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Review Article

Risks and complications in rhinoplasty

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Abstract

Rhinoplasty is regarded to be associated with many risks as the expectations of patient and physician are not always corresponding. Besides of postoperative deformities many other risks and complications have to be considered.

Reduction-rhinoplasty e.g. can cause *breathing disturbances* which are reported in 70% of all revision-rhinoplasty-patients. One has to be aware however that scars and loss of mucosal-sensation can also give the feeling of a "blocked nose".

The main risks of autogenous *transplants* are dislocation and resorption, while alloplasts can cause infection and extrusion. In this respect silicone implants can have a complication rate between 5-20%. Less complications are reported with other materials like Gore-Tex.

Complications of *skin* and *soft tissues* can be atrophy, fibrosis, numbness, cysts originating from displaced mucosa or subcutaneous granulomas caused by ointment material. Postoperative swelling depends mainly on the osteotomy technique. Percutaneous osteotomies cause less trauma, but may result in visible scars.

Infections are rare but sometimes life-threatening (toxic-shock-syndrome). The risk is higher, when sinus surgery and rhinoplasty are combined. Osteotomies can also cause injuries of the *orbital* region. Necrosis of eye-lids by infections and blindness by central artery occlusion are known. There are reports on *various* other risks like rhinoliquorrhea, brain damage, fistulas between sinus-cavernosus and carotid artery, aneurysms and thrombosis of the cavernous sinus. Discoloration of incisors are possible by damage of vessels and nerves. Rhinoplasty can also become a *court-case* in dissatisfied patients, a situation that may be called a "typical complication of rhinoplasty". It can be avoided by proper patient selection and consideration of psychological disturbances.

Postoperative deformities are considered as main risks of rhinoplasty, causing revision surgery in 5% to 15% of the cases. The analysis of postoperative deformities allowes the identification of specific risks. The most frequent postoperative deformity is the "pollybeak" when a deep naso-frontal angle, cartilaginous hump and reduced tip projection are present preoperatively. The pollybeak is the indication in about 50% of all revision rhinoplasties. Other frequent postoperative deformities are a pendant and wide nasal tip, retractions of the columella base or irregularities of the nasal dorsum. These deformities are very often combined and caused by a loss of septal support. This is why the stability of the caudal septum in septorhinoplasty is the key for a predictable result. Maintaining the position of the tip and the columella is one of the main issues to avoid typical postoperative deformities.

The risks for rhinoplasty-complications can be reduced with increasing experience. A prerequisite is continuing education and an earnest distinction between complication and mistake.

1 Complication or mistake?

Rhinoplasty is considered to be an operation with high risks, primarily because of the limited predictability of the aesthetic result. What are the reasons? A perfect result immediately after surgery may be totally different one year later. Reports on long term results of rhinoplasty are rare. Limited predictability is mainly due to the dynamics of the healing process. Many different types of tissues are involved: bone, cartilage, mucosa, skin, fat, fascia, muscles, nerves, vessels, perichondrium and periosteum. The individual reactions of these tissues are not always under the control of the surgeon. This is especially true for cartilage, the main supporting structure of the nose.

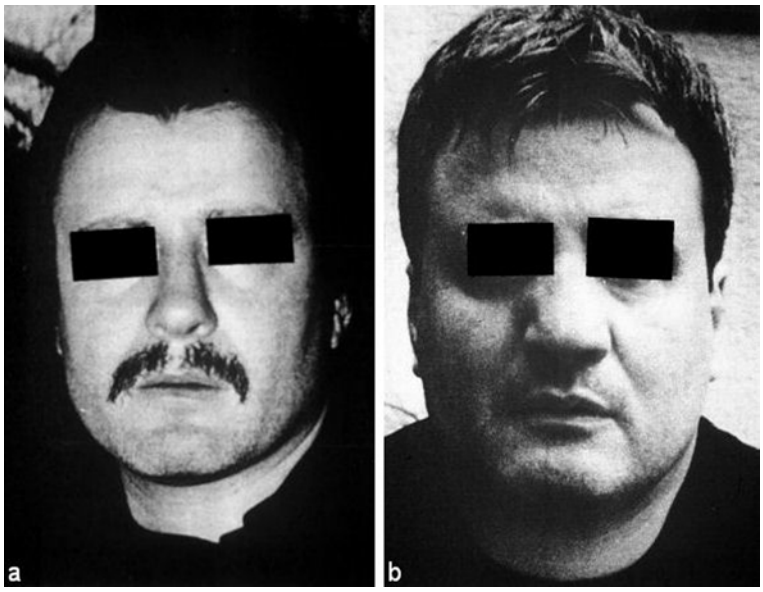


Figure 1: Persistent obstruction after multiple septorhinoplasties a) Preoperative: Moderate deviation of nasal dorsum b) After 7 operations: Excessive widening of nostrils by implants

An unfavourable result of rhinoplasty is clearly visible ("everybody is an expert"). The patient very often blames the surgeon for this result while the surgeon tends to call it a complication. In principle, both are possible and cannot be definitely distinguished in many situations. Complications are effects of the individual reaction and the healing process. They are not under the control of the surgeon. In this case the physician has to identify the complication early enough and react adequately. Some "complications" however are in fact a mistake in preoperative analysis or surgical planning, in applying an inadequate technique or in postoperative care [1]. An earnest analysis is essential for prevention. The main issues of this article are postoperative deformities, their frequency and possible factors. It does not deal with the numerous techniques for revision surgery but with the types of deformities and their prevention. Risks and complications of rhinoplasty are emphasised and the nasal septum only adressed if it is an essential part of the deformity. Besides these deformities other risks and complications are reported in the following chapter.

