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"Functional Rhinofiller": Improvement of Nasal Airflow with Rhinofiller—A Retrospective Review

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Abstract

Introduction Rhinofiller is an aesthetic medical technique that can significantly enhance facial aesthetics by employing hyaluronic acid infiltration. The aim of this study is to review the impact of aesthetic rhinofiller on nasal airflow.

Methods This is a retrospective review of 63 consecutive patients. The evaluation of the change in nasal respiratory flow was performed subjectively using a Likert questionnaire and objectively using a rhinomanometer, which enabled active anterior rhinomanometry (AAR). Data were collected at pre-intervention, post-intervention, and at 6-month follow-up.

Results Among the 63 patients, the questionnaire responses resulted statistically significant both after the treatment and at the 6-month follow-up (p=0.00001). A statistically significant improvement was also observed at the rhinomanometric evaluation between pre-intervention and post-intervention (p=0.006 at 74 Pa, p=0.002 at 100 Pa, and p=0.001 at 150 Pa) and at the 6-month follow-up (p=0.008 at 74 Pa, p=0.003 at 100 Pa, and p=0.002 at 150 Pa). Differences between results were established with a Student's t-test. All p-values were two-tailed, and a value $<$ 0.05 was considered significant.

Conclusions Rhinofiller can be a valuable aid in enhancing both nasal airflow and facial aesthetics. Based on our experience, it resulted in an immediate post-operative improvement in nasal airflow that remains stable in the subsequent 6 months.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266. IV: Non-Surgical Procedures

Keywords Rhinofiller · Rhinomanometry · Nasal airflow · Functional rhinoplasty

Introduction

Rhinoplasty is one of the most widely performed aesthetic surgical procedures, ranking in the top five worldwide. Despite this, nasal filler, or rhinofiller, is an increasingly utilized non-invasive technique in the field of aesthetic medicine [1]. It can be defined as non-surgical rhinoplasty or liquid rhinoplasty with hyaluronic acid. It is a fast, non-invasive technique with immediate, albeit temporary, results. Usually, the duration of the results varies from 8 to 12 months. Establishing the exact longevity of rhinofiller is difficult, and in the literature, there are discordant data. The type of filler used influences the duration of the effect [2, 3]. Hyaluronic acid is injected into the deep dermis or subcutaneous tissue to modify the aesthetics of the nose [4]. However, it is important to note that this technique is not without risks. In fact, injecting product into the latter of

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vessels can cause tissue and skin necrosis. While there are numerous articles on functional nasal surgery in the literature, just two articles mention the potential functional impact of hyaluronic acid. In one case, it has been used with intranasal submucosal injections in patients with empty nose syndrome [5]. While Redaelli et al. described the possible use of infiltration of reticulated hyaluronic acid at the internal nasal level for the correction of the collapse of the triangular cartilages on the septum during a forced inspiration [6]. Therefore, the purpose of this study is to evaluate the effects of aesthetic rhinofiller on nasal airflow.

Materials and Methods

This is a retrospective review of consecutive patients treated with rhinofillers for aesthetic and functional purposes in the period between January and October 2023 at Centro Polispecialistico Calvani, Rome. All patients underwent hyaluronic acid infiltrations using the previously described technique. Nasal respiratory flow was assessed thought both subjective and objective methods. Regarding the subjective value, a validated questionnaire on the evaluation of nasal obstruction symptoms was used, which considered three parameters to which one could have a positive (+1), neutral (0), or negative (− 1) result: subjective perception of improved nasal respiratory function, enhanced daily and nightly respiratory comfort, and satisfaction with the aesthetic and functional results. Objective assessment was conducted using the rhinomanometer by performing active anterior rhinomanometry (AAR). The device used was the "RINOPOCKET ED200", which allowed us to calculate airflow and pressure gradients through the nostrils during a normal respiratory cycle. Rhinomanometric examinations were performed during three phases: pre-operative period, immediate post-operative period, and at 6-month follow-up visit. Our primary focus was on changes in the pressure gradient during inspiration at 75 Pa, 100 Pa, and 150 Pa. The questionnaire was administered both in the post-operative period and at the 6-month follow-up visit. No patients were lost at follow-up. To enhance the reliability and accuracy of the study's results, we applied exclusion criteria to the sample; all patients had never undergone any type of nasal surgery, whether cosmetic or functional, had not ever undergone decongestant or corrective medical therapy for their turbinate, had no history of previous cosmetic injection therapy, had not experienced significant trauma to the nasal area, and had not congenital anatomical impairment as deviated septum or hypertrophy of turbinate.

