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ORIGINAL ARTICLE

Rhinometry: An Important Clinical Index for Evaluation of the Nose Before and After Rhinoplasty

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Abstract
Background Preoperative planning and postoperative outcome assessment in rhinoplasty are important. For preoperative planning, some standard relationships are defined and evaluated primarily with standard photographs, but photographs do not necessarily reflect reality. Outcome assessment, on the other hand, is mostly subjective, and again, even photographic analyses may not address real changes after rhinoplasty.
Methods "Rhinometry" is introduced as a clinical method for preoperative evaluations and postoperative judgments, and rhinometric parameters are defined. Measurements of these parameters were performed for 300 patients before rhinoplasty and in the follow-up visits 3 months postoperatively.
Results Preoperatively, the nasal length and tip projection for most patients were more than ideal. There was moderate reduction in nasal length (mean, 9.21 mm) and a decrease in tip projection (mean, 3.34 mm) for the majority of the patients after rhinoplasty. Reductions in nasal length, tip projection, bony base width, alar base width, and alar base width during a smile were statistically significant. Patients who underwent surgery using the closed approach had significantly more reduction in nasal length and less reduction in tip projection. All the patients were satisfied with these pre- and postoperative data. Rhinometry changed the ideas of the authors about some changes that their operative approaches produce.
Conclusions Rhinometry can change the ideas of plastic surgeons about the changes their operative approaches accomplish and can be a very useful guide for patients. It is recommended as a part of the pre- and postoperative physical examination of patients undergoing rhinoplasty.

Keywords Evaluation · Outcome · Rhinoplasty

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The aim of rhinoplasty is to create a nose aesthetically pleasing to the patient without compromising nasal function [6]. Aesthetic surgeons should have an idea of nasal aesthetics. Standard relationships between various areas of the head and face were formulated by scholars and artists of the Renaissance based on clinical Greek canons [10]. These formulas referenced an artistic ideal of beauty [13].

Neoclassical canons are well known to plastic surgeons, but their use has been limited to the role of working guides [10]. The average proportions differ from the widely used aesthetic standards [13]. Ideal aesthetic proportions, angles, and geometric relationships are not exactly seen in beautiful faces, and cannot be obtained surgically in the general population [23].

All of us have an inborn sense of beauty, and recent findings indicate that this perception is, or is becoming, consistent across races and cultures [16]. Some patients seek a beautiful nose, but rhinoplasty is very often performed to correct shape changes caused by trauma, to correct asymmetries, and to obtain a normal-looking nose. Therefore, it may be false to assume that all patients necessarily prefer beauty to correction of specific shape changes [5]. Besides, preoperative planning is based mainly on photographic measurements and does not necessarily reflect reality.

Patients seeking rhinoplasty frequently have dimensional abnormalities, including excessive or inadequate nasal length or tip projection [7]. Many patients seek

reduction in dimensions, but most do not recognize that a simple nasal reduction may not achieve their goals [8]. In rhinoplasty, the difference between a good result and a poor result can be measured in millimeters [19]. Most often, patients, and sometimes surgeons, do not have an idea of the real changes that occur after rhinoplasty. A nose, for example, may appear short due to the high position of the cephalic edges of the alar cartilages and the wide intercrural space. Their correction makes the nose appear longer when it actually has become shorter [21].

Many studies have recommended assessing the outcome of aesthetic surgeries subjectively by measuring quality of life or the patient's opinion via questionnaires [2, 12, 15, 17]. Asking about patient satisfaction is a qualitative way to assess rhinoplasty outcome [9, 11]. No method has been validated in the clinical settings [1, 3]. Objective quantification of the outcome for plastic surgery is important, but measures still are elusive [14].

Photographic evaluation, using varied parameters, has been applied for outcome assessment [20]. Photographs, as two-dimensional views, do not assess the detailed depressions, projections, and asymmetries shown by other views. For example, if a nose is deviated to the right side, a right-angled triangle can be imagined in the frontal view so that its longer side is the nose, another side is the vertical midline, and the last side is a horizontal line drawn at the nasal tip level. We measure the vertical side during photography analysis, but that is less than the real nasal length. If we straighten the nose during the operation without any change in nasal length, the nose will seem elongated in the postoperative photographic analysis. Similarly, such a triangle can simply be drawn for almost all patients in the sagittal plane because the radix is almost always posterior to the tip. We measure the vertical side of the triangle during photographic analysis, whereas the real nasal length is longer. Change in tip projection may affect nasal length in postoperative photographic analysis and vice versa.

