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ORIGINAL ARTICLE BREAST SURGERY

The Comparison of Scars in Breast Implantation Surgery with Inframammary Fold Incision Versus Axillary Incision: A Prospective Cohort Study in Chinese Patients

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Abstract

Background A prospective cohort study was developed to compare the surgical scars in the axilla and the inframammary fold at short-, medium- and long-term time periods after surgery.

Methods Patients who underwent primary breast augmentation with implants in our department were divided into two groups based on the incision location they chose and were followed up for scar assessment at 1 month, 6 months and 12 months post-surgery from June 2012 to March 2016. Each scar was evaluated by the Vancouver Scar Scale (VSS) and patient satisfaction score. The data were analyzed with Wilcoxon rank-sum tests, Cochran–Armitage trend tests and Fisher's exact probability tests based on the data type.

Results One hundred and sixty-three patients were completely investigated three times. Ninety-four patients underwent breast augmentation surgeries with implants through axillary approaches and 69 patients through IMF approaches. At 1 month after surgery, the median total VSS score was 6 in the axillary incision group and 4 in the IMF group, with statistically significant differences ($P < 0.05$). Larger proportions of high scores in terms of vascularity and height were found in the axillary incision group ($P < 0.05$). At 6 months after surgery, the median total VSS score was 4 in the axillary incision group and 3 in the IMF group, with statistical significance ($P < 0.05$). The axillary group still had a larger proportion of high scores in terms of vascularity and height than that of the IMF group ($P < 0.05$). At 12 months after surgery, the median total VSS score was 2 in both groups. The median patient satisfaction score was 9 in both groups. No significant differences were noted in the total VSS and patient satisfaction scores between the two groups. However, the axillary group had a larger proportion of high scores in terms of vascularity and low scores in terms of pliability.

Conclusions The total VSS score for the axillary incision group was significantly higher than that for the IMF incision group one and 6 months after surgery, mainly on the subscales of vascularity and height. At 12 months after surgery, the total VSS scores were not different between the two groups, and patients with both kinds of incisions were highly satisfied with scar appearance. The research confirmed that the scars at two locations can achieve comparable appearance in the long term after surgery.

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

Keywords Scar assessment · Breast augmentation · Axillary incision · IMF incision

Introduction

Incision scars are unavoidable trade-offs of breast implantation surgery, especially for Chinese patients, who have a higher tendency of developing unpleasant scars [1, 2]. Some Chinese surgeons and patients prefer periareolar and axillary incisions to an inframammary fold

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(IMF) incision because they are worried that the unpleasant scars might be too obvious in the inframammary fold [3, 4]. However, the cosmetic outcomes of scar appearance and patient satisfaction with different types of incisions in Chinese women have not been fully studied. The incision scar should be comprehensively estimated by an objective standard evaluation as well as patient subjective satisfaction score.

The Vancouver Scar Scale (VSS) is one of the most commonly used systems for scar evaluation. The scar tissue was assessed based on four independent physical characteristics, including pigmentation, vascularity, height and pliability. The sum of the four subscales provides the total score, with increasing scores indicating greater pathologic conditions [5–7]. We have tested the efficiency and reliability of the combination of VSS and patient satisfaction scores in scar assessment after breast implantation surgery in a previous study. The results prove its applicability with remarkable reliability and validity [8]. On this basis, we have developed a retrospective study to compare the long-term (more than 1 year) cosmetic outcomes of incision scars between the axillary and IMF approaches. The results show that the axilla and IMF scars can produce comparable aesthetic outcomes and satisfaction degree in Chinese women [8]. However, the sample size and representativeness were not quite satisfactory. Further research is needed in this area to provide conclusive evidence. In this research, a prospective cohort study with a larger sample size was developed to compare the surgical scars in the axilla and inframammary fold at short-, medium- and long-term time periods after surgery.

