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Muscle-Splitting, Subglandular, and Partial Submuscular Augmentation Mammoplasties: A 12-year Retrospective Analysis of 2026 Primary Cases

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Abstract
Background Augmentation mammoplasty is a commonly performed procedure with a very high satisfaction rate. Various techniques have been described since the report of the first augmentation mammoplasty in 1963. Muscle-splitting augmentation mammoplasty, a technique first published in 2007, has been used by the author for primary and secondary augmentation mammoplasties and for mastopexy with augmentation.
Methods A retrospective analysis of data prospectively collected using the Excel spreadsheet was performed. The patients were divided into three groups. The mammoplasty for group A used the subglandular pocket. In group B, the partial submuscular pocket was used for mammoplasties. Both of these groups had their mammoplasties performed between 1999 and 2005. Group C, the third group, included patients who had muscle-splitting mammoplasties between 2005 and 2011.
Results Group A involved 793 patients who had their augmentation mammoplasties in the subglandular pocket. Of these 793 patients, 751 had the same size implants and were included in the analysis. The mean age of the patients in group A was 30.9 ± 7.98 years (range 18–59 years), and their mean implant size was 317.5 cc ± 2.05 (range 200–555). In group A, 45.1 % ($n = 339$) of the patients were smokers, and 62.2 % ($n = 467$) had drains. The majority of the patients (78 %) had an overnight stay in the clinic. Hematoma was seen in 2.7 % ($n = 20$) of the group A patients. Revision was performed for 6 % ($n = 45$). Periprosthetic infection was seen in 0.4 % ($n = 3$) and minor wound healing problems in 1.3 % ($n = 10$). Group B comprised 110 patients who had mammoplasties performed in partial submuscular pockets. All the patients had the same size implants. The mean age of the group B patients was 33 ± 8.26 years (range 20–58 years), and their mean implant size was 300.6 cc ± 35.92 (range 205–395). Of these 110 patients, 51.8 % ($n = 57$) were smokers, and 94.5 % ($n = 104$) had drains. Hematoma was seen in 1.8 % ($n = 2$), and revision was performed for 7.3 % ($n = 8$) in the submuscular subgroup. Infection was seen in 3.6 % ($n = 4$) and minor wound healing problems in 4.5 % ($n = 5$). Group C consisted of 1,123 patients who had breast augmentation in the muscle-splitting biplane. Of these 1,123 patients, 914 had the same size implants. The mean age of the patients was 30.0 ± 8.78 years (range 18–67 years), and their mean implant size was 338.2 cc ± 58.01 (range 170–655). In group C, 33.6 % of the patients were smokers, and 8 % had drains. The majority of the patients (93.4 %) were treated as day cases. Hematoma was seen in 0.7 %, and 1.2 % of the patients had revision surgery. Infection was seen in 1.6 % ($n = 15$) and minor wound healing in 4 % ($n = 45$).
Conclusion Muscle-splitting mammoplasty is a technique that can be performed as a day case without drains. The overall complications in the group were significantly lower than with the other two techniques performed by the author.
Level of Evidence IV This journal requires that authors assign a 41level of evidence to each article. For a full description of 42these Evidence-Based Medicine ratings, please refer to the 43Table of Contents or the online Instructions to Authors 44http://www.springer.com/00266.

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Keywords Dual-plane mammoplasty · Muscle-splitting biplane mammoplasty · Partial submuscular mammoplasty · Subglandular mammoplasty

After silicone implants for augmentation mammoplasty in the retromammary pocket were introduced 1963 [1], the quest for the perfect pocket that can meet and address the various forms, shapes, volumes, and tissue types of breasts a patient presents when requesting augmentation mammoplasty began. A high capsular contracture rate after subglandular augmentation mammoplasty [2] soon led to total submuscular augmentation mammoplasty [3].

However, the unnaturally high appearance of breasts with wide cleavages and delayed recovery soon replaced the total submuscular pocket procedure with a partial submuscular technique [4]. In the partial submuscular technique, the pectoralis major is released from the inframammary fold and continued up along the sternal edge to the third and fourth ribs, allowing a narrower intermammary distance. This extensive release of the pectoralis from the lower sternal and inframammary fold also results in superior or cephalic retraction of the released muscle, leaving the implant in a subglandular position in the lower part of the breast for a better lower pole appearance.

However, the technique did not have the capacity to address thin patients who presented with excessive skin envelopes at the same time. Creation of the partial submuscular pocket for such individuals resulted in descent of the breast parenchyma below the most projected mound of the breast.

The partial submuscular pocket included a modification in which sternal pectoralis release from its posterior aspect was replaced with release of the muscle from the anterior surface of the breast parenchyma and release of the pectoralis from the inframammary fold in most, if not all, of the patients and became popular as the dual-plane technique [5]. The results of these mammoplasties performed in the partial submuscular plane and its modified dual plane were associated with a high incidence of dynamic deformity with a potential for delayed recovery [6].

A novel subfascial technique was introduced to overcome these excessive and unnatural movements [7]. The muscle-splitting biplane procedure also is a newer technique in which the implant lies in front and behind the muscle at the same time [8]. The technique does not involve release of the pectoralis muscle at all, so the breast distortion or animation deformity commonly seen after partial submuscular or dual-plane breast augmentation mammoplasties is eliminated or decreased by conversion of the partial submuscular or dual-plane pocket into the muscle-splitting pocket [9].

The author has used the technique in 1,123 consecutive primary augmentation mammoplasties performed in the last 6 years. The results were compared with 903 primary mammoplasties performed in the subglandular ($n = 793$) and partial submuscular ($n = 110$) pockets by the same author in the preceding 6 years.

Materials and Methods

A retrospective analysis of data prospectively collected using the Excel spreadsheet was performed. The patients were divided into three groups. In group A, the mammoplasty used the subglandular pocket. In group B, the partial submuscular pocket was used for mammoplasties. Both of these groups had their mammoplasties performed between 1999 and 2005. Group C, the third group, included patients who had muscle-splitting mammoplasties between 2005 and 2011.

All the patients were administered a perioperative single dose of intravenous antibiotics, predominantly second-generation cephalosporin. The data were analyzed to evaluate the overall outcome of the muscle-splitting technique, and the results were compared with the data for subglandular and partial submuscular augmentation mammoplasties to determine the incidence of hematoma and infection as well as the revision rates in the respective groups. Patients presenting with breast and chest asymmetries requiring two different size implants were excluded from the comparative analysis.