Actual preoperative dimensions and postoperative changes can be obtained only by physical, three-dimensional measurements. In this study, we define real clinical measurements of the nose per se as "rhinometry," used as an adjunct to preoperative physical examination and postoperative judgment, but nevertheless an important aspect of the evaluation. We also examine the changes in rhinometric parameters using clinical pre- and postoperative measurements.

Patients and Methods

Measurements

The authors began clinical measurements together with photographic assessments for patients seeking rhinoplasty in 2005. The following clinical measurements, termed "rhinometric parameters," were done with slide-calipers:

1. Nasal length (L), defined as the maximum distance from radix to nasal tip (any part above the columella) (Fig. 1)
2. Tip projection (P), defined as the distance from the alar–cheek junction to the most projecting point of the tip (Fig. 2)
3. Bony base width (BB), defined as the widest distance between bases of the nasal bones at the junction of the nasal bone and the maxilla (Fig. 3)
4. Alar base width (AB), defined as the distance between the outermost points of alar bases at the junction of the alar base and the lip (Fig. 4)
5. Alar base width during a smile (AS), defined as the alar base width during a full smile (Fig. 5)
6. Right alar base to columellar base distance (RA)
7. Left alar base to columellar base distance (LA), measured with a horizontal ruler at the level of the columellar base in one hand while the vertical distance of the alar base is measured with this ruler on each side with the other hand (Fig. 6).

Two other measurements were performed for evaluation of the face:

8. Upper facial third (UF), defined as the distance from the trichion to the radix (Fig. 7)

Fig. 1 Measurement of nasal length

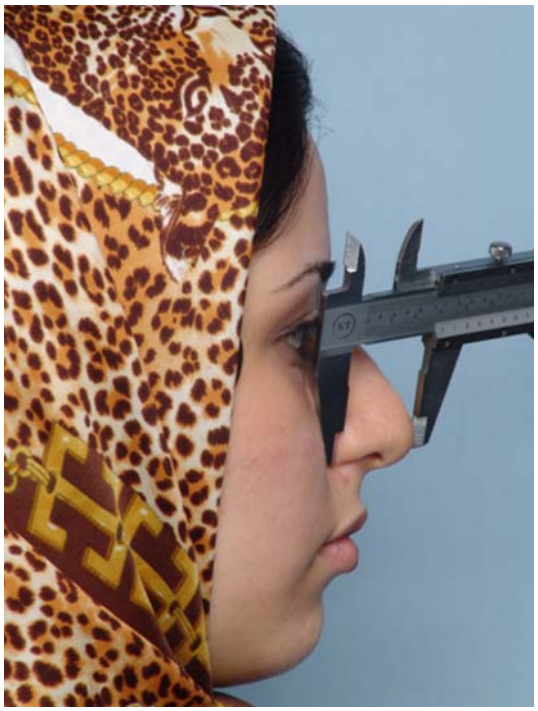

Fig. 2 Measurement of tip projection

Fig. 4 Measurement of alar base width

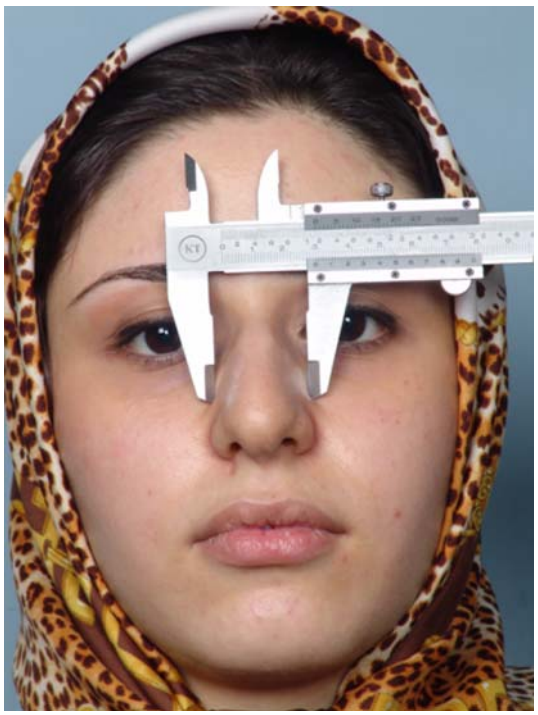

Fig. 3 Measurement of bony base width

Fig. 5 Measurement of alar base width during a smile

9. Lower facial third (LF), defined as the distance from the columellar base to the most inferior point of the chin (Fig. 8).