Patients and Methods

Patients

Patients who participated in our previous study concerning the investigation of incision intentions and who underwent primary breast augmentation with implants were included in this study. According to the exclusion criteria of the previous research, none of the participants presented with obvious breast deformities or an extremely strong history of hypertrophic scarring. The patients were provided with preoperative education material in terms of the characteristics of different incisions and were allowed to choose one incision based on the comprehensive understanding of the characteristics of each incision and the fact that the scar might be present at that location for a fairly long time [4]. After the implantation surgery, the patients were divided into two groups based on the incision location they chose and were followed up for scar assessment at 1 month, 6 months and 12 months post-operation from June 2012 to March 2016. The patients who underwent revision surgeries with the original incision and those who failed to come back as requested were excluded. All participants signed an informed consent approved by the institutional ethics committee.

Surgical and Suture Techniques

Dr. Luan and his group (experienced plastic surgeons) performed all the implantation surgeries with axillary and IMF incisions. Anatomical-type rough surfaced silicone gel implants (Allergan or Mentor) were placed mostly in the dual-plane level of both groups (146 patients, 89.57%). An endoscopic was needed when using the axillary incision. The incisions of both groups were interrupted sutured with synthetic absorbable strings (4–0 ETHICON coated VICRYL Plus VCP422) in the subcutaneous tissue and continuously sutured with synthetic absorbable strings (5–0 ETHICON coated VICRYL Plus VCP493) in the mid-level dermis [8]. All patients were prescribed Kelo-Cote Advanced Formula Scar Gel (a patented silicone gel, Advanced Bio-Technologies, Inc, Suwanee, GA, USA) and required to use it regularly until 6 months post-operation. No other treatments were used on any scar.

Scar Assessment

The scar-related symptoms such as pain and itching were recorded. Each scar was scored based on the VSS by two independent plastic surgeons who did not attend research design or data analysis. All patients, blinded to the VSS score given by the surgeons, were asked to rate their scars for satisfaction, on a scale of 0 to 10, 0 being poor and 10 being excellent. The standardized procedure and scoring example of scar assessment have been described in our previous study [8].

Statistical Analysis

SPSS software (version 24.0, SPSS) was used for statistical analyses. The baseline characteristics and scar scores were compared between the axilla and IMF groups. Non-normal distributed variables were described with median and interquartile ranges (P25–P75) and were analyzed using Wilcoxon rank-sum tests. Ranked data were described with percentages and were tested with Cochran–Armitage trend tests and Fisher's exact probability test (when Cochran–Armitage trend test was not suitable). The significance was assigned at $P < 0.05$.

Table 1 Baseline demographic and clinical characteristics of the two groups

Incision	*N*	Age	BMI	Upper chest circumference (cm)	Lower chest circumference (cm)	Difference between upper and lower chest circumferences (cm)	Implant volume (cc)
Axillary	94	30.5 (27–37)	19.1 (17.50–20.36)	83 (79–86)	70 (67–73)	13 (11.5–14)	250 (230–270)
IMF	69	31 (27–35)	18.69 (17.71–20.45)	84 (81–86)	70.5 (69.5–72.5)	13 (11–14.5)	255 (220–280)
Z		− 0.4542	− 0.3611	0.0252	1.0127	0.0337	0.2382
P		0.6497	0.718	0.9799	0.3112	0.9731	0.8117

The demographic and clinical characteristics were not normally distributed and were described with medians and interquartile ranges (P25–P75)
The differences between the two groups were analyzed with Wilcoxon rank-sum tests. *Z* was the test statistic, and *P* was the probability value
There were no statistically significant differences between two groups ($P > 0.05$)

Results

One hundred and sixty-three patients were completely investigated three times. The median age of the patients was 31 years (range 20–48). The median BMI was 19.05 (range 15.57–24.22). All of the patients were Chinese. Ninety-four patients received axillary incisions, and 69 patients received IMF incisions. The follow-up rate was 83.19% (94/113) in the axillary group and 82.14% (69/84) in the IMF group. The demographic characteristics were not significantly different between the participants and withdrawn patients. Table 1 presents the demographic and clinical characteristics for the study groups. The data were not subject to normal distribution and were analyzed with Wilcoxon rank-sum tests. There were no statistical differences between the two groups in terms of age, BMI, implant volume, upper and lower chest circumference as well as the differences between them ($P > 0.05$).

