

**Oblique lateral incision and subpectoral dissection in modified Nuss procedure minimize future breast deformity**

Hiroaki Kimura, Tomoyuki Yasuoka, Munetomo Nagao, Shin Kudoh, Seiichiro Kobayashi

Department of Plastic, Reconstructive and Aesthetic Surgery, Iwate Medical University School of Medicine, 19-1 Uchimaru Morioka, Iwate 020-8505, Japan

Address correspondence and reprint requests to:

Hiroaki Kimura, MD, PhD

Tel: +81-19-651-5111

Fax: +81-19-651-8402

E-mail: [hkimura@iwate-med.ac.jp](mailto:hkimura@iwate-med.ac.jp)

This work was presented at the Chest Wall Interest Group in Seoul, South Korea, in June 2013.

## **Summary**

**Background:** We experienced the occurrence of breast deformity in some young female patients who underwent a modified Nuss procedure before breast development. We studied the causes of and preventive measures for this complication.

**Methods:** We classified 13 prepubescent female patients who underwent our modified Nuss procedure into three groups according to the direction of the skin incision and the dissection layer for bar insertion. Four patients who underwent transverse lateral thoracic skin incision and bar insertion through subpectoral dissection were assigned to the T/SP group, five who underwent oblique skin incision along the rib and bar insertion through a suprapectoral dissection were assigned to the O/IP group, and four who underwent oblique skin incision and subpectoral dissection were assigned to the O/SP group. Each patient in the T/SP group underwent the operation by a different surgeon, two of whom were authors, including the first author; the first author performed all operations in the O/IP and O/SP groups. The first author evaluated the shape of the developed breasts using the frontal- and oblique-view photographs. We also investigated the location of the lateral border of the mammary gland in seven other adolescent and adult female patients using three-dimensional computed tomography images.

**Results:** Lateral depression of the breast occurred in four of eight breasts with a transverse incision, and flattening of the lowermost portion of the inframammary fold occurred in six of 10 breasts with suprapectoral dissection. None of the eight breasts with an oblique incision and subpectoral dissection exhibited deformities. The lateral border of the mammary gland was on the fifth rib in five patients and on the fifth intercostal space in two patients.

**Conclusion:** An oblique lateral thoracic skin incision along the sixth rib and subpectoral dissection may reduce the occurrence of breast deformity.

## **Key Words**

pectus excavatum, Nuss procedure, breast deformity

## Introduction

We began performing a modified Nuss procedure for the treatment of pectus excavatum in 1999. Several authors have stated that the optimal age for this method is 6 to 12 years.<sup>1-3</sup> We considered that the optimal age is 7 to 10 years because chest wall rigidity becomes more diverse among patients after 10 years of age as they approach puberty.<sup>4</sup> In our experience, almost all 50 patients who underwent repair with the modified (i.e., extrapleural bar insertion) Nuss procedure before puberty obtained satisfactory results. However, some young female patients acquired several degrees of breast deformities as their breasts developed (Fig. 1). In the present study, we evaluated the causes of and preventive methods for this complication.

## Patients and Methods

Thirteen prepubescent girls underwent a modified Nuss procedure with an extrapleural approach from July 1999 to September 2012. We classified them into three groups based on the surgical approach and dissection method. Patients who underwent a *transverse* lateral thoracic skin incision (Fig. 2a) and bar insertion through *subpectoral* dissection (Fig. 2b) comprised the T/SP group (n = 4). Patients who underwent an *oblique* skin incision along the rib (Fig. 2c) and bar insertion into the intercostal space with piercing *into the pectoralis major muscle* through suprapectoral dissection (Fig. 2d) comprised the O/IP group (n = 5). Patients who underwent an *oblique* skin incision and *subpectoral* dissection comprised the O/SP group (n = 4).

All patients underwent the first operations at a prepubescent age. Each patient in the T/SP group underwent the operation by a different surgeon (two of whom were authors, including the first author). The first author performed all operations in the O/IP and O/SP groups. Although the bar was removed from patients in the T/SP and O/IP groups more than 2 years previously, it was not removed from patients in the O/SP group because their postoperative period was 18 to 31 months (Table 1).