2 Special risks and complications

2.1 Functional disturbances

Certain deformities like twisted noses and tension noses are associated with breathing problems. In these cases, rhinoplasty is indicated to improve function. On the other hand rhinoplasty can reduce the cross sectional area of the nasal airways. As a result 10% of the patients after primary rhinoplasty complain about residual or new breathing problems [2]. In 70% of the patients for revision rhinoplasty, breathing problems are the main complaint [3], [4], primarily because of residual septal deviations or nasal vestibular stenosis. Valve problems are very often caused by the separation of the upper lateral cartilages from the septum and can be diagnosed with acoustic rhinometry [5]. Deep osteotomies can narrow the airways at the piriform aperture [6]. Excessive alar cartilage resections can cause alar collapse and semicircular scars. In most of the cases however rhinoplasty does not deteriorate the breathing function [7].

If a patient's complaint of a blocked nose cannot be explained by inspection or measurement, a loss of mucosal sensitivity has to be taken into consideration. The feeling of warm and cold air during respiration is essential for the perception of a well functioning nose [8]. The loss of sensitivity caused by surgical scars can give the impression of a blocked nasal airway. Additional surgical interventions like turbinate resections or widening of the nasal vestibule do not improve the situation but even make it worse (Figure 1, Figure 2).

Hyposmia after rhinoplasty is only temporarily in most cases because of mucosa swelling. It is only found by testing and not even realised by the patient [9]. A permanent anosmia is rare [10].

2.2 Transplants and implants

The main risks for implants and transplants in the nose are infection, extrusion, distorsion and resorption [11]. In general these complications happen in less than 1% [12], [13], [14]. In our own series of 184 revision cases only eight twisted or dislocated autogenous rib cartilages were found (Figure 3), besides five dislocated and infected implants (Proplast, silicone, Gore-Tex, allogeneic bank cartilage). In primary rhinoplasties autogenous rib cartilage is only needed for major augmentation. With adequate technique the risks for resorption and distortion even in long term observation are minimal [15], [16], [17]. Depending on the conditions of the recipient area resorption of all types of autogenous cartilage is still a problem. The extend is not predictable what makes overcorrection crucial. Significant resorption has to be

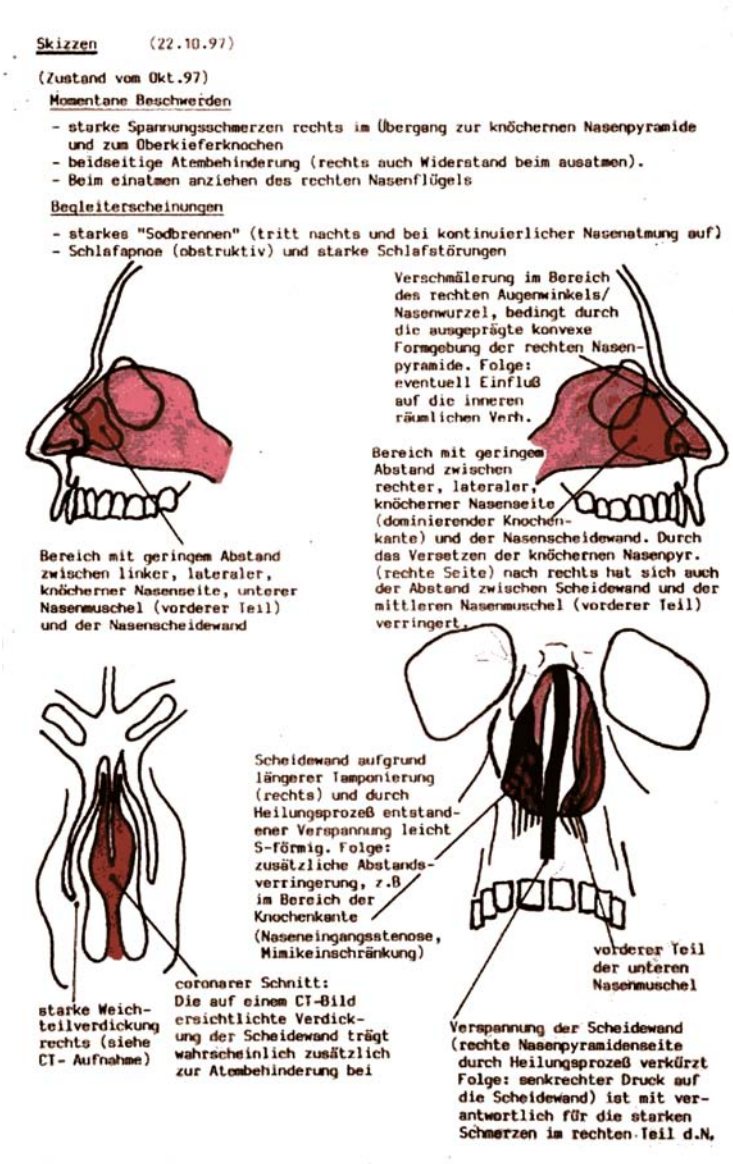


Figure 2: Persistent obstruction after multiple septorhinoplasties. Patient's explanation of suspected areas of blockage. In fact nasal airways are "tube like" and disturbed nasal breathing is based on a loss of mucosa sensitivity.

expected with diced cartilage because of the large surface in contrast to solid cartilage. Warping the cartilage with autogenous fascia lata can support survival of condrocytes [18]. On the other hand even undesired growth of cartilage is possible and resection of perichondrium in ear cartilage transplants is recommended [19].

