assessors with Cohen's Kappa values of 0.88, 1.00, 0.87 and 1.00 respectively.

DISCUSSION

Since first being described in 1927 for the correction of midface deformity[34], the Le Fort I osteotomy has become a mainstay in elective orthognathic surgical procedures. Despite all of the advancements made in perfecting the technique a variety of complications associated with its use have been documented with overall complication rates reported between 6.1-9%[35,36]. A recent systematic found that only 17.8% of publications relating to complications following orthognathic surgery were clinical trials[37].

Neurosensory deficit is widely reported in the literature as a complication of mandibular orthognathic surgery. The published literature and evidence base for neurosensory deficit in the maxilla following Le Fort I osteotomy is less well reported with heterogeneity in the methodology and assessment methods used leading to wide range of reported incidences. There is, therefore, a need for prospective clinical studies that add to the evidence available particularly, as neurosensory deficit is the most commonly reported complication following orthognathic surgery[37]. Capturing this data with valid and reliable methods is challenging especially in light of no standardised protocol available. There is, however, an evidence based protocol put forward which underpins the basic methodology in this study [14]

Objective evaluation found a high incidence of NSD immediately after surgery, particularly, for intra-oral mucosal sites (Figures 5a and 5b). There is a gradual reduction in NSD with the majority of improvement occurring between 1- and 6-months following surgery. The pattern of recovery is varied with extra-oral sites recovering to near baseline values between one to three months after surgery. Intra-oral soft tissues sites take between 3-6 months to recover to near baseline values suggesting their recovery is more prolonged . Finally, the pattern of recovery for the maxillary dentition is such that recovery of sensibility continues up until the

12 month time point. Neurosensory deficit intra-orally is a frequent finding following a Le Fort I osteotomy. Anatomically, the branches of the anterior, middle, and posterior superior alveolar nerves along with terminal branches in the vestibular mucosa are affected together with the nasopalatine nerve. A number of other authors have reported varying incidences of NSD following Le Fort I surgery[2-4]. The differences in results can be explained by variability in assessment method, length of follow up as well as dissimilarities in surgical technique and skill level of the surgeons. In keeping with the reported findings, other studies have found significant improvement in extra- and intra-oral NSD within the first 6-months following surgery[4,11]. Furthermore, the pattern of recovery appears to be similar with intra-oral mucosal NSD taking longer to improve in comparison to extra-oral NSD[4,11].

Few studies have assessed the effect of age, gender and extent of surgical movement following Le Fort I surgery, most studies which do, are associated with mandibular procedures. Gender and extent of surgical movement did not influence the extent of NSD reported in our study. In relation to gender and extent and of surgical movement these findings share similarities to other limited published literature[12,38]. Ueki et al. reported on 29 patients that underwent a Le Fort 1 osteotomy and found the extent of surgical movement did not influence neurosensory recovery[12]. A limitation of the aforementioned study was that it only assessed NSD in relation to the upper lip[12]. Alolayan and Leung conducted a comprehensive retrospective appraisal of risk factors associated with orthognathic surgery and found that age was not a risk factor to development of neurosensory disturbance for maxillary procedures[38]. Increasing age appears to be a risk factor for NSD early after surgery at intra-oral sites (especially the palate), however, longer-term no significant age related effects on NSD are found. With reference to the influence of age as a risk factor for NSD the literature is limited with regard to Le Fort I procedures. One study, reports an interesting finding when assessing the influence of age. At 6 months after surgery, increasing age appeared to be a risk factor for NSD but when the same cohort of patients was assessed long-term (12 and 24 months) age was not reported as a risk factor[38]. These Findings bear similarity to our results regarding the influence of age as a risk factor and highlight the importance of long-term follow of patients to fully assess the impact of age on NSD.

Authors of previous studies have discussed the importance of analysing subjective outcomes in conjunction with objective ones[27]. The ability to comparatively discuss the outcomes between the objective and subjective findings can put into context the pattern of recovery. There are limited studies which have reported on subjective outcomes following LF1 osteotomies, where they have, there are limitations[2,9]. A Visual Analogue Scale was chosen as a method to assess subjective changes in patient outcomes due to their high validity and reliability[39]. The questions chosen to ask the cohort, were designed to reflect how the NSD would potentially impact their daily lives. Other studies have asked their cohort to "rate changes in somatosensory sensitivity bilaterally" at differing sites[2].

