The Scar Cosmesis Assessment and Rating Scale To Evaluate The Cosmetic Outcomes of The Totally Thoracoscopic Cardiac Surgery

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Abstract

Background

Conventional median sternotomy is widely used in cardiac surgery, while the totally thoracoscopic cardiac surgery which is considered to have aesthetic advantages now is increasingly used in China because patients' requirements for minimally invasive and aesthetically pleasing are significantly increased. Fewer studies have been conducted on the assessment of surgical scars after cardiac surgery. Compared to a median sternotomy approach, multiple-incision totally thoracoscopic cardiac surgery offers smaller but numerous and scattered incisions. In addition to two working ports on the upper and lower margins of the right breast, we also need an inguinal incision and an axillary incision. So, does totally thoracoscopic cardiac surgery really have aesthetic advantages? This study has the following objectives: (a) to compare the long term cosmetic effect of post-operative scars between median sternotomy cardiac surgery and totally thoracoscopic cardiac surgery; (b) to evaluate the effectiveness of the Scar Cosmesis Assessment and Rating(SCAR) scale, in combination with the Numeric Rating Scale(NRS) in the assessment of surgical scars after cardiac surgery.

Methods

Collection of consecutive patients who came to our institution from January 2019 to May 2019 for cardiac surgery via median sternotomy or totally thoracoscopic approach for at least one year of follow-up. Inter-rater reliability, internal consistency and convergent validity were evaluated for the SCAR scale and the NRS. Clinic characteristics and the scores of the SCAR scale and the NRS were analyzed using the Student's t test or Mann-Whitney U-test between the two groups.

Results

Thirty-one patients underwent cardiac surgery via a totally thoracoscopic approach (TA n = 31), and forty-two patients via a median sternotomy approach (SA n = 42). No significant differences were found in demographic and clinical data between the two groups. Validity and reliability of the SCAR scale and the NRS were satisfactory. The results of the SCAR scale showed that SA group scored significantly higher than TA group on “overall impression” and “patient questions” subscales with statistical significance ($P < 0.05$). The overall SCAR scale scores and the NRS scores were statistically significant ($P < 0.05$).

Conclusions

The SCAR scale in combination with the NRS is an effective tool for assessment of scar aesthetics after cardiac surgery. Surgical scars of totally thoracoscopic cardiac surgery can achieve desirable cosmetic effects in Chinese population. Especially in susceptible individuals with high risk of keloid and

hypertrophic scars. Patients with appropriate indications can undergo cardiac surgery through the totally thoracoscopic approach and obtain a satisfactory scar appearance.

Introduction

The median sternotomy is the most common surgical access to the heart and is widely used worldwide[1]. Since Cosgrove[2] and Carpentier[3] performed minimally invasive cardiac surgery, with advances in technology and the accompanying improvements in extracorporeal circulation and surgical techniques, minimally invasive totally thoracoscopic cardiac surgery is rapidly advancing in clinical practice. Articles focus on its clinical effect and postoperative complications are abundant[4], but relatively little research has been conducted on cosmetic outcomes, especially in Chinese population.

Postoperative scar formation is inevitable due to surgery and can affect the physical and mental health of the patient. There are three distinct phases in the classic model of wound healing: inflammation, proliferation and the remodeling phase and it takes at least one year for the scar to mature[5], so scar assessment requires a long follow-up period. To date, there is no ideal valid and reliable scar scale that effectively assesses postoperative scarring in terms of aesthetics and function. However, the Scar Cosmesis Assessment and Rating (SCAR) Scale, proposed in 2016, was created with the initial goal of being used for the assessment of linear incisions after surgery. The SCAR scale has six clinician questions scored by observers and two simple questions regarding symptoms (itch and pain) answered yes/no by the patient[6]. This scale incorporates objective measures and patient-reported symptoms and has been tested for convergent validity, interrater reliability and intra-rater reliability and has shown outstanding integrative results in terms of feasibility, validity and reliability in postsurgical scar assessment outcome measures[7]. The reliability of the SCAR scale in scar assessment has been validated, however its application in totally thoracoscopic and median sternotomy approach cardiac surgery has not been assessed.

In addition to the evaluation of scar features, the cosmetic appearance from a patient’s perspective is integral and should be introduced to an integrated scar assessment progress. We used the Numerical Rating Scale (NRS) from 0 to 10 for patients' own assessment of the cosmetic appearance of the scar.

This study has the following objectives: (a) to compare the long term cosmetic effect of post-operative scars between median sternotomy cardiac surgery and totally thoracoscopic cardiac surgery; (b) to evaluate the effectiveness of the SCAR scale, in combination with the NRS in the assessment of surgical scars after cardiac surgery.