Statistical Analysis

Statistical analyses were performed using the Statistical Package of Social Sciences (SPSS), version 11.0 (SPSS, Chicago, IL, USA). Chi-square and Fisher's exact test were used for comparison of smokers, hematoma, infection, minor wound breakdown, drains, and revision in the subglandular, partial submuscular, and muscle-splitting pockets. Analysis of variance (ANOVA) with the Tukey test was used for comparison of age with subglandular, partial submuscular, and muscle-splitting pockets. In all statistical analyses, only a p value lower than 0.05 was considered significant.

Results

Data were available for 2,026 patients. Almost all the patients had round cohesive gel silicone textured high-profile implants.

Group A comprised 793 patients who had their augmentation mammoplasties in the subglandular pocket. Of these 793 patients, 751 had the same size implants and were included in the analysis. The mean age of the group A patients was 30.9 ± 7.98 years (range 18–59 years), and they had a mean implant size of 317.5 cc ± 42.05 (range 200–555). Of these 793 patients, 45.1 % ($n = 339$) were smokers, and 62.2 % ($n = 467$) had drains. The majority of the patients (78 %) had an overnight stay in the clinic. Hematoma was seen in 2.7 % ($n = 20$) of the group A patients. Revision was performed for 6 % ($n = 45$). Periprosthetic infection was seen in 0.4 % ($n = 3$) and minor wound healing problems in 1.3 % ($n = 10$) (Tables 1, 2).

Group B consisted of 110 patients who had mammoplasties performed in the partial submuscular pockets. All the patients had the same size implants. The mean age of the patients was 33 ± 8.26 years (range 20–58 years), and the mean implant size was 300.6 cc ± 35.92 (range 205–395). Of these 110 patients, 51.8 % ($n = 57$) were smokers, and 94.5 % ($n = 104$) had drains. All the patients had an overnight stay in the clinic. Hematoma was seen in 1.8 % ($n = 2$) of the group B patients. Revision was performed for 7.3 % ($n = 8$) in the submuscular subgroup. Infection was seen in 3.6 % ($n = 4$) and minor wound healing problems in 4.5 % ($n = 5$) (Tables 1, 2).

Group C was composed of 1,123 patients who had breast augmentation in the muscle-splitting biplane. Of these 1,123 patients, 914 had the same size implants. The mean age of patients was 30.0 ± 8.78 years (range 18–67 years), and their mean implant size was 338.2 cc ± 58.01 (range 170–655). Of these 1,123 patients, 33.6 % were smokers, and 8 % had drains. The majority of the patients (93.4 %) were treated as day cases. Hematoma was seen in 0.7, and 1.2 % of the patients had revision surgery. Infection was seen in 1.6 % ($n = 15$) and minor wound healing problems in 4 % ($n = 45$) (Tables 1, 2).

The mean patient age was significantly older in the partial submuscular (SM) group (33.0 ± 8.26 years) than in the muscle-splitting biplane (BP) group (30.0 ± 8.78 years) or the subglandular (SG) group (30.9 ± 7.98 years) ($p < 0.05$).

The mean implant size was significantly smaller in the SM group (300.6 cc ± 35.92) than in the BP group (338.9 cc ± 58.0) or the SG group (317.5 cc ± 42.05) ($p < 0.01$). The hematoma rate was significantly higher in the SG group (2.7 %) than in the BP group (0.7 %) ($p < 0.003$). The infection rate was significantly higher in the SM group (3.6 %) than in the BP group (1.6 %) or the SG group (0.4 %) ($p < 0.5$). Minor wound breakdown was more common in BP group (4.9 %) and was statistically more frequent than in the SG group (1.3 %) or the SM group (4.5 %) ($p < 0.001$). The revision rate was significantly higher in the SG group (6 %) and the SM group (7.3 %) than in the BP group (1.2 %) ($p < 0.001$) (Table 3).

Discussion

Augmentation mammoplasty using a silicone implant was first described by Cronin and Gerow in 1963 [1]. Since then, the procedure has gained popularity and currently is one of the most commonly requested and performed procedures by plastic surgeons. Various types and profiles of the implants and different approaches for insertion and pockets have been described for the procedure.

The position of the implant in its pocket normally is described in relation to the pectoralis muscle, either as prepectoral or retropectoral. The subfascial pocket still is a prepectoral position, with the breast envelope reinforced by prepectoral fascia [7].

Table 1 Comparison of age and implant sizes among the patients with single-size implants in three groups

	BP group ($n = 914$)	SM group ($n = 110$)	SG group ($n = 751$)	p Value
A Age (in years)				
Minimum	18	20	17	
Maximum	67	58	59	
Mean	30.0	33.0	30.9	
Median	29	32	30	
SD	8.78	8.26	7.98	
Mean ± SD	30.0 ± 8.78	33.0 ± 8.26	30.9 ± 7.98	0.001
B Implant size (cc)				
Minimum	170	205	200	
Maximum	655	395	555	
Mean	338.9	300.6	317.5	
Median	350	300	300	
SD	58.01	35.92	42.05	
Mean ± SD	338.9 ± 58.01	300.6 ± 35.92	317.5 ± 42.05	0.001

BP muscle-splitting biplane; *SM* partial submuscular; *SG* subglandular; *SD* standard deviation

Table 2 Comparison for smokers, hematoma, infection, minor wound healing problems, drains, and revision rate of the patients with same size implants in three groups

	BP group ($n = 914$) n (%)	SM group ($n = 110$) n (%)	SG group ($n = 751$) n (%)	p Value
Smoker	307 (33.6)	57 (51.8)[a]	339 (45.1)[a]	0.001
Hematoma	6 (0.7)	2 (1.8)	20 (2.7)[a]	0.005
Infection	15 (1.6)	4 (3.6)[a]	3 (0.4)	0.005
Minor wound healing problems	45 (4.9)	5 (4.5)	10 (1.3)[a]	0.001
Drains	73 (8.0)	104 (94.5)	467 (62.2)[a]	0.001
Revision/ reoperation	11 (1.2)	8 (7.3)	45 (6.0)[a]	0.001

Patients having had different implant sizes in asymmetrical breasts were excluded from comparative analysis in this table

