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**TITLE PAGE**

**Use of injectables in rhinoplasty retouching: towards an evolution of surgical strategy? Literature review.**

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**Abstract**

Background: Surgical revision rate of rhinoplasty is from 5% to 15% in literature.

Objective of review: In the context of post-rhinoplasty deformities, we aim to investigate the modalities of using injectables, their impacts on revision rate of rhinoplasty as well as their influences on the surgical strategy.

Type of review: We realized an international literature review to collect informations on main studies reporting series of exclusive secondary medical rhinoplasties or mixed primary/secondary medical rhinoplasties, as well as per-operative injection.

Search strategy: The databases of the National Library of Medicine, Cochrane Library, Embase and Web of science were explored using the following Boolean string: (rhinoplasty OR nose) AND (injectable OR fillers OR hyaluronic acid OR calcium hydroxylapatite). The search was limited to the English language literature for studies published from 2007 up to December 2019.

Results: Fifteen cohort studies were included. Hyaluronic acid was the most commonly used injectable for rhinoplasty revision. Patient satisfaction rates varied between 80% and 100%. Reinjections were necessary in about 20 to 50% of cases whatever the used injectables. Minor complications (swelling, bruising, erythema) were frequent after filler injections (4%). Severe complications such granulomas or vascular embolism causing skin necrosis/visual impairment were rare (0.4%). Their physiopathology, management and prevention are detailed.

Conclusions. The use of injectables seems to reduce the need of secondary surgical rhinoplasties. It can be expected that an evolution in surgical practices will result from injectables using, but it will be possible only if the technique is perfectly understood to avoid potentially serious vascular complications.

**Keywords:** revision rhinoplasty; injectables; fillers; hyaluronic acid; calcium hydroxylapatite.

## 1 Introduction

2 Rhinoplasties are surgical procedures widely described and commonly practiced[1]. However, post-  
3 rhinoplasty deformities are frequent, even in the most experienced hands[2–6]. Thus, surgical  
4 revisions, or secondary rhinoplasties, could be necessary as evidenced by the rates of open or closed  
5 post rhinoplasty surgical revision ranging from 5 to 15% in the literature[7].

6 Beside surgical rhinoplasty, injections of fillers to correct nasal deformities are currently emerging and  
7 become more and more popular[8]. This emergence of injectables using may change our practices  
8 given their efficiency to correct some postoperative defects of rhinoplasties[3–6,9–14]. However, the  
9 iatrogenicity of injectable should not be underestimated and it is necessary to proceed with a rigorous  
10 technique to avoid complications, among which some may be serious[2,3,5,9–11,14,15].

11 Thus, in the context of post-rhinoplasty deformities, two questions remain unanswered. Do injectables  
12 reduce the surgical revision rate of rhinoplasties? Will injectables lead to changes in our surgical  
13 strategy and management? To try to get some answers, we have decided to realize a literature review  
14 on the subject. The aims of this literature review were to investigate and understand the type, the  
15 indications, the outcomes and the complications of using injectables in rhinoplasty retouching.  
16 Furthermore, we report some advices to avoid and manage complications as well as some elements  
17 of responses for the two above mentioned questions.

**18 Method**

19 A literature review was realized to collect information on the interesting studies. The databases of the  
20 National Library of Medicine, Cochrane Library, Embase and Web of science were explored using the  
21 following Boolean string: (rhinoplasty OR nose) AND (injectable OR fillers OR hyaluronic acid OR  
22 calcium hydroxylapatite). Inclusion criteria were as following: series of exclusively secondary medical  
23 rhinoplasties or mixed primary or secondary medical rhinoplasties, as well as per-operative injection  
24 published in the last twelve years i.e. from 2007 up to December 2019. The search was limited to the  
25 English language literature. We also considered literature reviews for the discussion. Studies reporting  
26 only primary medical rhinoplasties were excluded, as well as those involving silicone, collagen or  
27 permanent injections. The study flow diagram is available (figure1). The included studies are listed in  
28 Table 1[2–6,9–11,13,14,16–20].