Materials And Methods

Patients

Collection the clinical data of the patients who came to our department from January 2019 to May 2019 to undergo primary cardiac surgery using cardiopulmonary bypass with median sternotomy or totally thoracoscopic approach for at least one year of follow-up. The participants were all of normal heart disease without thoracic malformation, and all the patients had been given the alternative choices of surgical approach during pre-operative interviews. Sever events defined according to guidelines published by Akins[8]. This study was approved and monitored by the ethics committee of the Fujian Union Hospital. All participants included in this study signed a written informed consent form.

Surgical Technique

All the surgery was performed by the same team of experienced surgeons who had already completed the learning curve. The incision of thoracoscopic surgery was performed via an endoscopic right minithoracotomy. The primary incision was about 2–4 cm longitudinal at the middle axillary midline in the fourth usually or fifth intercostal space according to the position of hilum of lung on chest film. We used soft tissue retractors to enhance exposure without rib spreading and protect the wound incisions (Fig. 1). Two additional thoracic working ports about 2–4 cm were installed in the secondary and fifth intercostal spaces for manipulation and insertion of the prostheses. And a longitudinal incision about 3-4cm was made vertical to the inguinal ligament to exposes the femoral artery and vein. The sternotomy incision was carefully placed on the midline of the sternum.

All the surgical incisions of median sternotomy or totally thoracoscopic groups were interrupted sutured with silk thread in the subcutaneous tissue. Continuous suture technique with 3–0 prolene was used in the mid-level dermis. U-shaped suture is used to close the wound of drainage tube (Fig. 2).

Scar Assessment

The SCAR scale consists of two parts, one is clinician questions and the other is patient-related questions. There are six clinical items, scored by the observer, and patient-related questions answered by the patient including two simple yes/no questions about pain and itch. Scores can be provided through direct observation and evaluation or through the use of high-quality photographic images[9]. Patient-related questions can be obtained through the patient's verbal or written answers. In totally thoracoscopic cardiac surgery, there are totally four incisions, of which the selection of the highest score is its final score (Table 1).

Table 1
The Scar Cosmesis Assessment and Rating (SCAR) scale

Parameter	Descriptor	Score
Clinician questions		
Scar spread	None/near invisible	0
	Pencil-thin line	1
	Mild spread, noticeable on close inspection	2
	Moderate spread, obvious scarring	3
	Severe spread	4
Erythema	None	0
	Light pink, some telangiectasias may be present	1
	Red, many telangiectasias may be present	2
	Deep red or purple	3
Dyspigmentation	Absent	0
	Present	1
Suture marks	Absent	0
	Present	1
Hypertrophy/atrophy	None	0
	Mild: palpable, barely visible hypertrophy or atrophy	1
	Moderate: clearly visible hypertrophy or atrophy	2
	Severe: marked hypertrophy or atrophy or keloid formation	3
Overall impression	Desirable scar	0
	Undesirable scar	1
Patient questions		
Itch	No	0
	Yes	1
Pain	No	0
	Yes	1

All the scars were to be assessed and photo taken under standard conditions, and then scored based on the SCAR scale and the NRS. For each scar, it was rated by two independent observers who have been trained in the SCAR scale. The observers were experienced resident who were expertly in the patients' follow-up care. The scores given by this pair of observers were documented for reliability test. The two observers then discussed and assessed each scar and gave a determinant score. If the two observers disagree with this score, a new third observer (experienced surgeon) was added to the evaluation, and then given the final score. Patients were blinded when scoring. Figure 3 showed the application of the SCAR scale in the study cases.

Consider some patients were elderly and illiterate and may have visual and cognitive impairments. Cosmetic appearance was assessed with a numerical rating scale ranging from 0, which meant the patient found the most pleasing, to 10, which the patient did not like the appearance of the scar and was not comfortable for caring the wound.

For patients who could not return to the hospital for follow-up, depending on the characteristics of the scale we have selected, we used the mobile social software to obtain high-definition images and complete the corresponding scale. For those patients who were unable to return to the hospital for follow-up, we used social software for mobile phones to help them measure their own incision length.

Statistical Analysis

Statistical analysis was performed using SPSS 22.0. Cronbach's alpha statistic was used to test the internal consistency of the SCAR scale and the NRS. Spearman's rank correlation coefficient was used to estimate the inter-rater reliability of the SCAR. Correlations between the SCAR scale and the NRS scores

were tested for convergence validity using Spearman's statistics. The baseline characteristics and scores of the SCAR scale were compared between TA and SA groups. Variables of normal distribution were analyzed using Student's t test, and ordinal variables and non-normal distributed variables were analyzed using Mann-Whitney U test. All statistical tests in this study were two-sided, and P□0.05 was significant.

Results

Seventy-three consecutive patients were selected for the study, 32 of whom underwent cardiac surgery through totally thoracoscopic approach and 41 patients through median sternotomy approach. All patients were followed up for at least one year. The descriptive statistics for the study population are shown in Table 2. There were no significant differences in NYHA classification, body mass index, age, gender, mortality and morbidity between the two groups. Demographic characteristics and baseline clinical information were well-matched in the two groups.

