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Assessment of olfactory function after septoplasty: A longitudinal study*

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SUMMARY

***Aim**: Aim of the study was to evaluate septoplasty-related changes of lateralised olfactory function during both early and late postoperative periods in comparison to the preoperative situation.*

***Material/Methods**: Lateralised olfactory function was assessed in 30 patients using the "Sniffin´ Sticks" test battery. Measurements were performed preoperatively, and 4 and 9 months postoperatively.*

***Results**: Prior to septal surgery measurements revealed significantly higher odor thresholds for the obstructed nostril compared to contralateral thresholds. No such observations were made for suprathreshold measures. Postoperatively, a significant decline of odor discrimination was found in comparison to the preoperative situation. However, there was no significant change of odor thresholds and odor identification function during the 9-month postoperative follow up. On an indvidual basis, one of the initially normosmic patients became hyposmic following surgery.*

***Conclusions**: The present data indicate that odor thresholds, but not suprathreshold olfactory function, are related to nasal obstruction resulting from septal deviation. In contrast, postoperative changes were only seen for odor discrimination. Apart from psychological explanations of this finding, it may be hypothesized that these observations result from changes in intranasal airflow following surgery.*

Key words: olfaction, identification, discrimination, thresholds, lateralisation

INTRODUCTION

Septoplasty is frequently performed in patients with nasal obstrucion. In general, this surgery produces a change in nasal respiratory air-flow which many patients experience as an improvement (Courtiss and Goldwyn, 1983). This change of nasal repiratory air-flow also seems to be beneficial to the patients' olfactory abilities (Masing, 1967; Damm et al., 2002). However, all nasal surgery may bear a certain risk to the sense of smell, even when it is performed in areas remote from the olfactory epithelium (Kimmelman, 1994). While reasons for this are not entirely clear they may include psychological factors (Youngentob et al., 1986; Dalton et al., 1997) or changes of intranasal volumes significantly related to olfaction (Leopold, 1988; Damm et al., 2002). Despite of this, only few studies have quantitatively investigated correlations between septoplasty and its outcome in terms of olfactory function (Damm et al., 2003; Dürr et al., 2002; Goldwyn and Shore, 1968; Kimmelman, 1994), partly due to the fact that septal surgery is performed in an area remote from the olfactory epithelium. Further, neither of these studies investigated lateralised olfactory function, and, more importantly, none of them looked at long-term changes. Thus, the aim of the present explorative study was to investigate how olfactory function changes over a period of 9 months following surgery. In addition, to specifically explore surgically-induced changes through surgery, measures should be obtained in a lateralised fashion.

MATERIAL AND METHODS

The study was conducted according to the Declaration of Helsinki on biomedical research involving human subjects; it was approved by the Ethics Committee of the University of Dresden Medical School. The investigation was a prospective, randomized study of consecutive patients presenting with a primary complaint of septal deviation. Investigations included a detailed, standardized history followed by a physical examination through an ENT-specialist including nasal endoscopy. All patients received CT-scans of the nasal cavities.

Participants

A total of 30 patients participated (23 male, 7 female; mean age 38 years, age range 19-61 years). Half of the patients had a

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right-sided septal deviation (9 male, 6 female; mean age 36 years, age range 20-61 years), the other half had a left-sided septal deviation (14 male, 1 female; mean age 39 years, age range 19-61 years). Prior to surgery, none of the patients was functionally anosmic. However, 6 of them (4 male, 2 female; mean age 43 years, 26-61 years of age) were diagnosed with hyposmia, the remaining 24 patients were normosmic (19 male, 5 female; mean age 37 years, age range 19-54 years).

Surgical procedure

In all patients septoplasty was performed according to Cottle (1948) using a conservative approach: after hemitransfixion incision, access was provided to both anterior and posterior deviations by dissecting the avascular subperichondrial plane. Then partial resections of the deviated areas were performed. Finally, the septal membranes were re-approximated and silicone splints were fixed on the nasal septum to prevent septal hematoma. Surgery was completed by intranasal packs which were removed at the second postoperative day. The silicon splints were removed at postoperative day 10.