The VSS score of both incision types declined with time, and the patient satisfaction score increased accordingly. Figure 1 shows examples of scar appearances of axillary and IMF incisions at 1, 6 and 12 months post-surgery. Some patients reported slight pruritus 1 month after surgery, and no patients had scar pain or itching that affected daily life and work at 6 and 12 months.

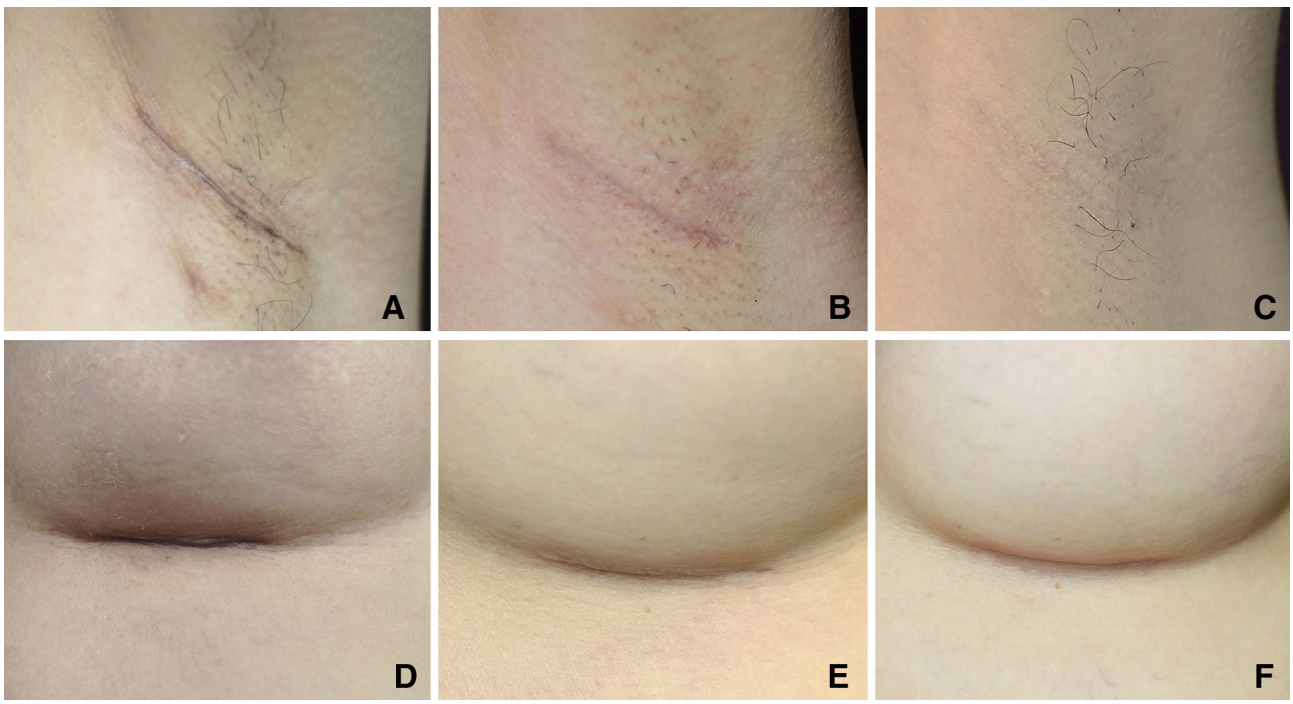

Fig. 1 Illustrations show examples of scar appearances. **a**, **b**, **c** Scars of axillary incision at 1, 6 and 12 months, respectively. **d**, **e**, **f** Scars of IMF incision at 1, 6 and 12 months, respectively. The photographs of IMF scar were taken from the bottom of the breast