All measurements were performed in millimeters by the first author using slide-calipers, then checked by the second author. These measurements were performed once before the

Fig. 6 Measurement of left alar base to columellar distance

Fig. 7 Measurement of upper facial third

operation and many times after the operation during all the visits. (Although the results of each visit are not provided in this article, measurements were performed routinely and checked for any incompatibility among them.)

Fig. 8 Measurement of lower facial third

Patients

Patients with any history of nasal fracture and those with surgery or any gross facial or nasal deformity were excluded from the study, although the authors performed measurements routinely in all cases.

A total of 300 adult women and men 18 to 30 years of age presenting for rhinoplasty were studied. During the operation, hump reduction was performed with rasping of the bony dorsum and resection of the dorsal cartilaginous septum, if indicated. Nearly all the patients underwent cephalic resection of the lower lateral cartilages, but no transection or resection of the lower lateral cartilages in medial, middle, or lateral parts was performed for tip setback.

Columellar strut grafts were used routinely for all open and some closed rhinoplasties. Tip-plasty with sutures was performed for most patients when needed, but tip grafts were used sparingly. Infracture was performed using the internal approach through a small internal incision in the piriform aperture area.

Follow-up measurements were performed during the visits 3 months after the operations. The patients were informed about these measurements. Consent was obtained, and the results were provided to the individual patient. The patient's satisfaction with these data was assessed during the follow-up visits.

Statistical Analysis

Statistical analyses were performed with the statistical package SPSS 13.0 for windows provided by SPSS Inc. (Chicago, IL, USA). Scale numeric variables were expressed as mean, range, and standard deviation, and rates as percentage. Comparison of means before and after the operation was performed with paired-samples t test, and between groups with independent-samples t test. Comparison of data between categories was performed with the Pearson chi-square test. A p value less than 0.05 was considered statistically significant.

Results

Most of the patients were women (81.7%) with a mean age of 22.49 ± 2.425 years. The preoperative measurements of faces and noses are shown in Table 1.

Generally, the lower facial third was larger than the upper third (mean, 6.4 ± 7.596 mm). In 7% of the cases, they were equal, whereas in 74.3% of the cases, the lower third was larger than upper third (maximum, 23 mm) and in 18.7%, the lower third was smaller than the upper third (maximum, 13 mm).

In all the patients, the length of the nose was more than the ideal nasal length (RTi, defined as lower facial third × 0.67) [7] (mean, 13.32 ± 4.373; minimum, 3.1; maximum, 24.4), and this also was the case if the ideal nasal length was defined as the upper facial third × 0.67 (mean, 17.61 ± 5.919; minimum, 4.4; maximum, 31.5). In 93% of the cases, tip projection was more than the ideal projection (defined as RTi × 0.67) [7].

Nasal length was significantly greater in men (mean, 60.75 ± 7.103 mm) than in women (mean, 56.77 ± 5.016 mm; $t = 4.884$; $p < 0.001$). Tip projection, too, was significantly greater in men (mean, 36.60 ± 4.271 mm) than in women (mean, 34.35 ± 2.684 mm; $t = 4.977$; $p < 0.001$).

In 70.7% of the cases, rhinoplasty was performed using the closed approach (for 69.4% of the women and 76.4% of the men). The approach selected did not differ significantly between the sexes (chi-square = 1.054; $df = 1$; $p = 0.304$). The postoperative measurements are shown in Table 2.

The mean change in nasal length after the operation was a reduction of 9.21 ± 4.502 mm, and the mean change in tip projection was a reduction of 3.34 ± 2.376 mm. Nasal length was reduced in 98%, increased in 1%, and not changed in 1% of the cases. Tip projection was reduced in 92.3%, increased in 3%, and not changed in 4.7% of the cases. The mean bony base width reduction was 2.73 ± 1.399 mm. The mean alar base width reduction was 2.16 ± 1.527 mm, and mean reduction in the alar base width during a smile was 3.78 ± 2.049 mm after the operation. The length was significantly reduced after the operation ($t = 35.424$, $p < 0.001$). Projection also was significantly reduced after the operation ($t = 24.375$; $p < 0.001$). Bony base width ($t = 33.747$; $p < 0.001$), alar base width ($t = 24.542$; $p < 0.001$), and alar base width during a smile ($t = 31.943$; $p < 0.001$) also were significantly reduced after the operation.