Figure 3: Distortion und dislocation of an autogenous rib-graft on the nasal dorsum a) Deformity of the nasal dorsum 8 weeks after transplantation b) Removed dorsal graft

Non-biological materials are stable and not endangered of resorption. Silicone is very often used as nasal dorsal transplant and extrusion rates between 4.8% [20] and 20.8% [21] are reported. There are favourable reports about polytetrafluorethylen (PTFE, Gore-Tex) or polyethylen (PHDPE), even in long term follow-up [22], [23], [24]. In a series of 309 Gore-Tex implants only 3.2% had to be removed because of infections [25]. Injectable fillers can correct small impressions after rhinoplasty and avoid revision surgery [26].

In spite of positive literature reports on alloplasts [23], [27], autogenous cartilage is still the transplant-material of choice [28]. Besides septal cartilage the cephalic margins of the alar cartilages are especially suitable for dorsal transplants.

2.3 Skin- and soft tissue-complications

Acute complications are abnormal swelling, hematomas, local infections and skin necrosis [29]. Consequences can be atrophy, rubeosis, fibrosis, pain and numbness. Subcutaneous cysts and granulomas may develop [30].
Limited swelling and periorbital hematomas after rhinoplasty are normal and cannot be called a significant risk or a complication. The extend depends mainly on the osteotomy-technique and the preparation of subperiostal tunnels [31]. Swelling is reduced with percutaneous osteotomies [32], however visible scars can be the consequence in 6% of the cases [33]. Subcutaneous giant emphysemas are uncommon [34] and may extend to the mediastinum [35]. Subconjunctival ecchymosis happens in 20% primarily in the temporal area. They are reabsorbed within two weeks [31]. Skin atrophy makes subcutaneous vessels visible and can be minimized with a décollement in a deep plane [30]. If akne rosacea is present, tetracyclines for 6 to 8 weeks can be helpful. In cases of visible vessels, Argon-laser-therapy can be applied [36]. In dark skinned persons infraorbital hematomas can be visible as “shadows below the eyes” and are reabsorbed only very slowly within months.
Reports on subcutaneous mucosal cysts are relatively frequent [37], [38], [39], [40], [41], [42], [43]. They are caused by dislocation of mucosa, e.g. during transmucosal osteotomies. For removal an external skin incision is necessary for adequate visibility. In specific cases, an open rhinoplasty or even endoscopic approach is possible [42].
Lipogranulomas (paraffinomas) are caused by dislocation of ointment material from nasal packings into the subcutaneous plane [44]. The material can enter this area through vestibular incisions or defects at the nasal dorsum. The granulomas are primarily located at the lateral nasal wall over the lateral osteotomies and mimic “new callus-formation” [45]. Sometimes they are also found near the medial canthus and the naso-frontal angle (Figure 4) [46]. The histological appearance is typical: droplets of liquid ointment-material appear as small holes like in a “Swiss Cheese”. To prevent this complication, all vestibular incisions should be closed with sutures and ointment for packings should be avoided whenever possible. Malignancy as a differential diagnosis is absolutely rare [47].
Numbness after rhinoplasty in certain areas is frequent and reported by the patients if asked [48], [49]. Very often the nasal tip and the inferior part of the columella are involved (nervus nasalis externus). This nerve leaves the nasal cavity between the nasal bones and the upper lateral cartilages. A damage to these nerves during the décollement cannot be avoided. Normally sensitivity recovers within 12 months. However neuralgia of the skin of the nasal dorsum at the junction of cartilage and bone or even a neuroma can develop [50]. In addition contact between mucosa and skin (“open-roof-syndrome”) can cause postoperative pain. In these cases interposition of cartilage can be helpful. Damage to the infraorbital nerve during rhinoplasty is rare [51] and should be considered as already pre-existing [52].

Figure 4: Subcutaneous lipogranuloma at the radix, one year following rhinopasty

2.4 Infections, systemic and rare complications

In spite of the fact that rhinoplasty is a “non-sterile operation” infections happen in less than 1% of all interventions [53], [54], [55]. Abscess formations close to the medial canthus are suspicious for a sequestrum from the lateral osteotomy and must be removed. The effect of prophylactic use of systemic antibiotics is uncertain. Antibiotics are unnecessary in uncomplicated cases. However it may be indicated in cartilage transplantations or revision surgery. A single preoperative administration is as effective as systemic antibiotics for one week [56]. The risk for infections however may increase, when rhinoplasty is combined with sinus surgery in presence of purulent sinusitis. Bacteria (streptococcus) can invade the osteotomies and cause live threatening complications. This is why rhinoplasty and sinus surgery in specific cases of sinusitis should not be combined [57]. In non-purelent sinusitis however a septorhinoplasty can be performed at the time of sinus surgery under antibiotic prophylaxis, especially in those cases, where a septorhinoplasty is necessary to get sufficient access to the sinus system.
Staphylococcus aureus is found in about 50% of all healthy persons in the nasal vestibule. Nevertheless bacteriaemia following septoplasty is rare [58]. Intraoperative blood cultures were negative [59]. On the other hand staphylococcus-exotoxine can cause a toxic-shock-syndrome (TSS) mainly originating from nasal packings [60], [61].
Orbital complications of rhinoplasty can be traumatic or infectious [61]. Swelling may impair lacrimal drainage, and can be demonstrated radiographically for 3 months [62].Laceration of the lacrimal sac can cause acute purulent dakryocystitis and should be treated with intubation of the lacrimal system [63], [64]. An enophthalmus, developing months after aesthetic rhinoplasty, is a rare complication. Permanent negative pressure by occlusion of the maxillary ostium may have caused a “silent-sinus-