### *Investigation of patients with breast deformity*

The first author evaluated the shape of the 26 developed breasts among all groups using frontal- and oblique-view photographs. Statistical analysis was performed with Fisher's exact test using R version 3.1.2. (R Foundation for Statistical Computing, Vienna, Austria).

#### *Investigation of the position of the mammary gland*

We also investigated the position of the lateral border of the mature mammary gland in seven other adolescent and adult female patients with pectus excavatum using preoperative three-dimensional computed tomography (3D-CT) images (Fig. 3). The patients ranged in age from 16 to 27 years.

## **Results**

#### *Patterns of breast deformities*

We recognized two patterns of breast deformity. One involved a depression across the border of the lateral portion of the inframammary fold (IMF) when the lateral incision line reached the breast mound, and there were no deformities at the lowermost portion of the IMF. The other involved flattening of the lowermost portion of the IMF coinciding with the position of the bar, and the lateral aspect of the breast contained no deformities related to the incisional scar along the lateral portion of the IMF (Fig. 4). Depression of the lateral portion of the IMF occurred in four of eight breasts in the T/SP group. However, flattening of the lowermost portion of the IMF occurred in six of 10 breasts in the O/IP group and in one of eight breasts in the T/SP group. None of the eight breasts in the O/SP group exhibited deformities (Table 2). There were statistically significant differences among the three groups ( $p = 0.0007489$ ). In other words, all lateral depressions of the breast occurred in breasts with a transverse incision, and six of seven cases of flattening of the lowermost portion of the IMF occurred in breasts with suprapectoral dissection.

#### *Location of the mammary gland*

We confirmed that the lateral border of the mature mammary gland was located on the fifth rib in five patients and on the fifth intercostal space in two patients (Table 3).

## **Discussion**

### *Difference in direction of skin incision and dissection layer for bar insertion*

We began to perform the modified Nuss procedure with a transverse skin incision between the anterior and midaxillary lines as described by Nuss et al.<sup>5</sup> We performed this operation in 17 patients from 1999 to 2004. However, we noticed that in female patients, the transverse skin incision line was associated with the possibility of the future breast mound developing across the lateral portion of the IMF because the incision line was usually oblique along the lateral portion of the IMF in adult female patients. Thus, in 2005, we began to use an oblique skin incision in prepubescent female patients to reduce the possibility of future breast deformity.

Bar insertion was performed through the subpectoral layer at the beginning of our procedure. We changed the dissection layer from subpectoral to suprapectoral in 2005 because Ostlie et al.<sup>6</sup> reported a low incidence of osseous bone formation around subcutaneously positioned bars. We thus attempted to interpose the muscle between the bar and the rib by suprapectoral dissection. The suprapectoral dissection was continued until we discovered that there was no significant difference in the incidence of bone formation around the bar between 11 patients who underwent suprapectoral dissection and 13 patients who underwent subpectoral dissection in 2011. Based on the results of this analysis together with the advantage of lessening the incidence of breast deformities, we changed the dissection layer back to the subpectoral layer in 2011.

As described above, we created three patient groups according to the combination of the direction of the incision line and the dissection layer for bar insertion: transverse incision and subpectoral dissection (T/SP group), oblique incision and suprapectoral dissection (O/IP group), and oblique incision and subpectoral dissection (O/SP group).

### *Effect of direction and location of skin incision on breast shape*

After performance of the operations in this study, we evaluated how the skin incision affects the breast shape. The patient shown in Figure 5 underwent a transverse incision. A depressive deformity was recognized on the lateral aspect of the right breast, but not on the left. This difference is based on whether the incisional scar reaches the breast mound across the IMF. The incisional scar will reach the future breast mound across its outline if the incision is positioned too close to the anterior axillary line; alternatively, the breast development will extend laterally. We believe that an important factor in the occurrence of depressive deformity is the relationship between the positions of the incision and breast mound as a three-dimensional structure. Creation of the incision along the outline of the three-dimensional breast mound will minimize scarring. The IMF defines the outline of the breast. Therefore, if the transverse incisional scar reaches the breast mound across the lateral portion of the IMF, the scar will not develop along the outline of the breast mound and will increase the possibility of inducing damage to the round outline of the breast. Because the lateral portion of the IMF is an oblique line at the border of the breast mound, the incision line in prepubescent female patients should be oblique to reduce the possibility of the incision line reaching the future breast mound.