## 29 **Results of the literature review**

### 30 History of injectables in rhinoplasty

31 Firstly, in 1904, Albert E. Stein injected paraffin to correct supratip depression (saddle nose)[21]. Then,  
32 in 1919, P. Bruning used fat injections to correct rhinoplasty deformities[22]. Nasal injections really  
33 developed in the 1980s with silicone and bovine collagen[23,24]. The recent emergence of new  
34 injectables such calcium hydroxylapatite (CaHA) and Hyaluronic acid (HA) has led to the concept of  
35 medical rhinoplasty[14,25–36].

### 36 Selection of injectables

37 HA is the most commonly used injectable for rhinoplasty retouches (Table 1), in particular because of  
38 its safety, plasticity, durability, and the possibility of reversing the HA effects with hyaluronidase. The  
39 2018 National Plastic Surgery Statistics reports the use of HA in 79.5% of cosmetic minimally-invasive  
40 procedures using fillers[8]. On the other hand, CaHA, Platelet-Rich Plasma (PRP), Polylactic acid and  
41 fat injections are used for the same indications in 8.4%, 4.8%; 4.6% and 1.7% of cases respectively.  
42 Permanent injectables are not recommended because of the difficult removal in case of excess as well  
43 as because they could compromise a future surgery[37–39].

### 44 Indications of the injections

45 Injectables are used to correct low to moderate aesthetic disorders. Several nasal subunits may be  
46 injected after rhinoplasty such the dorsum (irregularities), the osseocartilaginous flaps (asymmetry),  
47 the upper lateral cartilage (inverted V deformity, "spreader graft"), the supratip region (saddle nose,  
48 pollybeak), the tip (asymmetry, hypo projection), the columella and the naso-labial angle. Severe  
49 aesthetic disorders or respiratory functional problems are usually surgically managed[4].

### 50 Outcomes

51 Patient satisfaction rates vary from 80% to 100%[3–6,9–12,14]. However, this rate is related to the  
52 importance of the corrected disorder. Indeed, the greater is the defects to be corrected, the lower is

53 the satisfaction rate[11]. Other factors that influence this rate are the anatomic characteristics of the  
54 injected nose, the injection protocol and the experience of the injector[29]. Reinjections are necessary  
55 in about 50% of cases for HA[3,9] and 10 to 17% of cases for fat injections[5,13]. Regarding longevity,  
56 results of nasal injections seem to be more stable than those observed for other anatomical regions of  
57 the face due to the immobility/low mobility of the injection areas[9,15].

## 58 Complications

### 59 • *Overview*

60 Minor complications are frequent after filler injections with a mean rate of 4% (range 0-10). They are  
61 mainly swelling, bruising, erythema, hypersensitivity, nodules, lump and asymmetry, incomplete  
62 corrections, irregularities and asymmetries. Minor complications are most of the time transient. On  
63 the other hand, severe complications are rare with a mean rate of 0.4% (range 0-4) but they are most  
64 of the time critical. These are granulomas and vascular embolism causing skin necrosis or visual  
65 impairment[40,41]. Anatomy of the nose and physiopathology of the complications are important to  
66 understand for managing fillers complications.

### 67 • *Cutaneous and vascular anatomy of the nose*

68 Between the skin and the bony–cartilaginous framework there are 4 layers: superficial fatty layer,  
69 fibromuscular layer or superficial muscular aponeurotic system (SMAS), deep fatty layer, and  
70 periosteum-perichondrium[29,40].

71 The proximal part of the nose is vascularized by the internal carotid system via the ophthalmic artery.  
72 The distal part of the nose is vascularized by the external carotid system via the facial artery. Major  
73 blood vessels are located in the SMAS layer or the superficial fatty layer[42]. The skin is thin and loose  
74 in the upper two thirds of the nose, while the skin is thick and inextensible in the tip and supra tip[43].