Table 2 Total VSS scores and patient satisfaction scores of both groups 1 month after surgery

Incision	*N*	L-total VSS score	R-total VSS score	L-patient satisfaction score	R-patient satisfaction score	Average length (cm)
Axillary	94	6 (5–6)	6 (5–6)	7 (5–8)	7 (5–8)	5.0 (4.5–5.0)
IMF	69	4 (3–6)	4 (3–6)	7 (5–8)	7 (5–8)	4.1 (4.0–4.35)
Z		− 4.3776	− 4.1362	2.2066	2.0849	− 8.7752
P		< 0.0001*	< 0.0001*	0.0273*	0.0371*	< 0.0001*

The total VSS score, patient satisfaction score and average scar length of both sides were not normally distributed and were described with medians and interquartile ranges (P25–P75). The differences between the two groups were analyzed with Wilcoxon rank-sum tests. *Z* was the test statistic, and *P* was the probability value

L left side, *R* right side

*Statistically significant differences were noted between the two groups ($P < 0.05$)

Scar Assessment and Patient Satisfaction Score at Different Times

Short Term (1 Month) Post-surgery

The total VSS and patient satisfaction score regarding their incisions, as well as average scar length of both sides 1 month after surgery, is shown in Table 2. The data were not subject to normal distribution and were analyzed with Wilcoxon rank-sum tests. The median total VSS scores of both sides of the axillary and IMF groups were 6 and 4, respectively, with statistically significant differences ($P < 0.05$). The median patient satisfaction scores of both sides were 7 in both groups; however, the data distribution of the two groups was statistically significantly different ($P < 0.05$, $Z > 0$). The mean ranks from the axillary group were 75.30 and 75.65, left and right, respectively, while the mean ranks from the IMF group were 91.13 and 90.65, left and right, respectively. The patients from the IMF group had higher satisfaction scores than those from the axillary group. The median length of the axillary scar was 5.0 cm, while the number was 4.1 cm for the IMF group, with statistically significant differences ($P < 0.05$).

The subscales scores are presented in Table 3. The scores were ranked data and were tested with Cochran–Armitage trend tests. There were no differences between the two groups in terms of pigmentation scores and pliability scores of both sides ($P > 0.05$). However, remarkable differences were noted in vascularity and height scores of both sides between the two groups ($P < 0.05$). A larger proportion of high scores in terms of vascularity and height was found in the axillary incision than in the IMF incision ($P < 0.05$).

In summary, 1 month after surgery, the axillary scars were more obvious than IMF scars, mainly in terms of vascularity and height. The IMF scars were shorter than the axillary scars.

Medium Term (6 Months) Post-surgery

The total VSS scores and patient satisfaction scores regarding incision scars 6 months after surgery are shown in Table 4. The data were not subject to normal distribution and were analyzed with Wilcoxon rank-sum tests. The median total VSS scores from both sides of the axillary and IMF groups were 4 and 3, respectively, with statistical significance ($P < 0.05$). The median patient satisfaction scores of both sides were 8 in both groups, without differences ($P > 0.05$).

The subscale scores are presented in Table 5. The scores were ranked data and were tested with Cochran–Armitage trend tests. The data that were not suitable for Cochran–Armitage trend tests were analyzed with Fisher's exact probability tests. There were no differences in pigmentation and pliability scores of both sides between the two groups ($P > 0.05$). Noteworthy differences still existed in vascularity and height scores of both sides between the two groups ($P < 0.05$). The axillary group still had a larger proportion of high scores in terms of vascularity and height than IMF group ($P < 0.05$).

In summary, 6 months after surgery, the axillary scars were more obvious than IMF scars, mainly in terms of vascularity and height.