The limitations of using a VAS in this study centres on the interpretation of symptoms by patients when reporting the outcomes following bi-maxillary surgery. In this study 17 patients underwent a bi-maxillary procedure with the remaining 11 having only a LF1O; this may have had a bearing on the subjective outcomes and thus, potentially, any conclusions drawn. However, crosstalk of reported symptoms that could have been recorded in the VAS were controlled primarily by instruction at each visit by the assessor to the patient, which was to report NSD relating to the maxillary anatomy only. It is clear from other studies assessing neurosensory recovery, that due to the complexity and individuality of treatment planning, it is difficult to identify a sufficient sample size of patients only undergoing maxillary osteotomies; most studies include and report on bi-maxillary osteotomies[2,4,9,40].

Overall, this study reports a positive improvement in subjective outcomes over the 12-month assessment period following a Le Fort 1 osteotomy for both intra-oral and extra-oral sites (Figure 7). There is a gradual reduction in how much NSD 'bothers' the patients with the greatest improvements reported as occurring within the first three months following surgery. Travess et al. (2008) followed up a of cohort 26 patients for six months following bi-maxillary surgery and reported similar findings with a gradual reduction in distress caused by sensory impairment over time with rapid improvement in the first six weeks after surgery[41]. Intra-oral sites present with slightly higher subjective NSD (mean VAS score of 6.2mm) at the end of the assessment period, even in the presence of lower objective outcomes; the converse was true for extra-oral sites (mean VAS score of 3.5mm). The results suggest patients are more

sensitive to intra-oral numbness at 12 months, however, not so concerned about extra-oral numbness (Table 7).

When comparing objective and subjective assessment of NSD there is a gradual reduction in mean scores over time highlighting a similar pattern of reporting between the two assessment methods. Long term recovery is only reported in a few studies; Nardi et al. (2002) found that 43% of their sample reported altered tactile and pain sensitivitiy in comparison to 17% reporting deficit through objective measures[42]. These findings compare favourbly to the subjective findings of this study, whereby at 12-months 35.7% of patients report NSD in the presecence of objective assessment methods recording an incidence of NSD at 17.9% (Table 1). Interestingly, the reported incidence of NSD (17.9%) assessed via objective testing does not change between 6 months to 12 months post surgery (Figure 4) . However, during the same time period the subjective scores reduce, suggesting a reduction in how much the sensory impairement bothers the patients. This finding is important and suggets a degree of adaptation to the exisiting NSD over a prolonged period following surgery. This observation is consistent with a a study that followed up 516 patients for 3 years following orthognathic surgery and found that patients seem to adapt to sensory impaiment following surgical intervention[43]. In another study, patients reported satisfaction and said they would recommend surgery to other patients despite the prescence of objective sensory impairment at 12-months with subjectively reported high levels of somatosensory change; thus, implying adaptation to existing NSD[2].

As with any area of research, this clinical study has both strengths and suffers from some limitations. The trial was conducted with a standarised methodology comparing both objective and subjective outcomes over a long duration. Very few studies of this nature exist with regard to the primary and secondary outcome measures assessed, thus, this paper adds to the evidence base surrounding NSD associated with LF1O. Three particpants did not complete the study and contributed to the smaller sample analysed over a 12 month period. Futhermore, the surgical procedures were carried by two experienced maxillo-facial surgeons with similar training and techniques so the results may lack generalisability.

Despite these limitations, in particular the limited sample size, the findings from this study have important clinical implications for health care professionals involved in providing orthognathic care, in particular, in relation to enhancing the consent process for informing patients regarding risks pertaining to NSD with Le Fort I surgery. Furthermore, it can help in understanding the pattern of neurosensory changes observed following Le Fort I surgery over a prolonged period of time and relate this to subjective patient perceptions with the aim to help counsel patients during the post-operative period.

Further robust clinical trials assessing complications of piezo-surgery compared with conventional osteotomy for Le Fort I procedures would add to the current limited evidence base in the literature. Additionally, qualitative based research exploring patients experiences and perceptions to long-term neurosensory deficit would aid clinicians and patients understanding in relation to the implications of prolonged NSD.

CONCLUSIONS

- NSD is high following Le Fort I surgery, particularly, intra-orally in the palate. At 12-months, the incidence of NSD is 17.9%
- Recovery of NSD to an insignificant value from baseline takes up to 3 months for extra-oral sites and between 3- 6 months for intra-oral soft tissues. The maxillary dentition continues to recover from NSD up to 12 months post -surgery.
- Age, gender and extent of the surgical movement do not influence the extent of NSD at 12 months. Increasing age is associated with increased NSD at intra-oral sites immediately after surgery.
- Intra-oral NSD is more of a concern to patients than extra-oral NSD. Patients concern associated with NSD reduces overtime demonstrating a degree of adaptation in the longer term.

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