Olfactory testing

Olfactory function was assessed using the "Sniffin' Sticks" test battery (n-butanol odor threshold, odor discrimination, odor identification) (Hummel et al. 1997; Kobal et al. 2000); categorization in terms of functional ansomia, hyposmia, or normosmia was based on the summated results from the 3 tests termed "TDI"-score (Kobal et al. 2000; Wolfensberger et al. 2000). In individual patients a clinically significant change of olfactory function was assumed in cases where the TDI-score differed by 6 points (Klimek et al. 1998). Investigations were performed before, 4 and 9 months after surgery. Olfactory function was assessed in a lateralized fashion with either one nostril sealed with odorless tape (Microfoam, 3M, Minnesota, MN, USA). In individual patients measurements always started at the same side. However, the side where olfactory testing started was randomized across all patients with regard to left- or right-sided septal deviation.

Statistics

Statistical analysis was performed using the software SPSS 10.0 (SPSS Inc., Chicago, IL, USA). Results were submitted to analyses of variance for repeated measures (ANOVA; general linear model; within subject factors "side tested", and/or "time"; between subject factor "septal deviation"). Degrees of freedom were adjusted according to Greenhouse-Geisser. In case the ANOVA yielded significant results, t-tests were employed for post-hoc comparions. Correlations were performed using statistics according to Spearman. The level of significance was 0.05.

RESULTS

The study started out with 30 patients; 5 of them did not return for testing 4 and 9 months after surgery, respectively.

Prior to surgery odor thresholds were found to be lower at the non-obstructed side (interaction between factors "side tested" and "septal deviation": $F[1,23]=12.7$, $p=0.002$) (Figure 1). No such differences were seen for odor discrimination or odor identification ($F[1,23]<0.18$, $p>0.67$). There were no significant main effects of the factors "side tested" and "septal deviation" ($F[1,23]<3.10$, $p>0.09$).

The difference in odor thresholds between obstructed and non-obstructed sides disappeared after surgery (Table 1). This was indicated by the significant interaction between factors "time" and "septal deviation" ($F[2,34]=5.39$, $p=0.01$). This interaction was only present for odor thresholds, but not for odor discrimination or odor identification ($F[2,34]<1.86$, $p>0.17$) indicating that suprathreshold odor perception did not change as a function of the obstructed or non-obstructed side.

Changes over the entire observational period became only significant for odor discrimination (factor "time": $F[2,44]=7.67$, $p=0.002$) (Figure 1), but not for odor thresholds or odor identification ($F[2,44]<0.76$, $p>0.45$). For odor discrimination, post-hoc testing indicated that measures taken 4 ($t=3.37$, $p=0.003$) and 9 months ($t=2.45$, $p=0.022$) after surgery were significantly lower compared to measures obtained before surgery. These changes seen for odor discrimination were not reflected in the overall TDI score (factor "time": $F[2,44]=2.71$, $p=0.086$) which indicates overall olfactory function (Figure 3).

On an individual level, 4 months after surgery changes of olfactory function in relation to baseline were seen in 6 of the 25 patients (Figure 2). Specifically, improvement was found in one patient (male; age 26 years). In 5 of these patients (4 male, 1 female; 29-39 years of age) olfactory function decreased; in 4

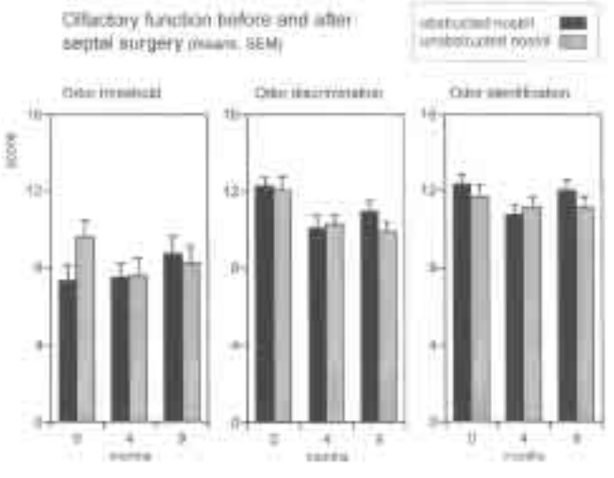

Figure 1. Olfactory function (odor thresholds, odor discrimination, odor identification) in patients before, 4 and 9 months following surgery for septal deviation separately for the obstructed (filled black bars) and non-obstructed nostril (filled grey bars) (means, standard errors of means). Prior to surgery, odor thesholds were different in relation to the nasal obstruction; following surgery, this difference disappeared. Suprathreshold odor discrimination was found to be significantly decreased 4 and 9 months following surgery.