Long Term (12 Months) Post-surgery

The total VSS and patient satisfaction scores 12 months after surgery are shown in Table 6. The data were not subject to normal distribution and were analyzed with Wilcoxon rank-sum tests. The median total VSS scores of both sides were 2 in both groups. The median patient satisfaction scores of both sides were 9 in both groups. There were no significant differences in total VSS and patient satisfaction scores between the two types of incisions ($P > 0.05$).

The subscale scores are listed in Table 7. The scores were ranked data and were tested with Cochran–Armitage trend tests. The data that were not suitable for Cochran–

Table 3 Scores of the subscales 1 month after surgery

	Axillary	IMF	$\chi 2$	*P*
L-pigmentation				
0	–	–	–	–
1	–	–		
2	94 (100%)	69 (100%)		
R-pigmentation				
0	–	–	–	–
1	–	–		
2	94 (100%)	69 (100%)		
L-vascularity				
0	8 (8.51%)	22 (31.88%)	20.2401	< 0.0001*
1	25 (26.60%)	24 (34.78%)		
2	61 (64.89%)	23 (33.33%)		
R-vascularity				
0	10 (10.64%)	17 (24.64%)	19.9578	< 0.0001*
1	20 (21.28%)	32 (46.38%)		
2	64 (68.09%)	20 (28.99%)		
L-pliability				
0	2 (2.13%)	13 (18.84%)	3.0607	0.0802
1	70 (74.47%)	39 (56.52%)		
2	22 (23.40%)	17 (24.64%)		
R-pliability				
0	2 (2.13%)	15 (21.74%)	2.9274	0.0871
1	73 (77.66%)	37 (53.62%)		
2	19 (20.21%)	17 (24.64%)		
L-height				
0	20 (21.28%)	38 (55.07%)	19.8278	< 0.0001*
1	74 (78.72%)	31 (44.93%)		
2	–	–		
R-height				
0	20 (21.28%)	35 (50.72%)	15.4344	0.0001*
1	74 (78.72%)	34 (49.28%)		
2	–	–		

The scores of the subscales were ranked data and were described with percentage. The differences between the two groups were tested with the Cochran–Armitage trend test. χ^2 was the test statistic, and *P* was the probability value

L left side, *R* right side

*Statistically significant differences were noted between the two groups ($P < 0.05$)

Armitage trend tests were analyzed with Fisher's exact probability tests. There were no differences in pigmentation scores of both sides between the two types of incisions ($P > 0.05$). However, remarkable differences were noted in vascularity and pliability scores of both sides and height scores of the left side ($P < 0.05$). A larger proportion of high scores in terms of vascularity of both sides and height of the left side, while low scores in terms of pliability of both sides was found in the axillary group.

In summary, 12 months after surgery, there were no differences in the total VSS scores and patient satisfaction scores between the two incisions. The axillary scars were more vascular and pliable than IMF scars.

Discussion

The Chinese version of the Vancouver Scar Scale (VSS) comes into widespread use in China. The validity and reliability of the VSS (Chinese version) were tested and reported to be convincing. The Cronbach's alpha reliability coefficient of VSS is 0.84, the ICC of repeated measurements is 0.776–0.900, and the ICC of inter-rater reliability is 0.768–0.936 [9]. In our previous study, the Cronbach's alpha values were 0.825 and 0.874 for VSS and the patient satisfaction scores, respectively. The inter-rater reliability of the total VSS was tested by Spearman's correlation coefficients with the results of 0.746–0.832. The total VSS and patient satisfaction scores were negatively correlated with the Spearman's rank coefficients of 0.667 to 0.732. The combined application of VSS and patient satisfaction scores proves to be a valid and reliable system for scar evaluation after breast implantation surgery.