Table 2
Demographic and clinical data compared between TA group and SA group

Item	SA group	TA group	P
Male/Female	15/17	22/19	0.57
Age (years)	52.49 ± 10.17	51.69 ± 10.69	0.88
Current NYHA (median)	II	II	
BMI (kg/m²)	22.26 ± 1.51	22.49 ± 1.73	0.64
Mortality	0	0	NS
Morbidity(severe events)	3	1	0.31
Poor wound healing	2	2	1.00
Subcutaneous emphysema	2	0	0.18
NYHA class: New York Heart Association functional classification; BMI: body mass index			

Reliability and Validity Test

Reliability is the quality that reflects consistent measurement results when measured repeatedly. It involves stability and internal consistency. In this research, Cronbach's alpha value was used to reflect the internal consistency, with a Cronbach's α value of 0.81 for the SCAR scale and 0.83 for the NRS. Cronbach's α value greater than 0.8 indicated good agreement[10–12]. The Spearman's rank correlation coefficient was used to estimate the inter-rater reliability (Table 3). The eight subscales and the overall scores of the two groups all showed strong inter-rater reliability with statistically significant(P□0.05). Validity of convergent indicates the extent to which theoretically relevant scales are also relevant in

reality[10]. Spearman's rank coefficients were used to evaluate convergent validity between the overall SCAR scores and the NRS scores. Correlation analysis showed a significant correlation between the overall scores of SCAR scale and the NRS scores (correlation = 0.78), the results showed a strong positive correlation between the overall SCAR scores and the NRS scores(P□0.05). Patients with a lower SCAR score showed greater satisfaction with the cosmetic effects of the scar. The results showed satisfied convergent validity.

Table 3
Inter-rater reliability of the SCAR scale: Spearman's correlation analyses

SCAR parameter	Correlation coefficient	p
Scar spread	0.76	P□0.01
Erythema	0.72	P□0.01
Dyspigmentation	0.81	P□0.01
Track marks or suture marks	0.75	P□0.01
Hypertrophy/atrophy	0.77	P□0.01
Overall impression	0.82	P□0.01
Itch	1.00	P□0.01
Pain	1.00	P□0.01
Overall scores	0.83	P□0.01
Correlation coefficients: 0–0.20 = "week"; 0.21–0.40 = "fair"; 0.41–0.60 = "moderate"; 0.61–0.80 = "strong" reliability; 0.81–1.00 = "strongly" reliability[12]		

Scar Assessment

The post-operative scars of cardiac surgery were evaluated using the SCAR scale and the NRS. The scores of each subscale and the length of the scar are shown in Table 4. There were significant differences between the two groups in the scores of "Overall impression" and "Patient questions" (P□0.05). "Overall impression" scores were higher in the median sternotomy group than that in the totally thoracoscopic group. The results showed that the scars in the totally thoracoscopic group were less impressed, less pain and less itchy than those in the median sternotomy group with statistical significance.

Table 4
Cosmetic effect of surgical scars between two different approaches

parameter	TA group	SA group	p
Scar spread(median)	1	1	0.18
Erythema(median)	1	1	0.84
Dyspigmentation(median)	0	1	0.15
Track marks or suture marks(median)	1	1	0.31
Hypertrophy/atrophy(median)	1	1	0.54
Overall impression(median)	0	0	0.04
Patient questions(median)	0	0	0.049
Overall SCAR scores(median)	3	5	0.04
NRS scores	3.07 ± 2.40	4.80 ± 2.04	0.04
Scar length	20.21 ± 2.92	13.42 ± 2.14	P□0.01
Significant differences were found in the scores of Overall impression, Patient questions, Overall SCAR scores and NRS scores of both sides between the two groups. (P□0.05)			

The overall scores of the SCAR scale, the scores of the NRS and total length of the incision are also listed in Table 4. There were significant difference (P□0.05) in the overall SCAR scores and the NRS scores. The scores of the median sternotomy group was higher than that of the totally thoracoscopic group in terms of overall scores. The mean scar length was 20.21 cm in the SA group and 13.42 cm in the TA group, and the results were statistically significant (P□0.05), which indicated that the length of the scar in the SA group were longer than those in the TA group.

Discussion

Postoperative scar can affect a patient's health-related quality of life after surgery, and scar assessment is an integral part of assessing the cosmetic outcome of cardiac surgery, especially in Asian populations, which are at a higher risk of developing unsightly scars[13–14]. Study shows that patients often develop keloid scar at the incision site after median sternotomy[15]. The Vasudev's opinion is that large and multiple keloids are difficult to treat completely and can currently only be treated with multiple modal therapies that aim to relieve the symptoms of keloid[16]. The incidence of scar hypertrophy, and scar stretch in the anterior sternal region of individuals with fair skin after open heart surgery via median

sternotomy incision was studied by Elliot. Study demonstrates scar hypertrophy and stretching often occur. And its occurrence is not related to different types of subcutaneous suture materials[17].