We also found that the lateral border of the mature mammary gland is located at the fifth rib or fifth intercostal space. This finding is similar to previous anatomical studies of the IMF.<sup>7,8</sup> We believe that knowledge of the location of the structural outline of the breast is important to ensure that the position of the skin incision is not too close to the outline of the breast and thus decrease the risk of breast deformity. The outline of the breast is determined by the mammary gland; thus, we investigated the location of the mammary gland. The knowledge acquired on this topic suggests that an incision positioned on the sixth rib is sufficiently remote from the expected future breast mound.

### *Effect of dissection layer for bar insertion on breast shape*

Flattening of the lowermost portion of the IMF developed in some patients who underwent suprapectoral dissection. The deformity coincided with the position of the bar, suggesting the

following cause of this deformity. If the scar tissue around the bar, as generally forms around an artificial material, is particularly dense within the subcutaneous layer, the scar might interfere with the caudal expansion of the mammary gland. Imanishi<sup>9</sup> reported that the two layers of the subcutaneous adipofascial system are the protective adipofascial system (PAFS) and lubricant adipofascial system (LAFS). He stated that the mammary gland exists between these two adipofascial systems and that these systems form a fuzzy skeleton within the subcutaneous tissue. We believe that the fuzziness of these systems contributed to the differences in the findings of the presence or absence of a firm ligament in the IMF in some reports.<sup>7,8,10-12</sup>

Performance of the tunneling for bar insertion in a blunt or destructive manner may increase the magnitude of scar formation. However, we have never used a “dissector”, which is generally used in the Nuss procedure, and perform meticulous dissection above the pleura with some original small dissectors under endoscopic visualization following gentle open skin dissection just above the pectoralis major and serratus anterior muscles through a 2-cm skin incision. We believe that the instrumental tissue damage induced when creating the bar tunnel did not contribute to the magnitude of scarring or scar contracture under our maneuver because both bleeding and muscle injury were minimal. Regardless of this gentle dissection, deformity secondary to subcutaneous scar formation occurred. Therefore, it is important that dissection layer for bar insertion is not located between two subcutaneous adipofascial systems (i.e., the above-described PAFS and LAFS) because the mammary gland develops between these two layers above the pectoralis major muscle and is finally enveloped by these two layers. Consequently, subpectoral dissection should not disrupt the subcutaneous adipofascial system above the pectoralis major muscle, lessening the severity of the breast deformity.

One of our recent patients who underwent oblique lateral thoracic incision along the sixth rib and subpectoral dissection for bar insertion based on the principles discussed herein had no breast deformity after breast development (Fig. 6).

## **Conclusion**

An oblique lateral thoracic skin incision along the sixth rib and subpectoral dissection will minimize the occurrence of future breast deformity when performing a modified Nuss procedure in prepubescent female patients. Additional cases and further investigation of these deformities are needed to confirm the results of this small series.

**Funding:** None.

**Conflict of interest statement:** None.

**Ethical approval:** Not required.



## References

1. Hebra A. Minimally invasive repair of pectus excavatum. *Semin Thorac Cardiovasc Surg* 2009; 21: 76-84.
2. Kim do H, Hwang JJ, Lee MK, Lee DY, Paik HC. Analysis of the Nuss procedure for pectus excavatum in different age groups. *Ann Thorac Surg* 2005; 80: 1073-7.
3. Olbrecht VA, Arnold MA, Nabaweesi R, et al. Lorenz bar repair of pectus excavatum in the adult population: should it be done? *Ann Thorac Surg* 2008; 86: 402-8; discussion 08-9.
4. Kimura H, Kobayashi S. A Strategy for Repair of Pectus Excavatum and Long-term Results. *Jpn J Plast Surg* 2010; 53: 957-66.
5. Nuss D, Kelly RE, Croitoru DP, Swoveland B. Repair of pectus excavatum. *Pediatr Endosurg Innov Tech* 1998; 2: 205-221.
6. Ostlie DJ, Marosky JK, Spilde TL, et al. Evaluation of pectus bar position and osseous bone formation. *J Pediatr Surg* 2003; 38: 953-6.
7. Bayati S, Seckel BR. Inframammary crease ligament. *Plast Reconstr Surg* 1995; 95: 501-8.
8. Nava M, Quattrone P, Riggio E. Focus on the breast fascial system: a new approach for inframammary fold reconstruction. *Plast Reconstr Surg* 1998; 102: 1034-45.
9. Imanishi N. Adipofascial Structure of the Breast. *Jpn J Breast Cancer* 2011; 26: 649-55.
10. van Straalen WR, Hage JJ, Bloemena E. The inframammary ligament: myth or reality? *Ann Plast Surg* 1995; 35: 237-41.
11. Boutros S, Kattash M, Wienfeld A, et al. The intradermal anatomy of the inframammary fold. *Plast Reconstr Surg* 1998; 102: 1030-3.
12. Muntan CD, Sundine MJ, Rink RD, Acland RD. Inframammary fold: a histologic reappraisal. *Plast Reconstr Surg* 2000; 105: 549-56; discussion 57.