In this research, a well-organized prospective cohort study was performed for the first time to get further information about surgical scars of breast augmentation in Chinese women. The scar appearance and patient satisfaction regarding the axillary and IMF incisions were assessed one, 6 and 12 months after surgery. It was found that the VSS score of both types of incisions declined with

Table 4 Total VSS scores and patient satisfaction scores of both groups 6 months after surgery

Incision	*N*	L-total VSS score	R-total VSS score	L-patient satisfaction score	R-patient satisfaction score
Axillary	94	4 (3–5)	4 (3–5)	8 (8–9)	8 (8–9)
IMF	69	3 (2–4)	3 (2–4)	8 (8–9)	8 (8–9)
Z		− 2.6032	− 3.6375	− 0.722	− 0.4661
P		0.0092*	0.0003*	0.4703	0.6411

The total VSS and patient satisfaction scores were not normally distributed and were described with medians and interquartile ranges (P25–P75). The differences between the two groups were analyzed with Wilcoxon rank-sum tests. *Z* was the test statistic, and *P* was the probability value

L left side, *R* right side

*Statistically significant differences were found between the two groups ($P < 0.05$)

Table 5 Scores of the subscales 6 months after surgery

	Axillary	IMF	$\chi 2$	*P*
L-pigmentation				
0	10 (10.64%)	2 (2.90%)	2.3256	0.1273
1	5 (5.32%)	5 (7.25%)		
2	79 (84.04%)	62 (89.86%)		
R-pigmentation				
0	6 (6.38%)	4 (5.80%)	0.0001	0.9927
1	7 (7.45%)	6 (8.70%)		
2	81 (86.17%)	59 (85.51%)		
L-vascularity				
0	27 (28.72%)	35 (50.72%)	14.2355	0.0002*
1	39 (41.49%)	29 (42.03%)		
2	28 (29.79%)	5 (7.25%)		
R-vascularity				
0	26 (27.66%)	40 (57.97%)	17.5792	< 0.0001*
1	44 (46.81%)	24 (34.78%)		
2	24 (25.53%)	5 (7.25%)		
L-pliability				
0	56 (59.57%)	44 (63.77%)	0.4298	0.5121
1	32 (34.04%)	22 (31.88%)		
2	6 (6.38%)	3 (4.35%)		
R-pliability				
0	56 (59.57%)	47 (68.12%)	1.2478	0.2640
1	32 (34.04%)	19 (27.54%)		
2	6 (6.38%)	3 (4.35%)		
L-height				
0	47 (50.00%)	50 (72.46%)	8.3332	0.0039*
1	47 (50.00%)	19 (27.54%)		
2	–	–		
R-height[a]				
0	41 (43.62%)	48 (69.57%)		0.0016*
1	50 (53.19%)	21 (30.43%)		
2	3 (3.19%)	–		

The scores of the subscales were ranked data and were described with percentages. The differences between the two groups were tested with the Cochran–Armitage trend test. χ^2 was the test statistic, and *P* was the probability value

L left side, *R* right side

*Statistically significant differences were noted between the two groups ($P < 0.05$)

[a]The data were not suitable for the Cochran–Armitage trend test and analyzed with Fisher's exact probability test

time. Remarkably, the total VSS score of the axillary incision was significantly higher than that of the IMF incision one and 6 months after surgery, mainly in the subscales of vascularity and height. At 12 months after surgery, the axillary scars still have higher vascularity scores while lower pliability scores than IMF scars, which made the total scores no different in both groups. Operation via an axillary approach is more remote and inconvenient than via an IMF incision. The stronger retraction and abrasion might lead to more severe proliferation, which might last for at least 6 months after surgery based on the results of our study. However, the axillary scar seemed to be more pliable than the IMF scar 12 months after surgery. This result is likely related to the different tensions and thicknesses of the skin in the axilla and the IMF. Scar pliability was evaluated by being wrinkled and stretched with fingers [7, 10]. The skin and subcutaneous tissue in the axilla is more soft and ductile than that in the inframammary fold. Furthermore, the breast implant may cause extra tension by extension of the inframammary skin. These factors may influence the scores of pliability for the IMF scar. Patient satisfaction scores increased with time, which was consistent with the decline in total VSS scores. At 12 months after surgery, the median satisfaction score was 9 for both groups, which indicated a high level of satisfaction of patients with both kinds of incisions. IMF incisions are not more disturbing or annoying for patients than axillary incisions.