"Functional Rhinofiller" Technique

The technique used is based on the injection of hyaluronic acid at three specific points:

1. The dorsum
2. The anterior nasal spine, including the columella
3. The tip of the nose

The first infiltration is performed at the level of the dorsum, in the supraperiosteal plane (Fig. 1A). It is aimed at aesthetic correction of the nasal dorsum and harmonization of the face, making the profile more regular and achieving a suspension of the apical portion of the nose itself. This correction contributes to a more regular profile and a suspension of the apical portion of the nose. The area of the anterior nasal spine that extends to the columella is the second site that is treated. The first infiltration is performed deep onto the supraperiosteal plane at the level of the nasal spine. A second infiltration, which increases columellar rigidity, is made in the subcutaneous plane between the medial crus; the needle is bent at an acute angle to make this infiltration possible (Fig. 1B). Make a linear retrograde injection after the needle has been inserted all the way to the end of the crura; such injections allow the creation of a fictitious *columellar strut* by increasing the projection of the tip and the nasolabial angle. The third point is the tip of the nose, where product is infiltrated at both the subcutaneous and supracartilaginous levels (Fig. 1C). Multiple injections are performed closely together with the intention of lifting the tip while improving aesthetics and enhancing the opening at the level of the nostrils and external nasal valve.

As each nose is unique, we did not use the same amount of filler at each infiltration point. We used 0.7–1 ml of hyaluronic acid for each patient, depending on the level of correction required. A biphasic filler was used in all patients: This is a hyaluronic acid-based filler with a high G Prime (517 Pa) and a high cohesivity (54 gf) (LG YVOIRE, Y-Solution 720°).

Statistical Analysis

The Kolmogorov–Smirnov test for normality was performed for continuous variables. Normal distribution continuous variables are reported as mean and standard deviation. Differences between results were established with a Student's t-test. All p-values were two-tailed, and a value < 0.05 was considered significant. We considered the change of the pressure gradient during inspiration at 75 Pa, 100 Pa, and 150 Pa in the immediate post-operative period and at the 6-month follow-up.

The validated questionnaire for the subjective analysis considered three parameters to which one could have a

Figure 1 **A** Dorsum infiltration, **B** columella infiltration, and **C** tip infiltration

positive (+1) or negative result (− 1) or be neutral (0): subjective perception of improved nasal respiratory function, enhanced daily and nightly respiratory comfort, and satisfaction with the aesthetic and functional results. For each questionnaire parameter during the pre-operative period, a neutral value (0) was assigned, and the post-operative score was compared with the pre-operative score using a Student's t-test. For the 6-month follow-up, the same procedure was followed.

Results

The study involved 63 patients, including 53 women with ages ranging from 26 to 61 (mean 35.4, SD +/- 12.7), and 10 men aged between 18 and 47 (mean 27.9, SD 7.5) (Table 1). The AAR revealed a statistically significant mean decrease in the pressure gradient change during inspiration at 75 Pa, at 100 Pa, and at 150 Pa in the immediate post-operative period and at the 6-month follow-up (Table 2).

Considering the questionnaire (Table 3) in the immediate post-operative period for "subjective perception of improved nasal respiratory function", 55 patients yielded a positive result (+55), five patients yielded a negative result (− 5), and three patients yielded a neutral result (0). A significant improvement in subjective perception was observed (p=0.00001). For "enhanced daily and nightly respiratory comfort", 53 patients yielded a positive result (+53), six patients yielded a negative result (− 6), and four patients were neutral (0). A significant result was observed (p=0.00001). For "satisfaction with the aesthetic and functional results", 57 patients yielded a positive result (+57), two patients yielded a negative result (− 2), and four patients were neutral (0) (p=0.00001). Considering the entire questionnaire, the percentage of positive answers was 87.3%, a significant result was observed (p=0.00001). At the 6-month follow-up, the results remained statistically significant. No complications were reported.