BP muscle-splitting biplane; *SM* Partial submuscular; *SG* subglandular

[a] Statistically significant ($p < 0.05$). Infection was significantly higher in the SM group ($n = 4$, 3.6 %) than in the BP (1.6 %) and SG (0.4 %) groups ($p < 0.05$)

Table 3 Causes of reoperations and their distribution after primary augmentation mammoplasty in three planes

	SG group ($n = 751$)	BP group ($n = 914$)	SM group ($n = 110$)
Asymmetry	3	1	2
Capsular contracture	6	2	0
Malplacement	5	0	2
Larger size	3	3	0
Infection	3	3	2
Hematoma	20	1	2
Others	5	1	0

SG subglandular; *BP* muscle-splitting biplane; *SM* partial submuscular

As expected, the first implant insertion technique was described in the prepectoral position due to the natural prepectoral position of the breast [1]. A high capsular contracture [2] rate with the subglandular pocket led to the total submuscular position of the implant [3]. However a bidimensional muscle did not have the capacity to give a three-dimensional result in a multidimensional breast. Inadequate results with longer recovery led to the novel idea of partly releasing the pectoralis in which the muscle covers the implant only in its upper two thirds. That allowed the lower pole of the breast to accommodate the prosthesis in the subglandular pocket to give three-dimensional results for the majority of patients [4].

The technique was later modified to accommodate skin envelope excess seen in thin individuals [5]. However a high incidence of animation deformity seen after the partial submuscular position and its modification, dual-plane augmentation mammoplasty, led to further modification of submuscular placement of breast implants using the muscle-splitting technique [8]. The technique has the added advantage of minimizing the animation deformity due to the absence of sternocostal muscle release. The application of the muscle-splitting concept also has been published for reversal of animation deformities seen after partial submuscular and dual-plane augmentation mammoplasties [9, 10].

Muscle-splitting augmentation is a technique in which a muscle is separated along its direction and not divided. The bidimensional or flat pectoralis muscle lies in front of the implant in its upper and medial two thirds part, covering the device in the flatter part of the breast while leaving the lower and flat pectoralis behind the implant in the lower multidimensional part of the breast. The final appearance and results are as natural as those seen after subglandular augmentation mammoplasty with the addition of muscle in the upper part of the breast. The addition of the muscle in its upper part provides extra support and a layer of tissue without compromising the natural look with almost all types of breasts while retaining the capacity to extend support to the ever-changing physical characteristics of the breast. For this reason, the technique is regularly used even in the presence of a positive pinch test [11].

Reliance on a pinch test at a particular moment in time is highly unpredictable, especially in young individuals with ever-changing breast envelope thickness and consistency. For the very same reason, the revision rate for breast rippling after subglandular breast mammoplasty has gone down to zero percent in muscle-splitting breast augmentation. The undivided lateral end of the muscle (Fig. 1a, b) holds the implant in place and prevents lateral or superior displacement of the prosthesis, as often seen in partial submuscular augmentation.

Splitting of the muscle at the junction of middle and lower sternum allows for a very natural and narrow intermammary distance (Fig. 1a, b). Splitting the muscle just below the nipple–areolar complex results in a cephalic shift of the upper pectoralis and an en bloc lift of the breast at the muscle–parenchymal interface in a patient with an excess skin envelope or borderline ptosis, avoiding mastopexy in early ptotic breasts [12] (Figs. 1c–d). Since its first publication, the author has extended its use in primary [13–15] and secondary [9, 16–20] augmentation mammoplasties, with the result that the technique has been widely practiced and reported [21–26].

To date, the comparative results between the three techniques used by the author have shown a very encouraging outcome, with a marked decrease in overall revision rates (Table 2). The current series is an audit of a single surgeon's experience with three techniques over a period of 12 years. A learning curve is involved in each individual surgeon's clinical career depending on the surgeon's understanding, planning, and execution of the procedure together with the work load of the surgeon's particular surgery.

The low incidence of revision surgeries performed after muscle-splitting mammoplasties was due to the explanation cited earlier in the discussion. The author has always used silicone cohesive gel implants, predominantly Perous Plastie Perthese implants in the earlier half of the series and moving later to Poly Implant Prothese (PIP), McGhan, Allergan Natralle, and Nagor implants. Currently, the author exclusively uses Allergan Microtextured high profile (MHP)/Microtextured low profile (MLP) and Cohesive microtextured high profile (CMH)/Cohesive microtextured low profile (CML) Cox-uphoff International (CUI) cohesive silicone gel implants.

The author has almost always used the inframammary crease incision. Considering that the periareolar approach has been used by the author for patients presenting with tuberous breast or requiring periareolar mastopexy, execution of an inframammary approach is unlikely to disturb the only anatomic boundary of the breast. This helps to reduce revision surgeries seen after other approaches, especially the transaxillary approach [16]. The incidence of hematoma in the muscle-splitting group was lower than in the partial submuscular and subglandular pocket groups (Table 2). The rate of secondary or revision surgeries performed in the muscle-splitting group was lower than in the subglandular and submuscular groups, and the difference was statistically significant.