Various factors may affect scar appearances, such as the incision site, skin type, suture tension, dermatoglyphics, suturing skills, infection, delayed healing and other uncertain factors [11]. It is generally recognized that a scar on the chest is apt to suffer from hyperplasia. In addition, some experts consider that the thinner skin of the areola or axilla might reduce the possibility of scar hyperplasia compared to the IMF. In contrast, Tebbetts believes that enough length, minimized trauma and tension, and optimal closure techniques produce equal quality scars at all recent incisions in a wide range of skin types. He followed over 3000 cases of consecutive primary breast augmentations

Table 6 Total VSS scores and patient satisfaction scores of the two groups 12 months after surgery

Incision	*N*	L-total VSS score	R-total VSS score	L-patient satisfaction score	R-patient satisfaction score
Axillary	94	2 (0–3)	2 (0–3)	9 (8–10)	9 (8–10)
IMF	69	2 (1–2)	2 (1–2)	9 (8–10)	9 (8–10)
Z		− 1.0725	− 0.6744	− 0.3319	− 0.5131
P		0.2835	0.5	0.74	0.6079

The total VSS and patient satisfaction scores were not normally distributed and were described with medians and interquartile ranges (P25–P75). The differences between the two groups were analyzed with Wilcoxon rank-sum tests. *Z* was the test statistic, and *P* was the probability value

L left side, *R* right side

There were no statistically significant differences between two groups ($P > 0.05$)

Table 7 Scores of the subscales 12 months after surgery

	Axillary	IMF	χ^2	*P*
L-pigmentation				
0	36 (38.30%)	28 (40.58%)	0.1073	0.7432
1	12 (12.77%)	9 (13.04%)		
2	46 (48.94%)	32 (46.38%)		
R-pigmentation				
0	34 (36.17%)	28 (40.58%)	0.6840	0.4082
1	9 (9.57%)	9 (13.04%)		
2	51 (54.26%)	32 (46.38%)		
L-vascularity[a]				
0	69 (73.40%)	58 (84.06%)	–	0.0066*
1	14 (14.89%)	11 (15.94%)		
2	11 (11.70%)	–		
R-vascularity				
0	68 (72.34%)	61 (88.41%)	6.6117	0.0101*
1	12 (12.77%)	5 (7.25%)		
2	14 (14.89%)	3 (4.35%)		
L-pliability[a]				
0	85 (90.43%)	55 (79.71%)	–	0.0069*
1	6 (6.38%)	14 (20.29%)		
2	3 (3.19%)	–		
R-pliability[a]				
0	82 (87.23%)	55 (79.71%)	–	0.0024*
1	6 (6.38%)	14 (20.29%)		
2	6 (6.38%)	–		
L-height				
0	68 (72.34%)	60 (86.96%)	5.0414	0.0248*
1	26 (27.66%)	9 (13.04%)		
2	–	–		
R-height[a]				
0	73 (77.66%)	60 (86.96%)	–	0.2100
1	18 (19.15%)	9 (13.04%)		
2	3 (3.19%)	–		

The scores of the subscales were ranked data and were described with percentages. The differences between the two groups were tested with the Cochran–Armitage trend test. χ^2 was the test statistic, and *P* was the probability value

L left side, *R* right side

*Statistically significant differences were noted between the two groups ($P < 0.05$)

[a]The data were not suitable for the Cochran–Armitage trend test and analyzed with Fisher's exact probability test

through the IMF approach; only two patients' scars needed steroid injection, and none of them needed scar revision surgery for poor-quality scars [12]. Our results provided supportive evidence in Chinese women. The scars in the inframammary fold seemed to have no more hyperplasia than those in the axilla. Besides, the pocket layer and volume of implant may also affect the scar by exerting tension. In our study, no differences in terms of implant size were found between the two groups. The majority of patients underwent dual-plane implantation (146 patients, 89.57%), and the number of other cases was too small to undergo stratified analysis.