## Figure Legends

Fig. 1. 14-year-old female patient who underwent a modified Nuss procedure 10 years previously  
Severe breast deformity was recognized on the inframammary fold (IMF).

Fig. 2. Direction of the skin incision and dissection layer for bar insertion

a, Transverse skin incision; b. oblique skin incision; c, subpectoral dissection; d, suprapectoral dissection.

Fig. 3. Location of the lateral border of the mature mammary gland

In this 18-year-old patient, the lateral border of the mammary gland was located at the fifth rib.

Fig. 4. Patterns of deformity

The white arrowheads indicate the incisional scar, and the black arrowheads indicate the deformed regions.

Upper row: Patient in the T/SP group. Photo at 5 years of age (left) and 7 years after bar removal (right). A depression developed across the border of the lateral portion of the IMF.

No deformities of the lowermost portion of the IMF developed.

Lower row: Patient in the O/IP group. Photo at 9 years of age (left) and 2 years after bar removal (right). The flattening of the lowermost portion of the IMF coincided with the position of the bar. There were also no deformities of the lateral aspect of the breast.

Fig. 5. Skin incision and breast deformity

Patient in the T/SP group. Bilateral breasts at 7 years after bar removal. On the right breast (left), a depression developed across the border of the lateral portion of the IMF because the incisional scar reached the breast mound.

The white arrowheads indicate the incisional scar, and the black arrowhead indicates the deformed region.

Fig. 6. Oblique skin incision and subpectoral dissection for bar insertion

Patient in the O/IP group. Photo at 23 months after the operation. There is no breast deformity.

The white arrowhead indicates the incisional scar.