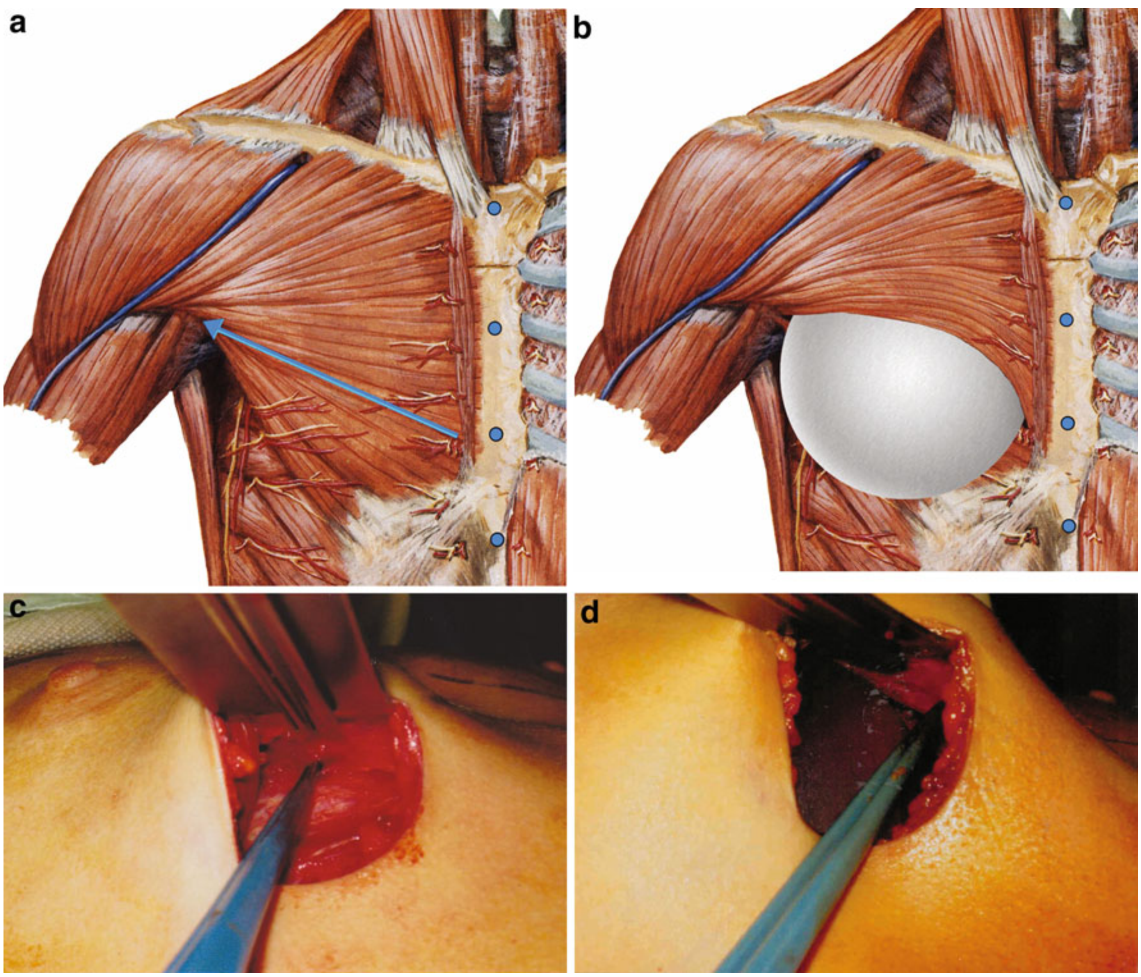

Fig. 1 **a** Level of muscle split starting medially at the junction of the middle and lower third of the sternum and going up laterally to the anterior maxillary fold. **b** Relationship of implant and pectoralis in the muscle-splitting biplane. **c**, **d** Intraoperative view through the inframammary crease showing the split muscle in the right breast. **c** Superior split muscle shown using the diathermy tip as the pointer. The gaping of the superior and inferior edge of the pectoralis muscle has resulted in the whole width of the rib coming into the view. This superior shift of the upper split muscle accompanied with the attached parenchyma of the breast results in an internal mastopexy effect. **d** Implant covered by the upper split pectoralis in its upper part, leaving the lower split pectoralis posterior to the prosthesis and the implant itself in the subglandular position

Fig. 2 **a**, **b** Preoperative photographs of a 29-year-old patient with a thin breast envelope after pregnancy. **c**, **d** Results 1 year after placement of 300-ml, round, cohesive gel textured high-profile implants in the muscle-splitting biplane. **e–g** Results after 4 years showing stable results