### 75 • *Physiopathology of the vascular complication complications*[3,5,9,10,13–15,44–50]

76 Vascular risk corresponds either to an arterial embolization or a vascular compression. Embolization  
77 of an artery in the proximal part of the nose can lead to blindness if the central artery of the retina is  
78 involved. Embolization of the distal part of the nose can lead to facial skin necrosis. Excess of  
79 injectables at the tip and supra tip may cause skin necrosis secondary to vascular compression due to  
80 the thickness and inextensibility of the skin at this level.

81 • *Prevention advices in literature*

82 To reduce the risk of complications, it is necessary to perfectly understand the vascular anatomy of  
83 the nose. It is also important to consider changes induced by previous surgeries. It is essential to  
84 respect several rules to avoid these vascular risks: mark the midline (the linear threading technique),  
85 small amount of filler (0.1 to 1.0 mL per injection session), retrograde injection (withdrawal technique),  
86 without hyper pressure (slow and gentle injection), in depth just above the perichondrium or  
87 periosteum (to minimize damage to vessels and avoid intravascular injection), at best with blunt  
88 cannulas. Before injection, aspirate to verify a negative flashback. A permanent control of the  
89 appearance of the teguments should be realized during the procedure. Epinephrine may be added to  
90 filler for vessel constriction as well as compression of proximal ophthalmic anastomosing vessels with  
91 non-dominant hand. In all cases patients should be always informed about all the risks associated with  
92 fillers injection. Injections should be realized at least 3 to 6 months after the primary rhinoplasty and  
93 intervals of 4 to 6 weeks are necessary if serial injection are planned. [2,3,9,10,13–15,18,29,29,38,51–  
94 55].

95 • *Management of complications in literature*

96 The prognosis depends mainly on the early recognition of complications and their prompt  
97 managements. Thus, during and after the procedures, surgeons should research the alarm signs  
98 associated with these complications. Immediate localized or distant pain or other classic symptoms  
99 and signs (skin blanching, livedo reticularis, slow capillary refill, and dusky blue-red discoloration) are  
100 not always apparent, which sometimes makes diagnosis challenging. In case of vascular complication,



101 immediate injection of 10 hyaluronidase units per 0.1mL of HA should be realized[38]. Topical  
102 nitropaste under occlusion, oral acetylsalicylic acid (aspirin), warm compresses, and vigorous massage  
103 are also useful. Secondary lines of treatment may involve intra-arterial hyaluronidase, hyperbaric  
104 oxygen therapy, and ancillary vasodilating agents (prostaglandin E1) [40,56–59]. At all, reported  
105 management strategies vary greatly from surgeons and there is no treatment that is consistently  
106 successful[41].

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107 **Discussion**

108 Rhinoplasty is a challenging procedure and results sometimes in unsatisfaction, even in the most  
109 experienced hands[2–6]. A recent study reporting the causes for litigation in facial surgery showed that  
110 dissatisfaction about the esthetic or functional result topped the list and that rhinoplasty was by far  
111 the most common claim[60]. Thus, surgical revisions are not so rare as evidenced by several studies  
112 reporting surgical revision rates ranging from 5 to 15% whether by open or closed techniques[7]. The  
113 cost and complexity of secondary surgical rhinoplasty, as well as the possible non-operative  
114 management (low to moderate defects and/or difficult to access for surgery) or the patient's refusal,  
115 give full meaning to injectables for revision rhinoplasties[16,55,61]. Injectables have already proven  
116 their effectiveness (high satisfaction rate), safety, simplicity of use and low cost[3–6,9–14]. Most of  
117 post-rhinoplasty defects are accessible to injectables in experienced hands. Resorbable injectables are  
118 recommended because they are reversible in case of excess and they do not compromise a future  
119 surgical revision[10].