syndrome" and the contraction of the cavity of the maxillary sinus can have resulted in a displacement of the orbital content [65]. Streptococci can cause a necrotizing periorbital or orbital infection [61], [66], [67]. It is essential to distinguish between "normal" postoperative swelling and periorbital infection. In cases of pain, fever and pathologic blood parameters, systemic application of penicillin may prevent orbital celullitis and lid necrosis. Blindness following rhinoplasty is mostly caused by occlusion of the central retinal artery [68], [69], [70], [71]. Also its embolisation as a result of intranasal injection of local anaesthetics has to be considered [72].
Vascular and endocranial complications can be live threatening and are not as rare as expected [73], [74], [75]. There are case reports on rhinoliquorrhea [76], encephalitis [77], brain damage with pneumocephalus [73], carotid-sinus cavernosus-fistula [78], [79], arterio-venous-malformations [80], aneurysm [81] and sinus cavernosus-thrombosis with septicaemia and subdural empyema [82]. The naso-cardial reflex can cause heart arrest [83]. Because of an atypical course of vessels and nerves to the upper incisors, devitalisation and discoloration may be a dental complication of rhinoplasty [84], [85], [86].

2.5 Psychological aspects

Septorhinoplasty is performed in a wide range of functional and aesthetic indications. The indication is the major factor influencing the rating of the result by the patient. Questionnaires can be used to analyze patient's satisfaction, especially when evaluation of appearance and quality of live are included [87]. As to be expected, patients with mainly functional problems will rate a rhinoplasty successful, when the breathing function is improved [88]. The more aesthetic demands are involved in the indication for rhinoplasty, the more patient's satisfaction will be based on multiple factors. There are reports that young males are more often dissatisfied with the result than women [89] while in another paper the results were just vice versa [90].
Independent of the indication the success of rhinoplasty should be based on patient's satisfaction [87], [91]. The assessment of the result by patient and surgeon can sometimes be different. Legal consequences may be named a "typical complication" of rhinoplasty. If financial interest is involved in patient's motivation, even an adequate relationship between patient and doctor will not help to avoid a court case. Inadequate reactions of the surgeon or misunderstandings can make the situation worse. It is helpful to inform of a possible revision already preoperatively [92].
The key for a successful career as a rhinoplasty surgeon is adequate patient selection. Patient's expectations can be unrealistic and beyond the capacity of the surgeon [93]. Patients may react inadequate on a less than normal result or maybe totally unsuitable for an operation (dysmorphophobia-syndrome).
In relation to rhinoplasty there are three main categories of psychological disturbances [92]:

- Psychoneurotic disorders (neurosis) occure when a patient has a real complaint or a deformity, but who exaggerates the severity. This psychologic disorder does not cause problems when these patients are handled in a caring fashion.
- Psychotic disorders may exist when the patient describes a functional or cosmetic abnormality that may not exist or does exist only to some degree. These patients should only be operated after consultation of a psychiatrist.
- Personality disorders are the most difficult to recognise. These patients lack the ability to feel deeply about things. They are manipulative and controlling and present in a challenging or demanding way. They look to others to take responsibility for misfortune. Operating on these patients is problematic.

There have been numerous attempts to define patients with psychologic problems with a simple screening questionnaire. Such a tool however does not yet exist in a feasable form. It would be very helpful to identify e.g. dismorphophobia-patients, as this group will not be satisfied even with a perfect surgical result. The most severe complication in these cases can be the suicide of the patient or the assassination of the physician. These tragedies happened, also in Germany [92].

3 Postoperative deformities

3.1 General remarks

In spite of severe risks and complications reported in chapter 2, residual or newly developed deformities are considered to be the main risk of rhinoplasty. Statistic data are problematic, even in retrospective studies on more than 1000 patients. These studies are based on revisions performed by a single surgeon or institution. Because of this specialisation revision surgery is frequent as patients are referred to these centers. It would be more interesting to analyse revisions after primary rhinoplasty by a single surgeon. However even these data may show bias because

- not all postoperative deformities are revised and
- not all patients who are dissatisfied return to the primary surgeon.

In addition specialists in rhinoplasty may have less complications because of their experience. This is why reports on frequencies of postoperative deformities may only give a rough idea about the risks while an analysis of the types of deformities found at revision surgery can give information on critical areas and techniques.

3.2 Types, frequencies and causes of postoperative deformities

Revision rates after primary rhinoplasty are between 5% [12], [13], [94] and 15% [95]. In an own series of 302

Table 1: Surgical risks and consequences (modified [97])