Discussion

Overall, our study showed that patients who underwent rhinoplasty by rhinofiller improved with statistically significant value the nasal airflow as reported both from rhinomanometry data and from subjective questionnaire.

Figure 2 shows an AAR of a patient undergoing rhinofiller in the pre- and post-intervention. In the top row, the airflow is represented by the blue line (pre-intervention) and the red line (post-intervention). At 75 Pa, the flow changes from 0.0 to –279.3 indicating an improvement. These lines describe the trend of the nasal airflow; it can be visually appreciated how the pattern became more regular in the post-intervention period. In the bottom row, the green line illustrates the pressure gradient during the respiratory cycle. At 75 Pa, it decreases from 0.268 to 0.000 signifying a reduction in pressure. The results obtained

Table 1 Demographic characteristic of the sample

Demographic characteristic of the sample	Male	Female	Total
Sex	10	53	63
Age (mean)	27.9 (SD 7.5)	35.4 (SD 12.7)	31.7 (SD 10.6)

Table 2 Pressure gradient before and after treatment and at six-month follow-up

	Pre-operative mean	Post-operative mean	Procedure-induced change mean	t-test ($p<0.05$) after the procedure
Pressure gradient at 75 Pa	0.9 (SD 0.60)	0.34 (SD 0.29)	− 0.55 (SD 0.52)	*p=0.006*
Pressure gradient at 100 Pa	0.85 (SD 0.69)	0.27 (SD 0.33)	− 0.69 (SD 0.66)	*p=0.002*
Pressure gradient at 150 Pa	0.95 (SD 0.87)	0.09 (SD 0.25)	− 0.86 (SD 0.75)	*p=0.001*
	Pre-operative mean	Six-month follow-up mean	Procedure-induced change mean	t-test ($p<0.05$) 6-month follow-up
Pressure gradient at 75 Pa	0.9 (SD 0.60)	0.36 (SD 0.29)	− 0.52 (SD 0.50)	*p=0.008*
Pressure gradient at 100 Pa	0.85 (SD 0.69)	0.26 (SD 0.30)	− 0.68 (SD 0.64)	*p=0.003*
Pressure gradient at 150 Pa	0.95 (SD 0.87)	0.07 (SD 0.21)	− 0.83 (SD 0.70)	*p=0.002*

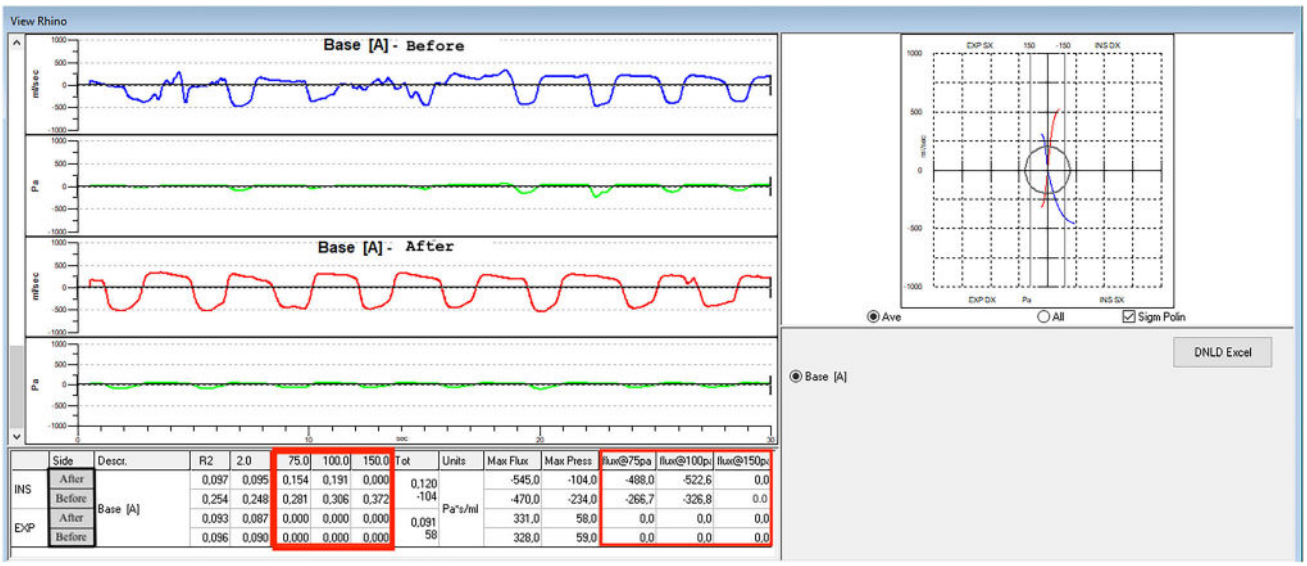
Table 3 Two-tailed t-Test of the questionnaire