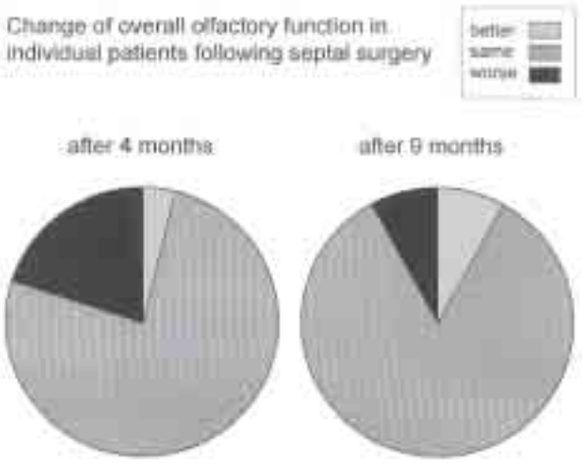

Figure 2. Change of overall olfactory function in individual patients in relation to baseline, 4 and 9 months following surgery for septal deviation. White areas indicate the number of patients who improved, black areas indicate the number of patients whose olfactory function decreased; grey areas indicate the number of patients where olfactory function did not change.

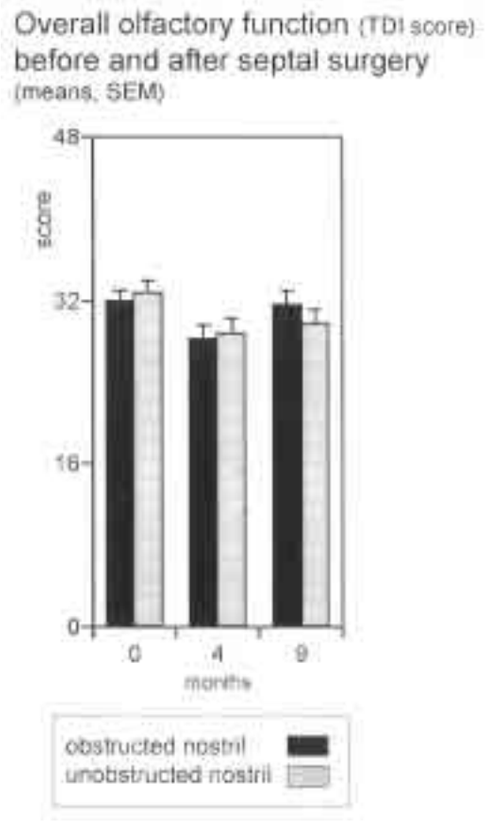

Figure 3. Overall olfactory function (TDI score) in patients before, 4 and 9 months following surgery for septal deviation separately for the obstructed (filled black bars) and non-obstructed nostril (filled grey bars) (means, standard errors of means). There was neither a significant difference between obstructed and non-obstructed nostril nor a significant change of function following surgery.

of them olfactory "status" changed from "normosmic" to "hyposmic". Of these 4 patients, 9 months after surgery, 1 patient still exhibited hyposmia (male; 36 years of age; TDI scores: before surgery – 31, after 4 months – 24, after 9 months – 21). Recovery back to normosmia was seen in 3 patients (2 male, 1 female; 27, 29, and 39 years of age). All of these patients had been diagnosed as normosmic at baseline examinations. None of the patients with unchanged olfactory function 4 months after surgery was found to loose olfactory function 9 months after surgery.

DISCUSSION

The current investigation produced three major findings. (1) Before surgery, odor thresholds, but not suprathreshold olfactory functions were related to nasal obstruction due to septal deviation. This difference in odor thresholds between obstructed and non-obstructed sides disappeared during the postoperative observation period. (2) During the postoperative period a significant decrease of odor discrimination was found whereas there was no change of odor thresholds and odor identification. (3) With regard to the entire sample, no significant change of overall olfactory function was found in the postoperative follow up. On an individual basis, however, one previously normosmic patient became hyposmic following surgery.