120 However, major defects are not an indication for injectable but require surgical rhinoplasty[3,4,38].  
121 Furthermore, the risk of serious vascular complications associated with injectables in the nasal area  
122 should not be omitted[40,41]. The two main involved mechanisms are: i-embolization of a vessel by  
123 the injectable and ii-extrinsic vascular compression by excessive injections in an anatomic area  
124 recovered by inextensible skin. A perfect knowledge of the vascular anatomy and soft tissues of the  
125 nose, as well as a rigorous technique performed by trained hands, make it possible to avoid the main  
126 part of these complications

127 In this review of the use of injectables for revision rhinoplasty, we noted some interesting information  
128 (Table 1). Firstly, the most commonly used injectable is HA followed by CaHA and fat. Furthermore,  
129 rhinoplasty using injectables is to be easy, safe, low cost, and becomes increasingly popular. This  
130 technique seems to be effectiveness for minor defects and provide a high satisfaction rate. Finally, few  
131 complications are reported in the literature.

132 With regard to question 1, "Do injectables reduce the rate of surgical revision?", the answer is yes.  
133 Only one author of our review (Hedén) clearly answers this question[9]. Given the large number of  
134 procedures reported, involving both minor and major defects, and high satisfaction rate, we can clearly  
135 hypothesize that injectables may reduce the rate of revision surgery. In addition, the number of  
136 rhinoplasty revisions using injectables is growing rapidly since this technique is increasingly popular  
137 among patients and surgeons. Indeed, injectables are no longer only indicated when surgical revision  
138 is refused but are primarily proposed as an effective therapeutic option and their indications are  
139 expanding[11–13,38]. Moreover, some surgeons do not yet use this technique which suggests that  
140 more cases of injections will be performed once they will be convinced by injectables benefits[62].  
141 Finally, given that respiratory functional disorders after primary rhinoplasty are a major cause of  
142 surgical revision[7], the using of injectables to correct inspiratory collapse of the nasal valve, especially  
143 by using endonasal injection at its apex ("spreader graft")[2,61,63–65] is promising.

144 Although the answer to this question is yes, we do not know the proportion. Prospective comparative  
145 studies should be designed, with sufficient follow-up time, to compare the surgical revision rates  
146 before and after the use of injectables for post-rhinoplasty retouching.

147 With regard to question 2, " Do injectables eventually lead to a change in our surgical strategy?", the  
148 answer is unclear. More and more surgeons use perioperative fat injections to prevent the occurrence  
149 of postoperative defects[6,13]. However, all the authors agree that surgery remains the gold  
150 standard[2,3,11,13–15] and that the rigor of the surgical technique should not be modified on the  
151 pretext that injectables can compensate its shortcomings[13,14]. Even if it is more complicated and  
152 more costly, surgery remains the most effective way to correct postoperative defects in rhinoplasty,  
153 especially when they are important[3–5,13,38].

154 Several questions remain unanswered and require serious considerations: i-What will be the place of  
155 injectables in perioperative surgery? At the end of the procedure, it is quite conceivable to correct a  
156 residual defect by injection especially if it appears too difficult or high-risk for surgically correcting it;

157 ii- Should we change our surgical management (i.e. more important resections) given that a residual  
158 depression is easier to correct using injectables comparing to residual excess?

159 At all, injectables may be considered pre or postoperatively[9]. Some authors consider surgery for  
160 major architectural modifications of the nose and injectables for "finishing"[38]. Others believe that  
161 each rhinoplasty project should be subject to medical and surgical considerations from the  
162 beginning[14].

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163 **Conclusion**

164 Surgery aiming for excellence remains the gold standard to correct nose aesthetic and functional  
165 disorders, whether for primary or secondary rhinoplasties. However, using injectables easy, low-cost,  
166 and allow correcting low to moderate disorders. While it is established that injectables reduce the  
167 number of secondary rhinoplasties, the optimal time for injectables in rhinoplasty retouching is not  
168 yet clearly defined. It can be expected that an evolution in our surgical practices will emerge from  
169 results of large rhinoplasty cohorts with injectable using. In all cases, the anatomy and the technique  
170 should be perfectly understood to avoid potentially serious vascular complications.