Fig. 1

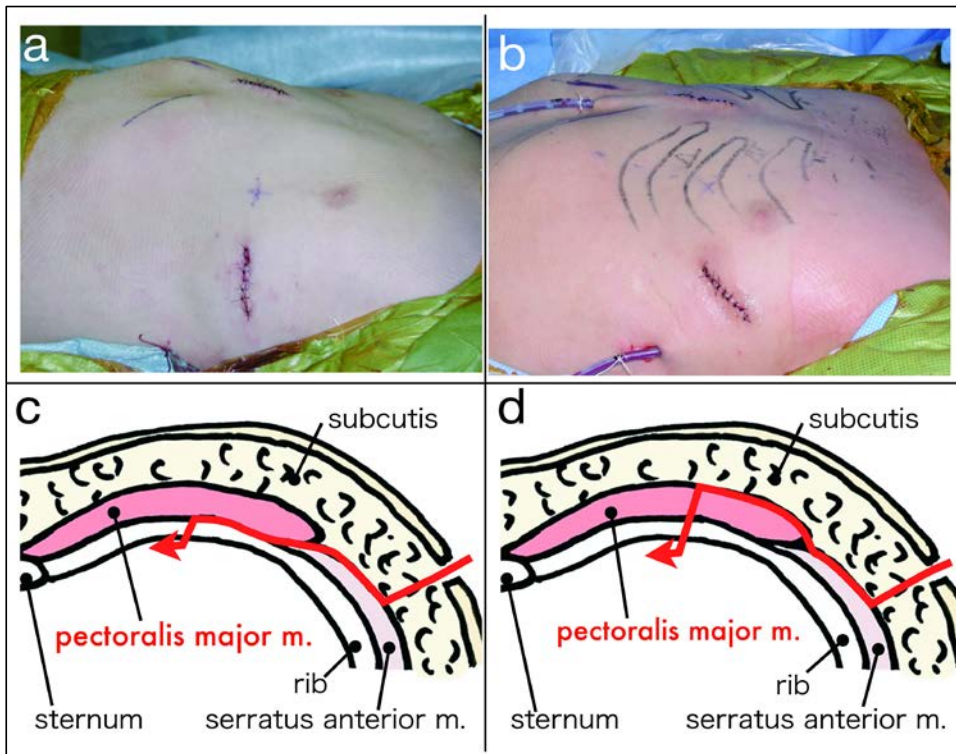


Fig. 2



Fig. 3

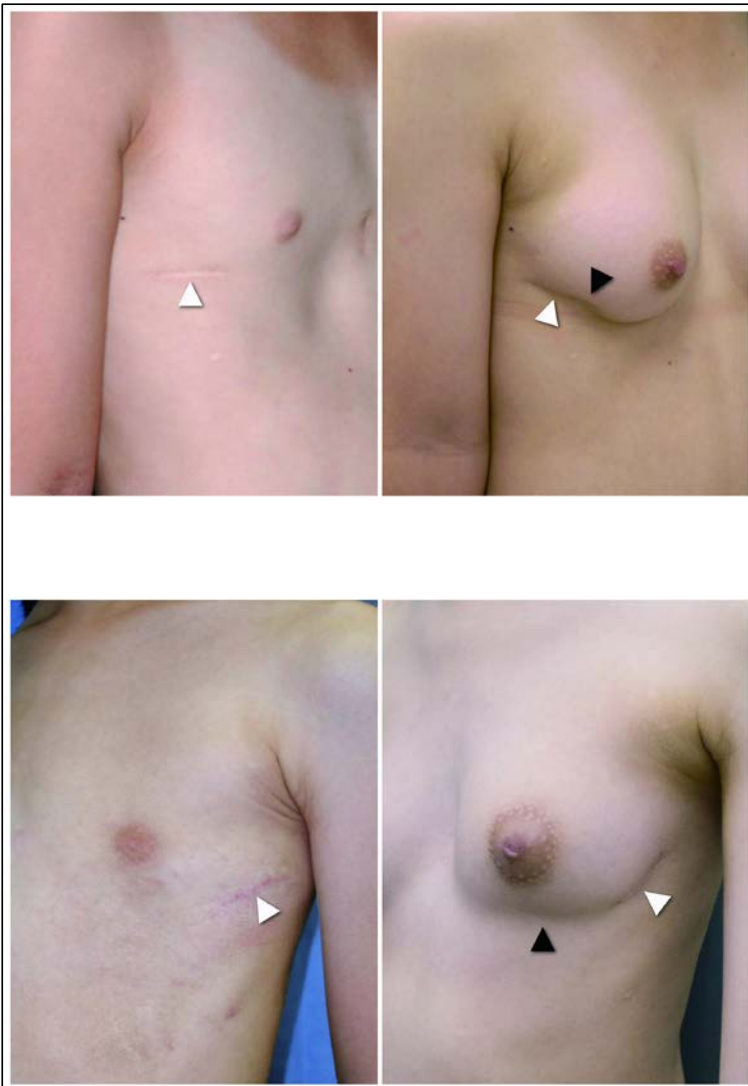


Fig. 4

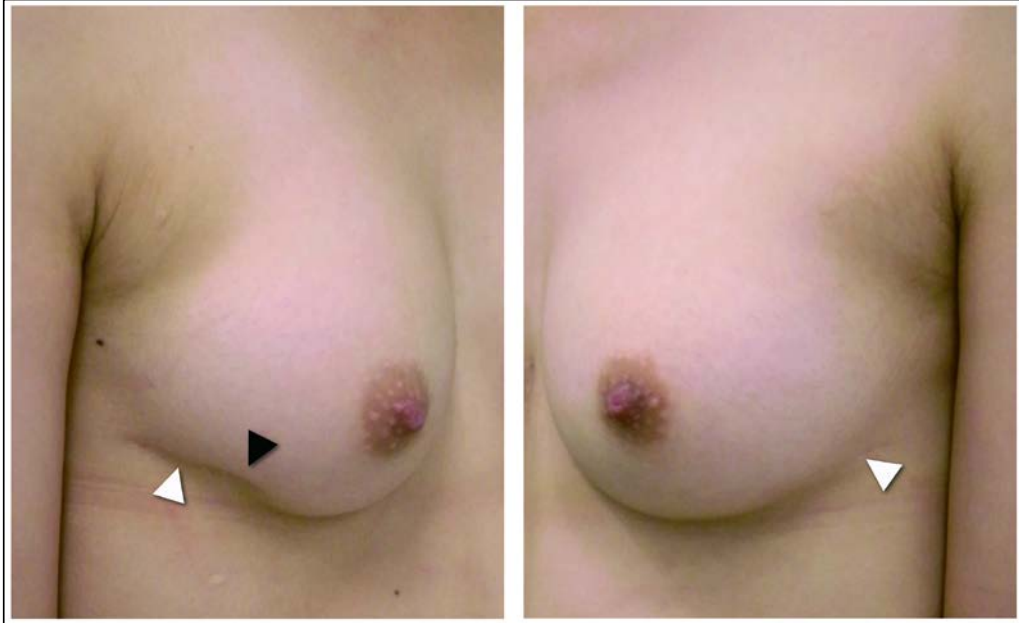


Fig. 5

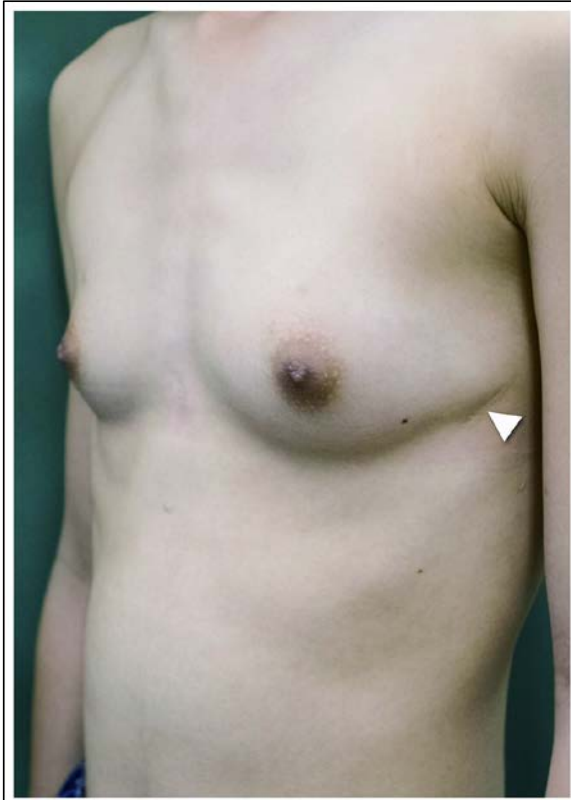


Fig. 6

Table 1. Summary of the cases

	n	Age (years)	Period after bar removal (months)
T/SP group	4	4–11 mean, 6.8	25.9–85.8 mean, 63.4
O/IP group	5	6–9 mean, 7.8	12.0–46.3 mean, 28.8
O/SP group	4	8–12 mean, 10.3	NA

T: transverse skin incision, O: oblique skin incision, SP: subpectoral dissection,  
IP: piercing into the pectoralis major muscle through suprapectoral dissection

Table 2. Results of breast investigation

Classification	T/SP	O/IP	O/SP
Lateral depression	4	0	0
Flattening of the lowermost IMF	1	6	0
No deformity	3	4	8
Number of breasts	8	10	8

Statistical significance was observed among these three groups (Fisher's exact test,  $p = 0.0007489$ ).

T: transverse skin incision, O: oblique skin incision, SP: subpectoral dissection,  
IP: piercing into the pectoralis major muscle through suprapectoral dissection

Table 3. Location of lateral border of mature mammary gland

Location of the lateral border	Number of patients
On the 5th rib	5
On the 5th intercostal space	2