Septoplasty described by Cottle (1948) has become the standard procedure for the treatment of septal deviation. By this technique the olfactory epithelium (Kimmelman, 1994; Leopold et al., 2000) may only be influenced indirectly, e.g. through changes associated with air-flow. Even when considering the possibility that olfactory epithelium on the septum may be damaged in some of the patients, olfactory epithelium on the lateral wall of the nasal cavity is not affected at all through this type of surgery (Say et al., 2004). Partly due to these assumptions, the relationship between septal surgery and olfactory function has received relatively little attention (Goldwyn and Shore, 1968; Kimmelman, 1994; Dürr et al., 2002; Damm et al., 2003). After a postoperative period of 5.4 months, olfactory function obtained through an olfactory screening test was not significantly different from before surgery (Dürr et al., 2002). Data obtained by Damm et al. (2003) indicated that, 9 weeks after septoplasty in combination with turbinoplasty, surgery had a beneficial effect on olfactory function. In contrast, using an odor identification test (Doty et al., 1984), Kimmelman et al. (1994) reported a small proportion of patients (1.1 %) showing anosmia 2-4 weeks after surgery.

According to Masing (1967) the presently observed preoperative difference of odor thresholds between obstructed and non-obstructed sides may relate to patterns of airflow in the nasal cavity (compare Keyhani et al., 1997), although this relation would need to be substantiated in future experiments. Leopold et al. (1988) quantitatively investigated correlations of human olfactory function and nasal volumetrics in 34 hyposmic patients. They identified 3 areas influencing olfaction, namely (i) `the space anterior to, and no more than 5 mm

below, the cribriform plate´, (ii) ´the space between 10 and 15 mm below the cribriform plate´ and (iii) ´the space posterior to and between 10 and 15 mm below the cribriform plate´ (compare Hong et al., 1998). Subsequently, Damm et al. (2002) assessed the intranasal volume and its relation to olfactory function in normosmic subjects using MRI-scans. They found significant correlations between odor threshold measurements and volumes of the segment in the upper meatus directly below the cribriform palate and the anterior segment of the inferior meatus. No such correlations were observed for suprathreshold measures of olfactory function, namely odor discrimination and odor identification. In combination with the presently reported data obtained prior to surgery, these results seem to indicate that suprathreshold olfactory function exhibits only a weak correlation with the intranasal anatomy while such correlations are clearly present for odor thresholds. These assumptions are supported by more recent research based on the modeling of intranasal airflow (Zhao et al., 2003).

The present data also revealed a significant decrease of odor discrimination during the observational period, whereas there was no such change of odor thresholds and odor identification. In their study on septoplasty in combination with partial turbinectomy, Damm et al. (2003) found improvement of odor identification in 80%, odor discrimination in 70%, and odor thresholds in 54%, respectively. They concluded that “this type of surgery has a significant effect on olfaction”. With regard to surgery of the middle turbinate alone, Friedman et al. (1996, 1999) reported no significant changes of olfactory function tested by the University of Pennsylvania Smell Identification Test (Doty et al., 1984). Also, using an olfactory screening test, Dürr and colleagues did not see a major difference between smell function before and after septorhinplasty (Dürr et al., 2002). Similarly, the present data in patients receiving septoplasty only suggest that this type of surgery has little or no effect on overall olfactory function. However, a significant decrease of odor discrimination observed 4 and 9 months postoperatively indicated that olfactory abilities were somewhat reduced, at least in some of the patients. On an individual basis in one patient this resulted in hyposmia 9 months after surgery.

Results from these studies indicate that different surgical procedures may produce different outcomes in terms of olfactory function. As mentioned above, they may be explained, at least partly, through minute changes of air-flow patterns in relation to the respective surgical procedure employed. Considering that only certain intranasal volumes correlate with olfactory function (Leopold, 1988; Damm et al., 2002) it becomes clear that subtle change of these volumes may result in significant effects on olfactory function.

Finally, the presently obtained results did not reveal significant changes of the overall TDI-score in the postoperative follow-up. From that point of view relevant changes to olfactory function may not be expected after surgery. However, in the present study one normosmic patients became hyposmic and remained in this category even 9 months after surgery. In addition, Kimmelmann et al. (1994) reported the occurance of anosmia following septal surgery. Taken together, the present study indicates that surgical changes of the nasal pathways may change olfactory function, and, consecutively, may have a considerable impact on the patients’ quality of life (Miwa et al., 2001; Temmel et al., 2002). Future studies in larger groups of patients are needed to provide more information to the question whether the present observations are a spurious finding.

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