Type of mistake	Typical example	Resulting deformity
Minor error in technique	Asymmetric correction of infrastructure (e.g. osteotomies, dome-sutures) Malposition of transplants	Asymmetries (e.g. dorsum, tip) Steps (visible or palpable)
Uncorrected deformity	Various (e.g. wide nasal tip)	Persisting deformity
Instability caused by insufficient reconstruction	Nasal tip Pyramid	Alar collapse, drooping tip Pollybeak, collapse of triangular cartilages, nasal valve stenosis, „inverted-V-deformity“
Overresection	Caudal septum Cephalic margin of lateral crus Nasal dorsum Interruption of domes Alar base	Short nose, retracted columella Alar collapse, alar rim retraction Saddle nose, “open-roof”, collapse of middle vault Asymmetry, bossae, alar collapse, pinched tip, slit-like nostrils Visible scars
Inadequate surgical planning	Hump resection and tip rotation in preoperative open nasolabial angle	Overshortened nose

consecutive primary rhinoplasties the revision rate was 3.6% what is comparable to other studies [96]. These figures however are not identical with the frequency of postoperative deformities (see above). The classification of deformities reported in the literature is inhomogeneous what makes a comparison of data difficult. Some publications describe the localisation of deformities, a few also possible causes [60], [97], [98], [99], [100], [101]. Table 1 gives an overview on operative mistakes and the resulting deformity. Mistakes in technique and preoperative planning, uncorrected deformities, instabilities and overresections can be distinguished. Inadequate planning in particular can cause a severe postoperative deformity when hump resection combined with tip rotation is performed in a pre-existing open naso-labial angle. This results in an overshortened nose with visible nostrils in the anterior view (Figure 5).

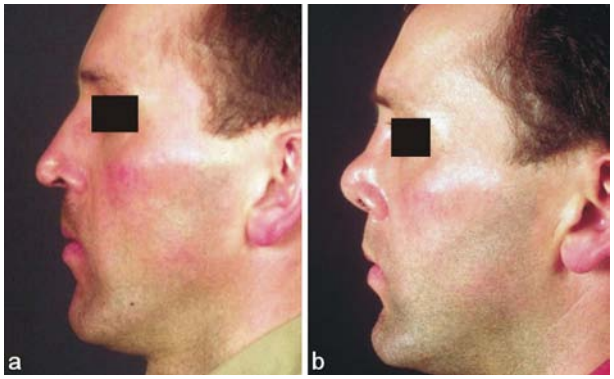


Figure 5: Over-rotated tip after septorhinoplasty a) Preoperative finding: Collapse of the cartilaginous vault by trauma and C-shaped-deformity of the dorsum b) Extremely short nose caused by insufficient reconstruction of the cartilaginous nasal dorsum

To analyse the frequency and type of residual deformities after rhinoplasty seven retrospective studies and own material was reviewed (Table 2). In general deformities are attributed to the upper third (bony pyramid), the middle third (cartilaginous pyramid) and the lower third (tip, ala, columella). Deformities of the upper and middle third are mostly combined (hump, saddle, deviation). This is why they are summarized in Table 3. In addition, the deformities of the nasal dorsum, tip, nasal base and caudal septum are described according to the investigator’s view (frontal, lateral and basal) (Table 3, Table 4, Table 5). Literature data are reported in per cent of deformities present at revision surgery. Very often more than one deformity in a single patient is found. So the number of patients is not identical with the number of revisions of certain deformities.

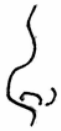
In addition to data from the literature own data from 184 consecutive revision rhinoplasties (out of a series of 502 consecutive septorhinoplasties) performed by the author are reported. In the own material revision surgery was the second operation (first revision) in 61%, the third operation in 22%, the fourth operation in 10% and the fifth operation in 2%. 5% of the patients had more than 5 previous operations. Only 15 of these 184 revisions were own revision cases. This is why the preoperative deformity and indication was not always known. The majority of these patients had functional and aesthetic complaints. So the situation may be different to studies with mainly aesthetic interventions. Depending on the history and the intraoperative finding some conclusions can be made whether the former surgery was more aesthetic or more functional. The indication was found to be primarily more aesthetic in 32% (e.g. no septal correction in case of septal deviation) while 24% were exclusively functional (septumplasty only) resulting in visible deformities. It is well known that consequences of septoplasty can become apparent in 21% [102]. The majority of the patients in our series (44%) had combined functional and aesthetic problems. Other indications were infections (septal abscess), malformations (naso- maxillary dysplasia) and others (e.g. prior surgery of the pituitary gland).

In summary Table 3, Table 4, Table 5 show the following frequent deformities after septorhinoplasty:

Table 2: Studies on postrhinoplasty deformities (character in column 1 relates to table 3-5)

Character in tables 3-5	Author/Year	Bibliography number	Total cases	Revision cases	Remarks
A	Bracaglia 2005	3	/	311	
B	Parkes 1992	13	1221	170	
C	Kamer 1988	12	697	126	
D	Constantian 2000	103	---	150	Consecutive series; only 4 variants analysed
E	Vuyk 2000	14	480	110	
F	Foda 2005	4	50	50	More than two previous operations
G	Mc Kinney 1981	90	200	24	Consecutive series
H	Rettinger 2006		502	184	Consecutive series

Table 3: Postoperative deformities of the nasal dorsum (same relations in tables 4 and 5)

	Anterior view			Lateral view			
				hump			saddle
	 Deviation (asymmetry)	 Wide („open-roof")	 Narrow vault („collapse")	 „Pollybeak"	 „High" dorsum	 Irregularities	 „Low" dorsum
A	80	40	---	50	---	---	70
B	10	2	14	33	7	16	bony 24
C	15	8	---	56	1	7	---
D	---	---	---		---		93
E	15	12	20	40	---	4	cartilaginous 20 bony 32 52
F	---	42	---	64	---	54	44
G	---	---	---	16	---	21	---
H	combined 36 cartilaginous 4 C-shaped 6 impression 3 49	20	2	14	bony 3 combined 8 11	15	cartilaginous 18 bony 9 combined 17 44