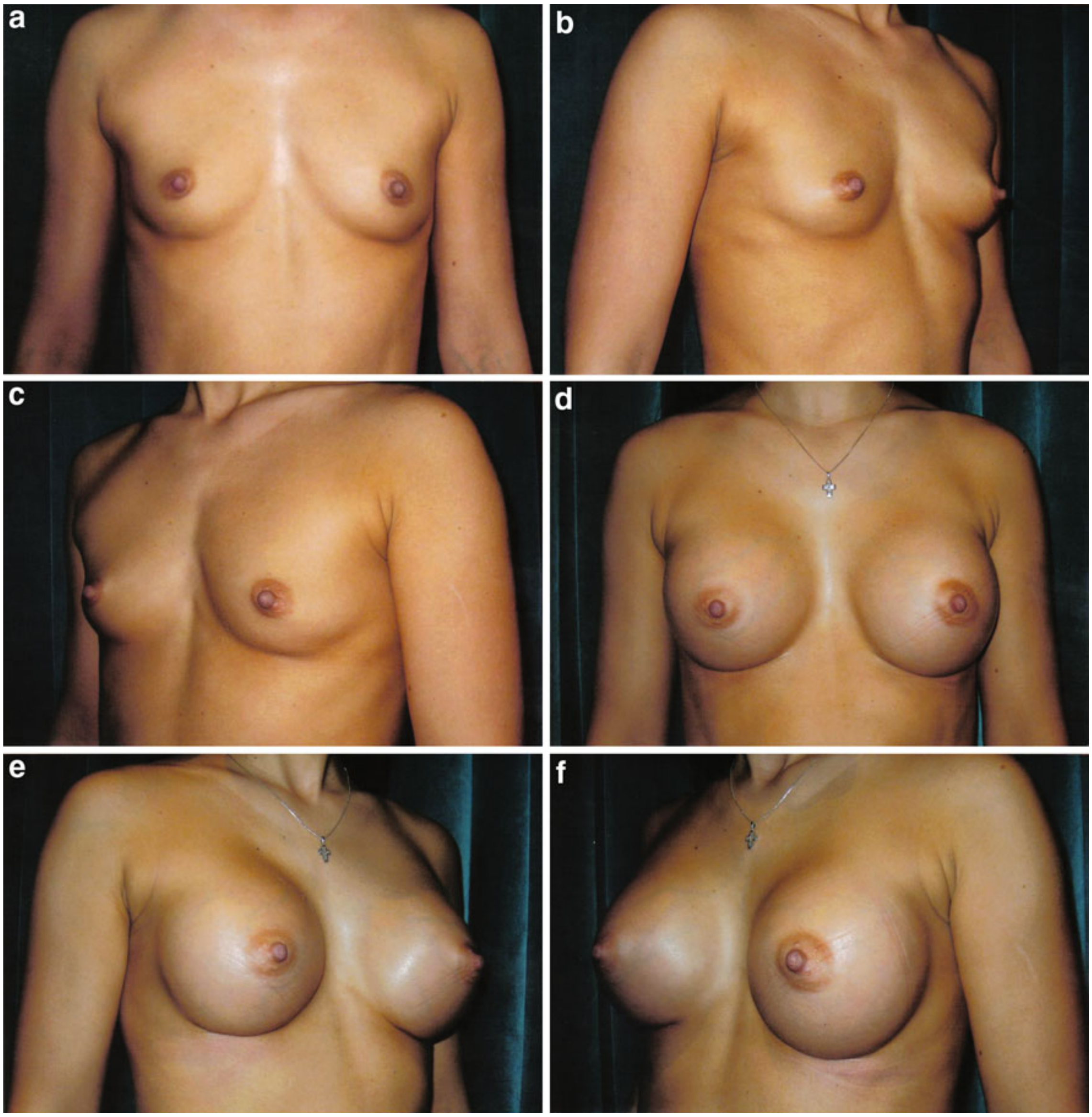

Fig. 3 **a–c** Preoperative photographs showing a 20-year-old athletic, fat-free nulliparous patient. **d–f** Photos 2 years after the placement of 270-ml, textured, round, cohesive gel high-profile silicone implants in the muscle-splitting biplane. **g–i** Results after 5 years and 6 months showing adequacy of the implantation

The muscle splitting technique has shown uniformly good results in younger patients due to more stable and longer-lasting results than with the other pockets (Figs. 2, 3, 4, 5a–f) and has significantly reduced the reoperation rate (Table 2). A zero percent 3-year reoperation rate has been documented for a single surgeon using the same type of form-stable implant as well as the same incision and pocket [27].

In a reported 5- to 9-year study after augmentation mammoplasty, with different surgeons using different approaches and pockets for the same type of form-stable implant, a single revision for implant rupture was reported [28]. Another core study comprising silicone memorygel breast implants with a 3-year follow-up period showed a revision rate of 15 %. The most common reason for revision was capsular contracture (36.7 %) followed by a change in style or size (14.7 %). Hematoma and seroma were seen in 11 % of the primary cases [29].

A long-term study reported by Nahi et al. [30] with a follow-up period of 15 years showed a 20 % total reoperation rate for primary augmentation mammoplasties. The most common reason for reoperation was capsular contracture (8 %), followed by rippling (7.1 %). Hematoma was seen in 2 % of the patients, and 25 % of them later experienced capsular contracture. The study did not mention the treatment method used for postoperative hematoma management. An infection incidence of 1.8 % was reported for the patients in the series.

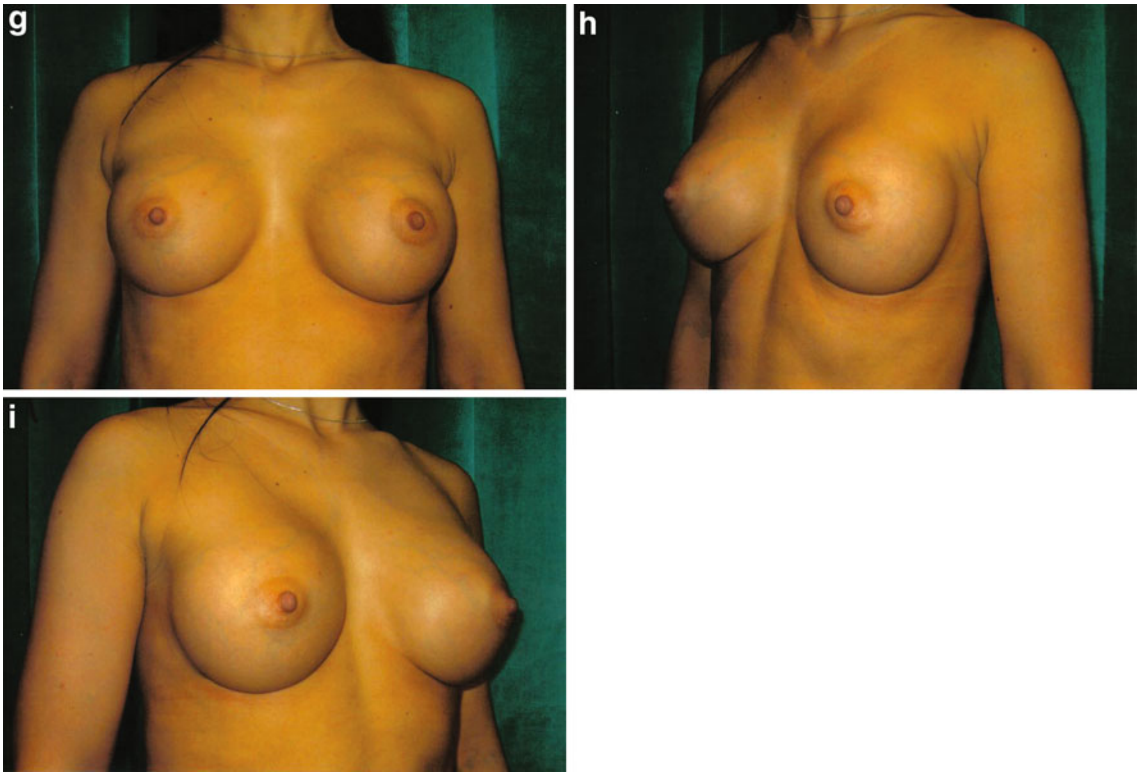

Fig. 3 continued

Hendel et al. [31] in their 25-year study on breast implants showed a reoperation rate of 15.5 % in the augmentation mammoplasty group. The single most common reason for reoperation in this group was capsular contracture (55.6 %) followed by a request for a size change (21.8 %). Infection was seen in 2.7 % of the patients. No hematoma was recorded for 1,601 patients who had augmentation mammoplasty.

The author of the current study has reported a 0.6 % incidence of hematoma in 1,838 primary augmentation mammoplasties that included all three groups [32]. The current 12-year retrospective analyses of the three different techniques show a hematoma rate of 2.6 % for subglandular mammoplasties and 1.8 % for partial submuscular mammoplasties compared with 0.7 % for the muscle-splitting biplane augmentation. The difference was significantly less. In the muscle-splitting biplane augmentation group, significantly fewer patients had drains postoperatively than in the partial submuscular and subglandular mammoplasty groups. Postoperative recordings for the drains in the muscle-splitting augmentation group showed a lower overnight drainage as well (Table 4). Out of eight hematomas, only one patient who had muscle-splitting biplane augmentation was explored with negative findings. All the others were treated conservatively using ice packs and compression dressings. No capsular formation was seen in the patients treated conservatively for hematoma, indicating a minor degree of nonprogressive collection of blood in these cases.