The mean reduction of nasal length in the men was greater (mean, 9.84 ± 7.205 m) than in the women (mean, 9.07 ± 3.638 mm), but the difference was not statistically significant ($t = 1.149$; $p = 0.252$). Conversely, the mean reduction of tip projection in the men was less (mean, 3.13 ± 3.180 mm) than in the women (mean, 3.39 ± 2.160 mm). Again, the difference was not statistically significant ($t = 0.746$; $p = 0.456$).

The postoperative nasal length was closer to RTi (ideal nasal length based on the lower facial third) than the preoperative nasal length (mean difference from RTi, 4.1 mm vs 13.3 mm preoperatively; $t = 35.424$; $p < 0.001$). The postoperative tip projection also was closer to the ideal projection (RTi × 0.67) than the preoperative projection (mean difference from the ideal projection, 1.8 mm vs 5.2 mm preoperatively; $t = 24.375$; $p < 0.001$).

Table 1 Preoperative measurements of the face and nose

	Minimum (mm)	Maximum (mm)	Mean (mm)	SD
Upper facial third	45	84	59.54	7.556
Lower facial third	50	85	65.95	5.760
Nasal length	42	80	57.50	5.658
Tip projection	27	42	34.76	3.152
Bony base width	24	35	29.16	2.703
Alar base width	25	38	31.25	3.051
Alar base width during smile	32	43	37.23	2.883
Right ala-columella height	1	9	4.74	1.502
Left ala-columella height	1	8	4.60	1.301

SD, standard deviation

Table 2 Postoperative measurements of the nose

	Minimum (mm)	Maximum (mm)	Mean (mm)	SD
Nasal length, postop	36	55	48.29	3.709
Tip projection, postop	25	38	31.42	2.665
Bony base width, postop	23	31	26.44	1.956
Alar base width, postop	23	35	29.09	2.754
Alar base width during smile, postop	27	40	33.45	3.067

SD, standard deviation; postop, postoperative

The patients who underwent surgery with the closed approach had significantly greater reduction in nasal length than those who had surgery by open procedure (mean reduction, 9.71 vs 7.99 mm; $t = 3.061$; $p = 0.002$). On the other hand, the patients who underwent surgery with the open approach had a significantly greater reduction in tip projection than those who had surgery by closed procedure (mean reduction, 4.07 vs 3.04 mm; $t = -3.467$; $p = 0.001$).

A total of 181 patients fulfilled 12 months of follow-up evaluation. The nasal length was decreased an average of 0.36 ± 0.556 mm, as measured at 3 months. The nasal length reduction during this follow-up period (3–12 months) was greater for the patients who had surgery using the open approach (mean, 0.47 ± 0.644 mm) than for those who had surgery using the closed approach (mean, 0.32 ± 0.514 mm), but the difference was not statistically significant ($t = 1.698$; $p = 0.091$). The mean reduction in tip projection after 12 months of follow-up evaluation compared with measurements at 3 months was 0.38 ± 0.497 mm. It was significantly more in the open group (mean, 0.57 ± 0.500 mm) than in the closed group (mean, 0.30 ± 0.477 mm; $t = 3.364$; $p = 0.001$).

All the patients expressed satisfaction with these pre- and postoperative data when they were simply asked about the results. Some pre- and postoperative cases are presented in Figs. 9 to 11.

Discussion

Preoperative assessment of nasal aesthetics is an integral part of preoperative planning. What occurs after the operation is not exactly what patients and surgeons see and feel. Subjective impressions can differ from objective realities, and this is most often the case. Objectively determined postoperative changes can be interesting for the patient and the surgeon, can facilitate communication between them, can help in outcome assessment, and can provide a guide for future cases.