Questionnaire	Before treatment mean	After treatment mean	Six-month follow-up	t-test after treatment ($p<0.05$)	t-test 6-month follow-up ($p<0.05$)
Subjective perception of improved nasal respiratory function	0	0.79 (SD 0.57)	0.75 (SD 0.62)	p=0.00001	p=0.00001
Enhanced daily and nightly respiratory comfort	0	0.75 (SD 0.62)	0.71 (SD 0.66)	p=0.00001	p=0.00001
Satisfaction with the aesthetic and functional results	0	0.87 (SD 0.42)	0.79 (SD 0.54)	p=0.00001	p=0.00001
Questionnaire in total	0	0.80 (SD 0.55)	0.73 (SD 0.60)	p=0.00001	p=0.00001

reflected an improvement in nasal airflow following rhinofiller, performed according to the technique described above. If we also observe Fig. 3, it is possible to appreciate an important aesthetic change. It is evident how the initial downward projection of the nasal tip changes to an upward projection after treatment with hyaluronic acid. The dorsum was camouflaged by the filler treatment. Additionally, can be appreciated how the nasolabial angle was increased, leading not only to an aesthetic effect but also to an improvement of the nasal airflow. The filler used possesses a very high G Prime a high cohesivity, and these characteristics played a crucial role in achieving the described results. This technique has not been tested with other types of fillers with different characteristics.

Regarding the subjective questionnaire, we observed that the patients were aware of the improvement in nasal airflow, as well as being satisfied with both the functional and aesthetic results. A statistically significant score was recorded at the post-operative period and at the 6-month follow-up

The demand for rhinofiller treatments is on the rise, and it is a subject of increasing discussion in scientific literature. Although the infiltration points are almost always the same, various techniques are employed. With this study, our aim was to investigate the impact of aesthetic rhinofiller on respiratory airflow. We performed rhinomanometry as it is an easy and minimally invasive diagnostic technique useful for measuring the air resistance as it passes through the nasal cavities. While there is still no gold standard method for measuring changes in nasal airflow resulting from surgical and non-surgical procedures, many studies in the literature describe rhinomanometry as a useful and reliable technique [7, 15]. It has been used to evaluate differences in nasal respiratory flow in patients undergoing functional septoplasty [8] and to compare the outcomes of functional rhinoplasty between open and closed techniques [9]. André et al. [7] with a systematic review aimed to compare subjective and objective airway assessment. The causes of nasal obstruction are multiple, ranging from structural to mucosal problems to psychological factors, which is why it is



	Side	Descr.	R2	2.0	75.0	100.0	150.0	Tot	Units	Max Flux	Max Press	flux@75pa	flux@100pa	flux@150pa
INS	After	Base [A]	0,097	0,095	0,154	0,191	0,000	0,120 -104	Pa*s/ml	-545,0	-104,0	-488,0	-522,6	0,0
	Before		0,254	0,248	0,281	0,306	0,372			-470,0	-234,0	-266,7	-326,8	0,0
EXP	After		0,093	0,087	0,000	0,000	0,000	0,091 58		331,0	58,0	0,0	0,0	0,0
	Before		0,096	0,090	0,000	0,000	0,000			328,0	59,0	0,0	0,0	0,0