A significant reduction in hematomas with no need for drains suggests good and predictable hemostasis with the muscle-splitting biplane augmentation. On the other hand, the use of drains with the other techniques did not necessarily prevent hematoma (Table 2).

An infection rate of 0.52 and 0.53 % has been reported by the author respectively for primary and secondary augmentation mammoplasties [19, 33]. In the current study, a 1.6 % incidence of periprosthetic infections was seen in 15 of 914 patients in the muscle-splitting augmentation group, or 0.8 % per breast in 1,828 breasts. The incidence of infection was significantly higher in the partial submuscular group than for the muscle-splitting and subglandular pockets. The infection rate was further analyzed for smokers and nonsmokers. Overall, 32 % of the patients were smokers. Of 15 infections seen in muscle-splitting augmentations, 33.3 % belonged to the smokers group compared with 66.6 % seen in the nonsmokers group, and the results were not significant.

Wound healing problems were more commonly seen with muscle-splitting augmentation and at a statistically higher rate than in the subglandular and partial submuscular groups. However, it is worth mentioning that in the early part of the muscle-splitting augmentation series, inframammary wound closure was performed using 4-0

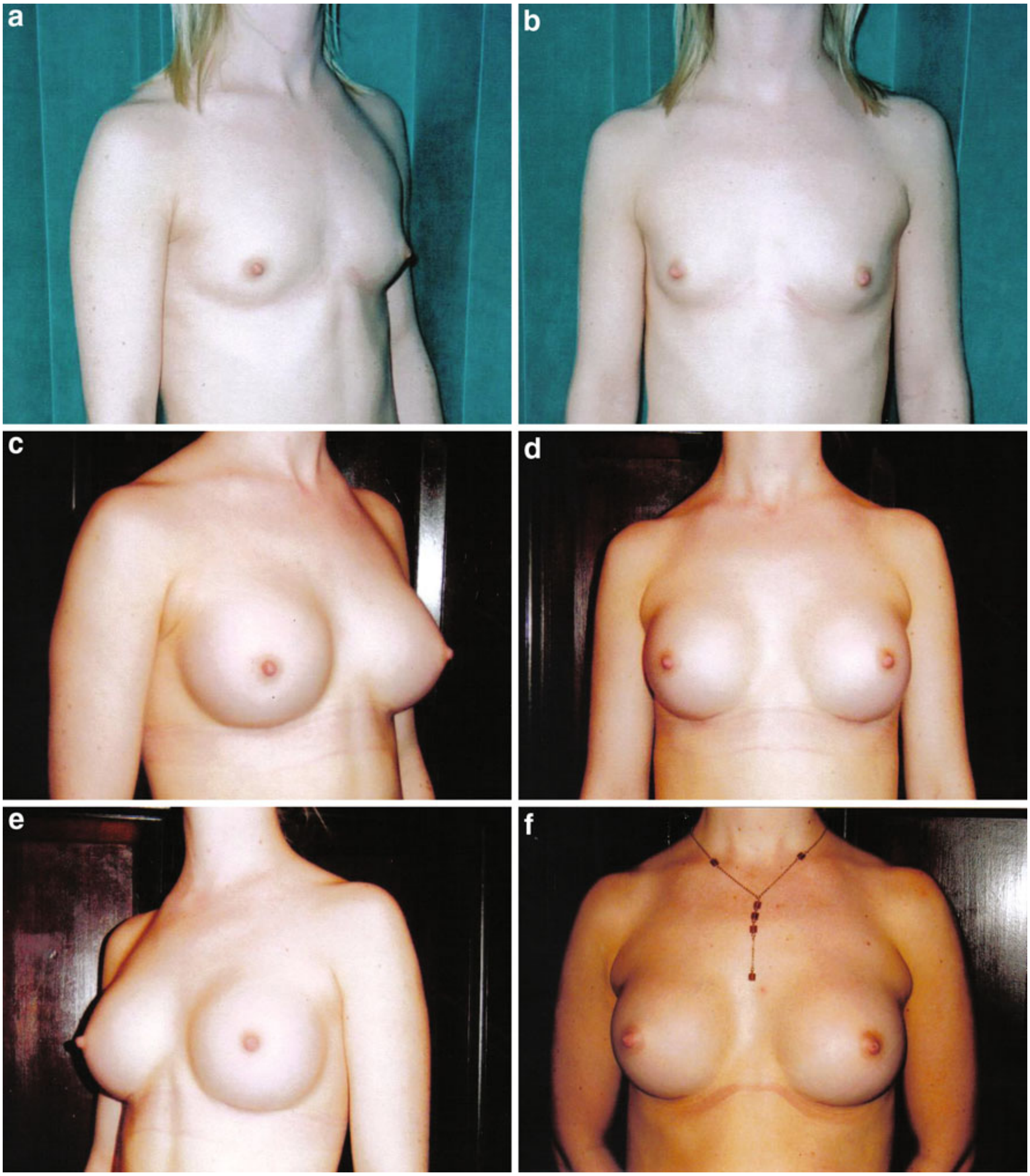

Fig. 4 **a–b** Preoperative photographs of a 21-year-old nulliparous patient with hypolplasia of the breast. **c–e** Postoperative photographs 18 months after her surgery using 230-ml, cohesive gel, round, textured high-profile implants in the muscle-splitting biplane. **f–h** Postoperative photographs 5 years after augmentation mammoplasty

Vicryl as an intradermal continuous layer, with knots tied at both ends. The knots used to have multiple throws and were too close to the skin. Most of these knots were slow to absorb and in some cases used to get extruded through the skin, resulting in delayed healing. Since the author has started using a 4-0 Monocryl continuous intradermal pull-through stitch instead of 4-0 Vicryl, this particular problem has almost disappeared. The long free extracutaneous ends of the stitch are trimmed in 2 weeks time.