Frequency of findings in % of total revision cases

- *Pollybeak-deformity* as combined problem of nasal dorsum and nasal tip
- *Deformities of the nasal dorsum*
  - Overresection (saddle)
  - Irregularities (following hump resection)
  - Wide bridge (e.g. "open-roof-deformity")
- *Nasal base deformities*
  - Under-rotation and under-projection of the tip combined with retraction of the columella base
  - Asymmetry/wide nasal tip
  - Alar collapse

Further deformities of the nasal dorsum are asymmetries and deviations. They can be the result of an inadequate preoperative analysis or an incomplete mobilisation by osteotomies. Because of swelling, a minor deviation of the dorsum is very difficult to be recognised intraoperatively. This is why preoperative analysis is essential. On the other hand a unilateral impression of the nasal wall can appear like a deviated dorsum. Such an impression can occur e.g. by asymmetric application of the external splints after osteotomies.

Irregularities of the nasal dorsum after hump resection are also frequent. Very often the upper lateral cartilages are involved, even if a bony deformity is suspected at palpation. They become evident because of an irregularity of the eyebrow-nasal line. For correction of these cartilaginous flanges a scalpel is much more effective than a rasp.

At the area of the nasal tip and the nasal base underprojection, wide tip, asymmetries, collapse and retractions can be found after rhinoplasty. Asymmetries of the position and the shape of the domes can be avoided by good access (open approach) and suture techniques (trans- and interdomal sutures). The direct view also prevents

Table 4: Postoperative deformities of tip, columella and alae in the side view

	 Overrotation: „short nose“	 Underrotation: „long nose“, drooping tip, retracted columella	 „Hanging columella“	 Alar retraction
A	---	---	20	10
B	---	10	28	20
C	---	9	13	11
D	---	---	---	---
E	6	17	6	7
F	42	---	---	---
G	---	---	---	---
H	10	53	5	5

Frequency of findings in % of total revision cases

Table 5: Postoperative deformities of nasal base and septum

	 Overprojection	 Underprojection	 Asymmetries/Bossae	 Wide/Amorphous	 Pinched tip Alar collapse	 Caudal septum: Deviation/Luxation
A	---	---	---	---	30	80
B	---	4	27	7	---	---
C	---	---	22	---	---	9
D	---	80	---	---	---	---
E	4.5	32	30	18	5	1
F	---	68	60	---	---	68
G	---	---	---	46	---	8
H	10	40	7.5	28	16	luxation 61 deviation 37 defect 78

Frequency of findings in % of total revision cases

overresection of the lateral crura and a resulting instability. Resection of vestibular skin should be avoided because of alar rim retractions.

Causes for breathing disturbances are not always analysed in the studies. In most cases, residual septal deviations, nasal valve stenosis and alar collapse are reported.

In order to identify nasal characteristics that predispose for undesirable results, four anatomical variants (deep naso frontal angle, narrow cartilaginous dorsum, underprojection of the nasal tip, position of the lateral crus) were analysed in groups of consecutive primary and secondary rhinoplasties [103]. In revision patients, these variants were found more often than in primary rhinoplasties. The most frequent combination was a low radix, narrow cartilaginous dorsum and an underprojected tip. With this preoperative situation an unfavourable result is more likely.

Other factors, influencing the aesthetic result, were sex and age. In male patients hump resection and tip rotation should be very moderate in order to avoid the appearance of an “operated nose” [104]. In elderly patients the skin is thin, supporting structures weak and the function frequently disturbed [105]. This results in a drooping tip with bony pseudo-hump and nasal vestibular stenosis. In order to increase stability in these patients very often autogenous cartilage transplants (columella, spreader grafts) have to be used [106]. Also the reactions of the soft tissues on changes of the infrastructure have to be respected [107]. The adaption may be insufficient with thick

skin, elderly patients and especially in the area of the columella and upper lip [108].
With increasing use of the open rhinoplasty the question was raised, if this approach is associated with specific risks [109]. Primarily scar problems at the columella would be expected, but the risk of remarkable scars is only 1-2% [110], [111], [112]. In our own series inadequate scars were somewhat more frequent (4%) (Figure 6). A columella strut placed during open rhinoplasty proved to give permanent results for tip projection and protection independent on other techniques applied [113]. In endonasal approaches a columella strut is rarely used to stabilise columella and tip. This can be the reason why 25% of the patients demonstrate a 25% loss of tip support when both alar cartilages are separated. Columella sutures can increase stability to 35% over the preoperative situations, a columella transplant even to 44% [114]. The importance of the tissues between the alar cartilages for the stability of the nasal tip and nasal base could also be demonstrated in specimens. The most severe loss of support was found with an endonasal delivery approach of the lower lateral cartilages. If only the skin was elevated from the alar cartilages, no change in tip support could be found [114]. Another study in specimens however demonstrated contradictionary results. The average loss of tip projection was 1.98 millimetres in a closed approach versa 3.43 millimetres in an open approach [115].