Generally, patients seek rhinoplasty mainly for reduction in the dimensions of their nose. We are many times faced with questions such as "How much do you think my nose will shorten?" or "Can you make my nose as small as possible?" The nose is a polyhedral organ, and patients, especially after rhinoplasty, note its details from many aspects. It is an exposed organ and, unlike other organs, many relatives, friends, colleagues, and others express their ideas about it. Generally, patients forget the look of their preoperative nose very soon after the operation and may not appreciate true changes in it.

Surgeons, on the other hand, note other aspects of the nose and know they cannot do everything. They realize that some things cannot be, or should not be, changed. But most ideas are subjective, and documentation is imperative. Before this study, for example, the authors believed that for most patients, a perfect postoperative result is achieved by minimal reduction in nasal length (2–4 mm) and an increase in tip projection. Surprisingly, this study showed that these perfect results were achieved by a moderate reduction in nasal length (average, 9.21 mm) and a decrease in tip projection for the majority of patients. Such a surprising amount of nasal length shortening may be related to our Middle-Eastern patient population (the preoperative nasal length was more than the ideal length by an

Fig. 9 Pre- and postoperative views of patients undergoing rhinoplasty

Fig. 10 Pre- and postoperative views of patients undergoing rhinoplasty

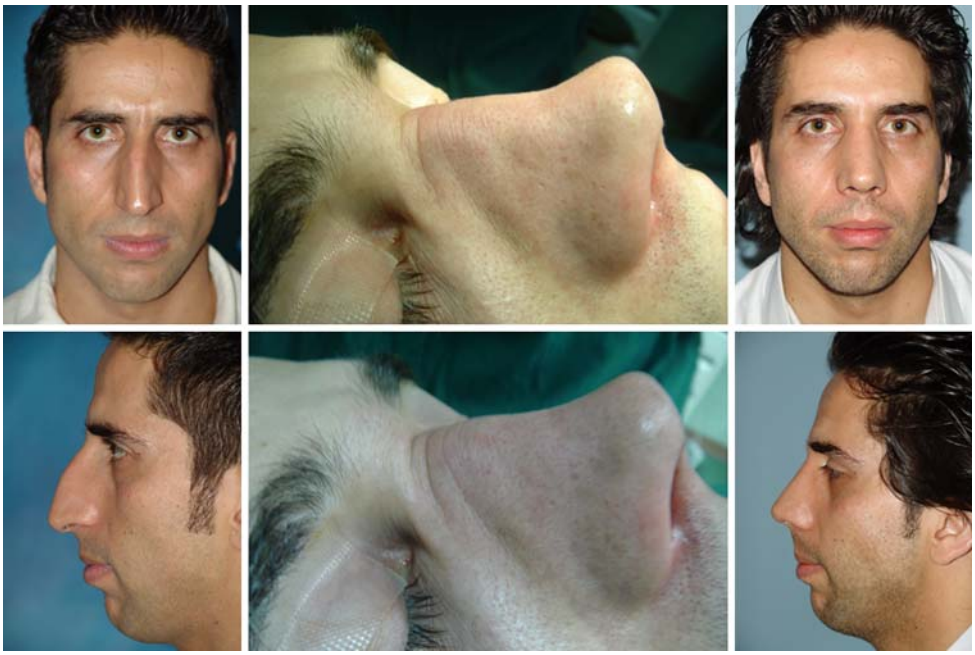

Fig. 11 Pre- (*left*), post- (*right*), and intraoperative (*center*) views of a patient demonstrating reduction in nasal length

average of more than 13 mm). Further studies are needed in other ethnic populations using pre- and postoperative rhinometry to address this issue.

Other studies also have reported decreased projection measured in most of their patients unless tip grafts were used [4, 18, 22]. We used columellar strut grafts routinely for all open rhinoplasties and some closed operations, but tip grafts were used only sparingly. Patients with a loss of tip projection had apparently increased projection postoperatively, but rhinometry showed that the reverse was true. This may be explained partly by the effect of the reduction on the dorsum or the decrease in nasal length or alar base width on apparent tip projection.

Conclusions

Rhinometry can be used as a guide for preoperative planning and as an instrument for assessing operation outcome and for comparing different procedures that play a role in any given aspect. Many surprising features of rhinoplasty may be extracted from the data it provides, such as the

postoperative change in tip projection we encountered. It can change ideas of plastic surgeons about the changes their operative approaches produce and can be a guide for patients. It is recommended as a part of pre- and postoperative physical examination for patients undergoing rhinoplasty.

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