Further analysis of wound healing delays in the muscle-splitting group showed that they occurred for 42.2 % of the smokers group compared with 57.7 % of the nonsmokers group, but the difference was not significant. Although a statistically significant difference was noted for infection and wound healing between the smokers and nonsmokers, an interesting observation in the data analysis noted that the number of smokers was significantly fewer in the later 6-year part of the study than in the earlier 6 years. The

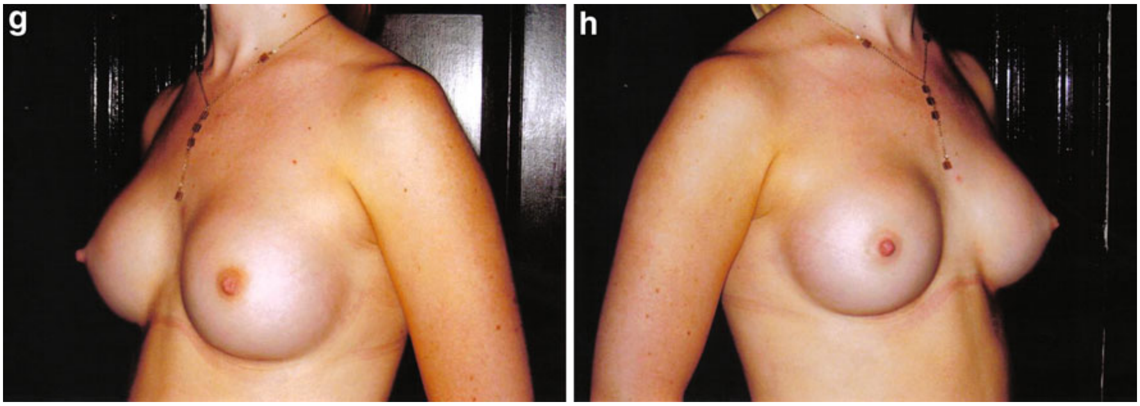

Fig. 4 continued

number of cigarette smokers was 45.1 % in the subglandular group and 51.8 % in the partial submuscular group, who had their procedures between 1999 and 2005, compared with 33.6 % in the muscle-splitting biplane cohort, who had their surgeries between 2005 and 2011. The results were not statistically analyzed. The decrease likely was due to the Department of Health and National Health Service (NHS) campaign to educate people on the hazards and risks of cigarette smoking and also due to the government ban on smoking in public places.

The total reoperation rate for the three different techniques also was analyzed in the series and showed interesting and encouraging results for the muscle-splitting pocket. The revision rate for the subglandular and partial submuscular pockets was significantly higher than for the muscle-splitting biplane (Tables 2, 3).

Study Limitation

In unpublished data on the author's 3-year reoperation rate for primary augmentation mammoplasty performed for 507 patients, the incidence of revisions was noted to be 1.9 %. However, the author recognizes and acknowledges the difficulty of obtaining accurate data on such a large series spread over 12 years. Similar difficulties have been reported in other long-term follow-up studies [30, 31].

In the current series, the author followed up patients for a minimum of 3 years. During this period, revision surgery for any prosthesis- or surgery-related complication was part of the aftercare plan, and hematoma, infection, and wound healing problems including capsular contracture were fairly and accurately recorded for most of the patients. Even after 3 years, surgical follow-up assessments are free, and because most of the patients live with in an hour's drive from the office, they are expected to contact the office in case of a complication.

Fear of PIP implants and their substandard silicone filler material has generated a concern among surgeons and patients alike. As a result, the author contacted 135 of his patients who had their mammoplasties using PIP implants between April 2003 and October 2004. Only 45 patients (29.6 %) responded and attended the author's clinic for follow-up assessment, examination, and further planning. All but one patient opted for a change of device. Of these 45 patients, 35 had subglandular and ten had partial submuscular augmentation.

During an average follow-up period of almost 9 years, 11.11 % of the patients presented with grade 3 or 4 capsular contracture. Of the ten patients who had partial submuscular augmentation, 2 (22.22 %) had grade 3 or 4 capsular contracture, as opposed to 3 (8.5 %) who had grade 3 or 4 capsular contracture in 35 subglandular mammoplasties. However, the findings, complications, and reasons for reoperation in the PIP group cannot be compared with those in the other group of patients who had devices other than PIP because the non-PIP implant patients constituted a much larger group during that period.

Muscle-splitting augmentation mammoplasty is versatile and has been performed consecutively for considerably more than 1,150 primary cases to date. The technique has been used for patients presenting with chest and breast asymmetries [15], for lateralization of breast pockets to offset lateralized nipples in the horizontal plane [13], and for simultaneous mastopexy with augmentation [12]. The unique position of the muscle in the muscle-splitting biplane allows the upper unused prepectoral or subglandular pocket to be used for internal glandulopexy (multiplane) for the patient requesting primary augmentation mammoplasty who presents with minor ptosis or minor nipple level asymmetry and is not too keen on skin reduction mastopexies.

The same multiplane concept has been used for the correction of early ptosis in patients presenting for revision