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**Figure and table legends**

**Figure 1:** The study flow diagram.

**Table 1:** Published studies in international literature concerning revision rhinoplasty with injectable (not mentioned in this table are studies with silicone, collagen or Polymethylmethacrylate [PMMA] injection, studies concerning only primary medical rhinoplasties and literature reviews) (Nb : number ; HA: hyaluronic acid; CaHA: Calcium Hydroxylapatite; NA: non-available; wk : weeks; periop: perioperative)

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Study	Number of Patients	Primary rhino	Revision rhino	Perioperative use	Type of injectable	Minor complications	Major Complications	Satisfaction
<b>Valente et al., 2018</b> <sup>16</sup>	135	0	135 (100%)	n/a	n/a	7% of complications		High satisfaction rate
<b>Hedén 2016</b> <sup>9</sup>	75 studied among >250 injected	55 (73%)	20 (27%)	0	HA	3 increase in telangiectatic vessels and erythema	0	Satisfied (35%), very satisfied (65%)
<b>Schuster 2015</b> <sup>10</sup>	46	39 (85%)	7 (15%)	0	CaHA (n=26) HA (n=20)	1 filler dislocation; 2 hematomas; 1 subcutaneous nodules (CaHA)	2 skin necrosis (HA); 1 infection	87% of patients very/completely satisfied at 9 months or later post treatment.
<b>Erol 2014</b> <sup>11</sup>	313	0	313 (100%)	0	Fat	0	1 severe bruising (with the threat of necrosis)	Good improvement for 82%, 98% and 100% of patients with major, minor nasal skin irregularities and damages nasal skin respectively
<b>Kose et al., 2013</b> <sup>3</sup>	12	0	12 (100%)	0	HA	0	0	All patients were satisfied with a means score of 9.1/10
<b>Jasin 2013</b> <sup>17</sup>	NA	Yes	Yes	0	HA, CaHA	2 herpetic eruptions	1 skin necrosis over a period of 9 years	n/a
<b>Liapakis et al., 2013</b> <sup>18</sup>	11	0	11 (100%)	0	HA	1 swelling	0	Esthetic correction was achieved in all patients as determined by overall patient's satisfaction.
<b>Baptista et al., 2013</b> <sup>5</sup>	20	0	20 (100%)	0	Fat	2 resorptions	0	90% were satisfied or very satisfied
<b>Monreal 2011</b> <sup>13</sup>	33	Yes	Yes	15 (45%)	Fat	0	0	80% of good to high satisfaction
<b>Bray et al., 2010</b> <sup>2</sup>	18	Yes	Yes	0	HA	0	0	n/a
<b>Siclovan et Jomah 2009</b> <sup>14</sup>	n/a	Yes	Yes	0	HA	0	0	n/a
<b>Rivkin et Soliemanzadeh 2009</b> <sup>19 *</sup>	385	237 (62%)	121 (31%)		CaHA	7 telangiectasias; 9 sensitive tips; 19 swelling > 2 wk; 33 erythema > 2 wk; 7 bruises; 6 cellulitis; 2 with visible skin irregularities/bumps.	N=2 skin necrosis	n/a

<b>Becker 2008</b> <sup>20</sup>	24	9 (37%)	15 (63%)	0	CaHA	Temporary minor pain, redness, and swelling following injection	0	78 % of the patients rated their satisfaction as 8/10 or better
<b>Cárdenas et Carvajal 2007</b> <sup>6</sup>	78	61 (78%)	17 (22%)	78 (100%)	Fat	0	0	99% of excellent or good satisfaction
<b>Stupak et al., 2007</b> <sup>4</sup>	13	0	13 (100%)		CaHA	1 mild erythema for several days	0	85% of good to excellent satisfaction

\*Not referenced on PubMed, no information on previous rhinoplasty was available for 27 patients (7.0%)

**Table 1:** Published studies in international literature concerning revision rhinoplasty with injectable (not mentioned in this table are studies with silicone, collagen or Polymethylmethacrylate [PMMA] injection, studies concerning only primary medical rhinoplasties and literature reviews) (HA: hyaluronic acid; CaHA: Calcium Hydroxylapatite; n/a: non-available; wk : weeks;)