Figure 2 AAR in the pre-intervention and in the post-intervention

Figure 3 Patient before and after "functional rhinofiller"

always challenging trying to objectify this data. In this study, rhinomanometry was considered a valid tool for obtaining objective results, although it is not yet recognized in routine rhinologic practice or for quantifying surgical results. Our device had also been tested by the Italian National Research Centre. The device was equipped

to detect alterations in a patient's breathing patterns, whether they increase or decrease the force of inhalation and exhalation; in response, the device repeats the examination. Therefore, thanks to this feature, it allowed us to observe the change in airflow and the change in pressure gradient brought by the hyaluronic acid treatment. The term functional rhinoplasty in the literature indicates procedures that address nasal obstruction at the level of the nasal valve [11, 14, 17]. This term is used to differentiate procedures aim to correct nasal obstruction from those that only address the aesthetic aspect (rhinoplasty). Surgical techniques performed to improve the functional aspect include procedures that affect the nasal septum (septoplasty) [12], as well as the internal and external nasal valve, turbinates, and the nasal vestibule [13, 14]. The structure and function of the nose are intimately and closely related: Procedures performed with the intention of changing its aesthetic appearance may affect its function and vice versa [4, 12, 14]. This relationship must be considered when advising patients and conducting nasal surgery for either cosmetic or functional purposes. The injection points described in the "functional rhinofiller" technique closely resembles the principles employed in functional rhinoplasty. According to Bernoulli's principle [14], the airflow passing through a narrowed segment accelerates, leading to a decrease in intraluminal pressure. The airflow changes from laminar to turbulent [7]. This happens at the level of the nasal valve which, when narrowed, leads to a collapse of the side walls of the nose resulting in obstruction of the nasal respiratory airflow and thus increasing the development of turbulences. The collapse of the nasal valve can be attributed to either a reduced size of the nasal valve or a lack of rigidity in the side walls. Hyaluronic acid infiltrations offer a solution to address both aspects, as they can increase the size of the nasal valve and provide more rigidity at the columella and anterior nasal spine. As a result, airflow increases. Zhao et al. reported a meta-analysis with a collection of 2024 patients who underwent functional rhinoplasty for nasal obstruction due to nasal valve collapse [11]. The external nasal valve consists of the lateral and medial crura, the premaxilla, and the caudal cartilage of the septum [16]. The rhinofiller technique targets the medial crura and the premaxilla with the second infiltration point (columella and anterior nasal spine). This approach was designed to address the external nasal valve. In a study conducted by Alan et al. [10], the effects of rhinoplasty with nasal dorsal preservation were compared to the classical technique. The results were obtained using patient-reported outcome measures (PROMs) and objective data obtained using rhinomanometry. The study found that both aesthetic and functional results could also be achieved with the preservation technique. We observed that even without any change in bone structure, an improvement in nasal airflow could be achieved using rhinofiller. Hyaluronic acid infiltrations at the supraperiosteal level allowed an aesthetic correction of the dorsum and a lift the entire caudal portion of the nose without, however, morphologically changing the bone component. Despite this, rhinofiller should not be compared to functional correction surgery, but we believe that in some cases, it can be a valuable aid in the short to medium term. It should not only be considered as a treatment that aims at better nose aesthetics and facial harmony, but also as a treatment that can improve nasal airflow. We could refer to this technique as "functional rhinofiller".

Study Limitation

As limitations, our study is a retrospective monocentric analysis with a relatively small sample size of patients. Furthermore, the technique cannot provide benefits in patients with significantly stenosed turbinate hypertrophy or deviated septum. A prospective study with a larger patient sample, which considers changes in the tip projection angle and at the nasal valve before and after treatment, may be advisable to demonstrate the effectiveness of this innovative technique. Furthermore, a comparative study between "functional rhinofiller" and functional rhinoplasty may be recommendable to understand how significant the nasal airflow improvement is.

Conclusion

"Functional rhinofiller" can be a valuable aid in enhancing both nasal airflow and facial aesthetic. Based on our experience, it resulted in an immediate statistically significant post-operative improvement in nasal airflow that has remained stable in the subsequent months. Patients reported a high satisfaction rate with both the improvement in nasal airflow and the aesthetic result.

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Declarations

Conflict of Interest The authors have no financial relationships or conflict of interest to disclose.

Human and Animal Rights Statement All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent had been obtained from the patients for the procedure and for the use of photographs.

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