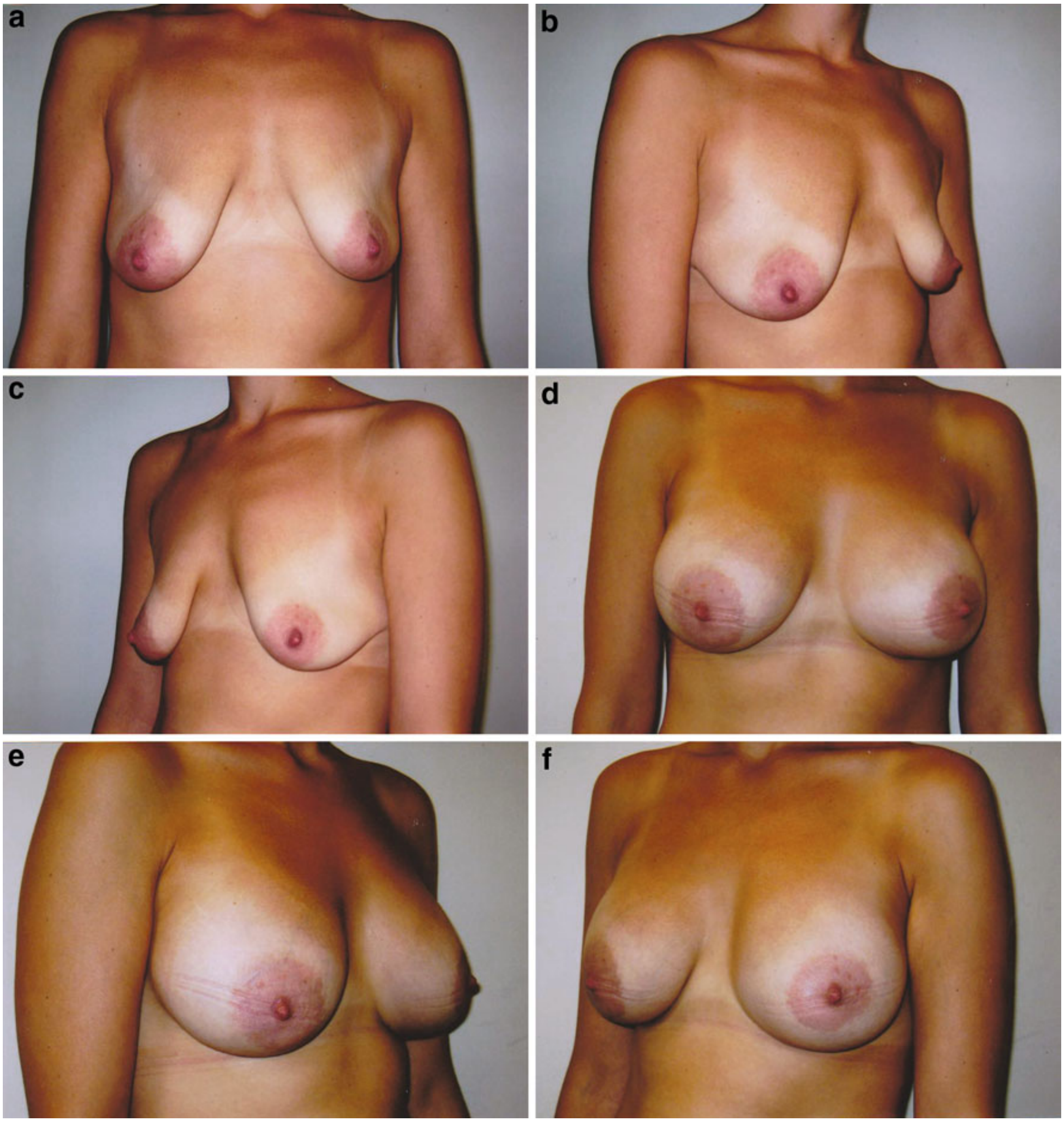

Fig. 5 **a–c** Preoperative views of asymmetric ptotic breasts in a 33-year-old woman after pregnancies and breastfeeding. **d–f** Views 1 year after augmentation mammoplasty using the muscle-splitting biplane, with 375- and 425-ml cohesive gel silicone breast implants placed respectively in the right and left sides. The adequate results using the muscle-splitting technique obviated the need for a mastopexy and scarring on the patient's breasts

surgery who had their initial mammoplasty performed with the subglandular pocket [14]. The ease of converting the partial submusclar and subglandular pocket into a muscle-splitting biplane pocket has extended the use of the technique in a variety of secondary procedures for patients who had their initial procedure performed with the subglandular or partial submuscular pockets.

Bottoming down [16], synmastia [17], upper pole rippling, and capsular contracture [19] after subglandular augmentation mammoplasty have been treated successfully and adequately using the muscle-splitting biplane. Similarly, dynamic deformity [9] and various types of implant malplacement [18] after partial submuscular augmentation mammoplasty have been treated by converting the partial submuscular pocket into a muscle-splitting biplane.

The muscle-splitting biplane is an anatomic pocket creating a natural anatomic breast shape when a round cohesive gel silicone implant of varying profile is used. The upper part of the implant is pressed down by the active muscle, allowing the lower pole of the implant to fill the lower part of the breast and giving it a one-unit feel as well as a natural teardrop appearance. Both the implant and the breast still retain their capacity to conform to gravitational or positional changes of the body. The same effect is not

Table 4 Drains used in 74 (6.6 %) of 1,123 cases of muscle-splitting augmentation and drainage recorded for 69 patients[a]

	Right drainage (ml)	Left drainage (ml)
n	35	34
Minimum	10	2
Maximum	220	100
Median	50	50
Mean	52.4	44.9
SD	38.4	26.5

SD standard deviation

[a] Difference between right and left drains: 52.4 ± 38.4 vs. 44.9 ± 26.5. The two drain sites did not differ significantly ($p > 0.05$, *t* test used for comparison)

seen in a form-stable cohesive gel implant that does not have the capacity to conform to such changes.

These form-stable teardrop implants have been given a misleading nomenclature of anatomic implants because the breast is not a teardrop in all naturally occurring positions except an upright posture [34]. The joined lateral end of the pectoralis locks an implant, disallowing the lateral or superior displacement often seen with the partial submuscular pocket [18]. However, the phenomenon of back-to-front flipping of an implant is a manifestation of the physical properties seen in microtextured implants with a low gel-fill ratio and cannot be prevented in the muscle-splitting biplane [34].

Clockwise or anticlockwise rotation with the round cohesive gel implants is not of any clinical significance because these implants have the capacity to adapt to natural gravitational, positional, or postural changes as opposed to permanent breast shape changes that may follow clockwise or anticlockwise rotation of form-stable teardrop implants. A rotation rate of 1 % to 14 % has been reported in the literature [28, 35].

The author personally prefers the use of high-profile implants that give a teardrop shape in a standing position and an anatomic breast shape in all other positions. Cohesive gel silicone in the muscle-splitting pocket gets pressed by the pectoralis, creating a teardrop implant from a round high-profile implant without the risk of rotation deformity.

Although the author does not use teardrop implants, the muscle-splitting biplane is an ideal pocket for these form-stable teardrop implants in which the lateral and medial locking effect of the intact pectoralis stabilizes the vertical orientation of the teardrop device at the point of its entry before it gains a submuscular position. The muscle-splitting approach should ideally obviate the need to use smaller pockets currently dissected for these form-stable implants to prevent their rotation in subglandular or partial submuscular pockets. An adequately dissected pocket in the muscle-splitting procedure obviates the need for these smaller and tighter pockets made for the insertion of teardrop implants and may further help to reduce the capsular contractures seen after the use of restrictive pockets.

Conclusion

Muscle-splitting mammoplasty is a technique that can be performed as a day case without drains. The overall complications in the group were significantly lower than with the other two techniques performed by the author.

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