A proper location of the IMF incision is essential to minimize scar visibility. The IMF scar with optimal appearance and location can be well concealed even in patients with minimal breast tissue and shallow inframammary creases [12]. In contrast, the scar might be very conspicuous if it lies above or below the inframammary fold, or even worse, the scar on the lower pole of the breast might be widened by greater stretch forces [12]. To place the IMF scar in an optimal location, the incision should be designed precisely in the planned postoperative inframammary fold based on the nipple site, implant size, skin elasticity and thickness of subcutaneous tissue. The dissection of the implant pocket also needs to be performed carefully to avoid implant migration. The subcutaneous tissue and muscles beneath the incision should be sutured tightly at the proper position.

One month after surgery, axillary scars were significantly longer than IMF scars (5.0 cm vs. 4.1 cm). The length of the incision was designed by the surgeons to be as short as possible based on operation needs. An axillary incision is remote from the breast, and as a consequence, it is more difficult and inconvenient to insert an implant through the axillary approach than through the IMF approach. If the axillary incisions are designed to be too short, the trauma to the skin edge and the risk of prosthesis damage will increase, which compromises surgical outcomes and scar quality [12]. As a result, longer incisions are needed when inserting implants through the axillary approach than through the IMF approach.

In general, the breast implants can be inserted most conveniently through the IMF approach with direct vision and great surgical control, which causes less tissue trauma and results in faster recovery [12–14]. In contrast, the implantation is much more difficult via an axillary incision because of the remote approach, with more tissue trauma and prolonged recovery [13, 15]. The IMF incision is commonly used in Western countries but is the least used in China [1, 3, 16, 17]. Some Chinese surgeons and patients consider that axillary scars which are remote from the breast are always more inconspicuous compared to areola and IMF scars. However, this idea is not necessarily true based on Tebbetts' opinions as well as our clinical experience [12]. The patients with unpleasant scars in the axilla also experience anxiety because they suppose it to be easily exposed when they are wearing sleeveless clothes and swimsuits. Our research further confirmed that scars at both locations could achieve comparable appearance 1 year after surgery. The IMF scar can be well concealed at the

new crease and is no more disturbing than axillary scar. This outcome suggests that the IMF incision is worth attempting on more Chinese patients with appropriate indication to get less trauma and a shorter recovery period. However, an IMF incision may not be the best choice for patients with an extremely strong history of producing hypertrophic scars, and it is not optimal for any patient who has a phobia or anxiety about having a scar on the breast. For these patients, an axillary incision might be a better choice [12].

Some limitations of this study should be considered. First of all, scar formation generally starts 6 to 8 weeks after re-epithelialization and matures 6 to 18 months after surgery [18]. The results of the research need longer-term follow-up data to get further confirmation. Besides, it was difficult to achieve random grouping and double-blinded evaluation based on the ethical terms and research contents. Furthermore, some patients failed to be contacted, and some could not manage to come back for follow-up, mainly because they lived in distant cities. In addition, the areolar incision, which is preferred by some Chinese surgeons and patients, was not included in this research mainly because the number of patients who chose the areolar incision was not quite sufficient [4]. Moreover, the assessment of scar appearance and patient satisfaction regarding an areolar scar might be influenced to some degree by the color and size of the original areola.

Conclusions

A prospective cohort study was performed to compare the scar appearance of axillary and IMF incisions 1, 6 and 12 months after surgery by the combination of VSS and patient satisfaction scores. At 12 months after surgery, the total VSS scores were not different between the two groups, and the patients with both kinds of incisions were highly satisfied with scar appearance. The research confirmed that scars at two locations can achieve comparable appearances in the long term after surgery.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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

Informed Consent All participants signed an informed consent approved by the institutional ethics committee.

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