5

Figure 6: Retracted columella scar after open rhinoplasty because of inadequate cartilage support and a linear skin incision

External and endonasal approaches demonstrate even more specific differences. Postoperative problems after open rhinoplasty was twice as frequent as after an endonasal approach in patients with revision surgery. The "open approach-group" however had already more than one previous operation. After former endonasal rhinoplasty the most frequent residual deformitites were overresection of the dorsum (50%) or tip (33%) as well as nasal valve stenosis (42%). In addition patients after open rhinoplasty very often had alar collapse (50%), overrotation of the tip (39%), wide columella base (36%), collapsed cartilaginous dorsum (31%), visible columella scars (25%) and a columella transplant with discomfort (19%). Only drooping tips were more frequent after endonasal surgery than after open rhinoplasty. In general "open-rhinoplasty-patients" more often complain about problems of nasal tip, ala and columella [116]. These results indicate, that an open approach can have advantages for nasal tip projection and protection, but may have specific risks for other postoperative deformities.
Besides loss of nasal tip protection and projection, asymmetries and bossae of the nasal tip are typical risks of nasal tip correction. Especially young patients with thin skin and bifid tip are at risk [117]. In a series of 1033 rhinoplasties however only 2% of the patients had postoperative tip deformities. The main factor was a preexisting asymmetry. The skin- and cartilage-structure had no influence on the result [118]. Most frequently asymmetries develop during the healing process because of cartilage resections and cartilage weakness. They are best avoided either by preserving the continuity of the alar cartilages or by reinforcement with cartilage transplants [119].

3.3. Combined deformities and their prevention

3.3.1 Pollybeak-deformity

In 50% of the cases the indication for revision is the pollybeak-deformity. This deformity is characterised by a deep radix, an overresection of the bony dorsum, a prominent cartilaginous dorsum (underresection or subcutaneous scar formation in the supra-tip-area) as well as a drooping tip [120]. The curved profile from dorsum to tip is characteristic for the "pollybeak". The risk for a postoperative pollybeak-deformity is higher in noses with a deep nasofrontal angle, a mainly cartilaginous hump and a drooping tip (Figure 7a, Figure 8a) [103], [121], [122]. A standard endonasal approach via transfixion and bilateral intercartilaginous incisions weakens the tip support (protection) and results in a loss of tip projection below the level of the dorsum during the healing process (Figure 7b-d). The loss of protection is a main factor for the development of the pollybeak-deformity. The relation between nasal dorsum and tip projection has to be taken into consideration already intraoperatively. If a certain decrease of tip projection is expected, reduction of the nasal dorsum must result in an "over-projecting tip" immediately postoperatively. Resection of the bony nasal dorsum is mostly unnecessary, as the nasal bones are found to be very short and the nasofrontal angle is already deep. A radix transplant in these cases can reduce the amount of dorsal resection. Overresection of the cartilaginous dorsal structures has also to be avoided in order to prevent middle vault collapse and an "inverted-V-deformity" [123]. With proper taping of the supra-tip area the development of a "soft tissue polly-beak" can be prevented (Figure 7d) [124], [125].

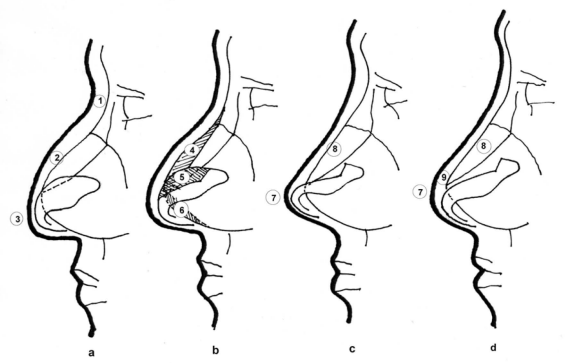


Figure 7: Causes and development of the "pollybeak-deformity". a) Risk-factors are deep nasofrontal angle (1), high cartilaginous dorsum (2) and under-projection of nasal tip (3). b) Lowering of the dorsum by resection of the septo-dorsal-cartilage (4) and tip rotation by resection of the lateral crus (5) and a triangular part of the caudal septum (6). c) Immediately postoperative overprojection of the nasal tip (7) in relation to nasal dorsum (8). d) Development of the pollybeak-deformity by the dynamic healing process resulting in a decreased tip projection (7) in relation to the level of nasal dorsum (8). The cartilaginous dorsum is the most prominent part, sometimes exaggerated by subcutaneous scar formation in the supratip area (9) (so called "soft tissue polly-beak").

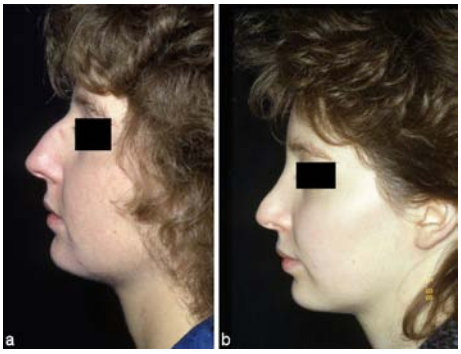


Figure 8: Pollybeak-deformity following rhinoplasty. a) "Risky nose" with deep radix, short nasal bones and primarily cartilaginous hump. The domes are below the level of the dorsum. b) Typical deformation of cartilaginous dorsum and tip one year postoperatively

3.3.2 Complex nasal base deformity due to loss of septal support

A reduction of the height of the septal cartilage by dislocation, defect or deformity has typical consequences.

- *Nasal tip*
  - wide
  - drooping
- *Columella*
  - wide
  - retracted (naso-labial angle <90°)
- *Nasal dorsum*
  - sagging
- *Nasal base*
  - wide
  - stenosis of the nasal vestibule

In our own series this deformity after rhinopasty was found most often. The deformity can develop after septorhinoplasty or after septoplasty. It is not mentioned in this combination in the literature. This is why the techniques for correction mainly rely on cartilage-transplants in columella and nasal dorsum. In fact however all visible deformities can be attributed to one single cause [126]. Soft tissues, upper lateral cartilages and lower lateral cartilages are a system under tension, provided by the septal cartilage. This tension is responsible for the shape of these structures and an undisturbed nasal breathing function (Figure 9a-c). With tension-loss (e.g. by trauma, operation, infection), the typical deformity develops as shown in Figure 9d-f. Nasal-tip-projection is not only reduced by columella retraction but also by increasing distance between the domes with widening of the dome-angles (Figure 10). This is why septoplasty can cause nasal tip deformities. In all corrections on the nasal septum, stability, dimension and position of the caudal cartilage have to be preserved or reconstructed. If rhinopasty is combined with septoplasty, what is routine in relevant septal deformities, there is an increased risk of postoperative deformities caused by the dynamic healing process of septoplasty. This aspect needs specific attention during septorhinoplasty.

The most frequent single factor for postoperative deformities after rhinopasty is nasal tip projection [127]. Tip projection depends on preservation or reconstruction of tip protection. The stability is based on the connective tissue between both alar cartilages [128] and the support of the alar-complex by the nasal septum and the upper lateral cartilages. The connection between the alar cartilages is divided mainly in tip-plasty (e.g. delivery approach) but also when an extensive columella pocket is created. The connection between the lower-lateral-cartilages can be restored with sutures. The relationship between the alar-complex and the supporting structures is interrupted with routine approaches of rhinoplasty: transfixion, intercartilaginous incisions and décollement sacrifice the connection to septum and upper lateral cartilages. The result of these incisions will be a decrease in tip protection by the pressure of the soft tissue envelope. The projection can be preserved with adequate septum-columella-sutures. Nevertheless a certain amount of loss of tip projection has to be expected postoperatively and the level of the nasal dorsum should be adjusted.

Septoplasty can result in a lowering of the anterior-inferior corner of the septal cartilage, resulting in a loss of tip support [115]. This explains the increased risk for tip deformities in a combined septo-rhinoplasty-procedure in contrast to rhinoplasty. Nevertheless septoplasty and rhinoplasty should always be combined in one stage if necessary. Refixation of a mobilized caudal septum is essential for a stable postoperative result [129]. Nasal tip projection however can be made independent of the nasal septum when a columella strut is applied. These struts are more often used in open approaches what explains less problems with nasal tip projection with this technique. Knowledge and understanding of these dynam-

ics and relationships of the nasal base and the surrounding structures is essential to minimise the risk for postoperative deformities.

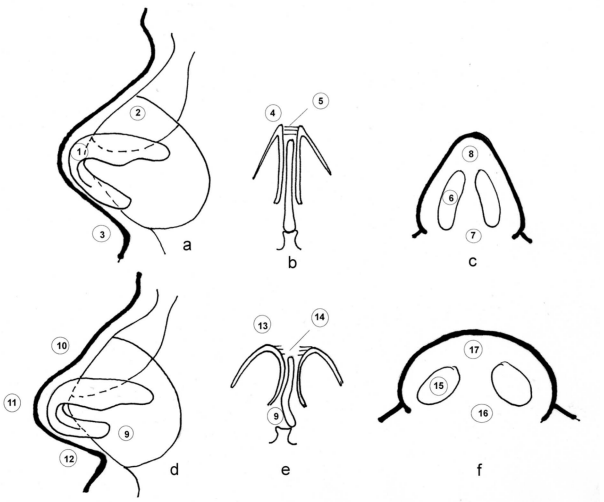


Figure 9: Tension-system of the nasal base, maintained by septal cartilage
a-c: Regular situation a) Lateral view: The septo-dorsal-cartilage (2) forms the cartilaginous dorsum and projects beyond the level of the anterior nasal spine for some millimeters. This projects the columella-base more caudal in relation to the nostrils and creates a physiologic nasolabial angle (3). The domes are above the level of the anterior inferior corner of the septal cartilage (1). b) Base view: Soft tissue connects the domes (4) and rests on the upper septal corner. c) Tension of the alar cartilages results in oval shaped nostrils (6), narrow nasal base (7) and tip (8).
d-f: Consequences of loss of tension caused by septal pathology d) Lateral view: Reduction of septal height (9) results in a cartilaginous saddle (10), drooping tip (11) and retracted columella base (12). e) Base view: Loss of septal height by cartilage defects, twisting or dislocation (9) as well as disruption of the interdomal connective tissue (14). The dome angles become more round. f) Consequences for the soft-tissue envelope: Wide columella-base (16), round nostrils (15) and amorphous tip (17)

Figure 10: Nasal-base-deformity caused by loss of septal support a) Lateral view: Cartilaginous saddle, underprojection of nasal tip and retracted columella base b) Base view: Amorphous tip with wide interdomal distance. Short Columella, wide columella-base and rounded nostrils. Prominence of lateral crura in the vestibule

4 Final remarks

Rhinoplasty is associated with specific risks and complications. An analysis of revision surgeries can provide information on frequency and types of postoperative deformities. Reports in the literature are based on different parameters what makes comparison difficult. There are much more papers on revision techniques than on analysis of deformities.

A standardized classification of the deformities would allow to compare the results of different studies. The inhomogeneous patient's population is an additional problem. This is why evidence is only based on description and comparison.

Rhinopasty is based on experience. Besides knowledge of literature and techniques a critical surgeon is a prerequisite for reliable results. Knowing the risks, mistakes should be identified and avoided in the future. A complication as cause of an undesirable result should only be assumed if there is no evidence of a mistake in patient selection, preoperative planning and operative technique.

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