Totally thoracoscopic cardiac surgery, which is commonly used in our institution, does not damage the sternum or break the ribs, does not harm the aesthetics of the breast, and is more invisible. Many people believe that totally thoracoscopic cardiac surgery has cosmetic advantages. However, there are few studies in the relevant fields that provide detailed data. Standardized scar assessment in totally thoracoscopic cardiac surgery was conducted and evaluated in this study for the first time.

There are a number of scar scales that have been used to evaluate the condition of scars, including the Vancouver Scar Scale (VSS) [18], the Patient and Observer Scar Assessment Scale (POSAS) [19], the Manchester Scar Scale (MSS) [20], and the Stony Brook Scar Evaluation Scale[21]. Each scale has advantages and disadvantages for estimating different characteristics of scars. However, there is currently no valid and reliable scar scale to effectively assess the quality of postsurgical scars. The VSS and the POSAS were originally developed to assess burn scars and are not suitable for assessing post-surgical linear scars. Although the applicability of these scales in post-surgical linear scars was later tested, the clinical considerations of these scales at their inception were very different. Therefore, a new evaluation tool is needed that provides a reliable outcome measure for post-surgical scars. Jonathan Kantor introduced the Scar Cosmesis Assessment and Rating (SCAR) scale, which is an outcome measure for assessing linear postsurgical scars in a clinical and research context. The SCAR scale was tested for convergent validity, inter-rater reliability and intra-rater reliability, and the results showed that the SCAR scale is outstandingly combination of the scale in terms of feasibility, validity and reliability of postoperative scar assessment outcome measures[7]. The Cronbach's alpha value of the SCAR scale in this study was 0.81. The SCAR scale and the NRS scores were convincingly reliable and valid, suggesting that the combination of the SCAR scale and NRS scores is a valid and reliable method for estimating scars after cardiac surgery. By briefly training the raters, the SCAR scale can be quickly and reliably applied during the clinical follow-up process. There is an advantage to choosing this scale, it can be assessed by photographs, a patient included in this study lived on a sea island, but scars can be assessed by uploading photographs via mobile phone social software[9].

Evaluation of the long-term cosmetic effects of post-operative scars is quite meaningful. Post-operative scars have a variety of final appearance, which are related to the incision site, the skin types, the suture tension, the suturing method, the wound closure technique, and the surgeon's technical ability and other factors[22]. There was no significant difference (P□0.05) between the two groups of patients in terms of poor wound healing and subcutaneous emphysema in our study(P□0.05). However, there were significant differences between the two groups in “Overall impression” and “Patient questions” scores. Scars in the TA group seemed less impressed, less painful and itchy compared to the SA group. The reason for the difference is unknown and may be related to median sternotomy, destruction of the periosteum, placement of a wire foreign body, additional tension caused by wire sutures to the sternum, etc[23–24].

The average score of the NRS for aesthetics was quite low in both the TA and SA groups. On the other hand, the TA group had more incisions than the SA group. The application of extracorporeal circulation and the application of thoracoscopy in totally thoracoscopic cardiac surgery can explain the large number of incisions and their dispersion. But the length of the scar is apparently shorter in TA group. In our study, we observed that a susceptible patient who underwent thyroid surgery had scar hypertrophy in neck, so she was more willing to request minimally invasive cardiac surgery and postoperative scar hypertrophy occurred in her incision site. If a median sternotomy incision was made, it was estimated that the scar hypertrophy can seriously affect the quality of life (Fig. 4).

In general, the median sternotomy is the most straightforward and simplest approach, as it is easy for the surgeon to operate, but the totally thoracoscopic incision is less painful and the recovery period is shorter[25]. The totally thoracoscopic approach with the aid of thoracoscopy has little tissue trauma, less pain and short recovery period[4]. The results of our study showed that there were differences in the “Overall impression” and “Patient questions” between the two groups, and there were significant differences in the overall SCAR scores and the NRS scores for scar appearance. Our study suggested that the combination of the SCAR scale and NRS scores is a valid and reliable tool for estimating scar appearance after cardiac surgery. Our findings may provide new evidence for the selection of surgical approach in clinical practice. Patients with appropriate indications can undergo cardiac surgery through totally thoracoscopic approach with a satisfactory scar appearance.

Conclusions

The SCAR scale, in combination with the NRS, constitutes a valid and reliable tool for estimating cosmetic appearance of surgical scars after cardiac surgery. Scars in the TA group were more satisfactory and less painful, itchy than scars in the SA group. Besides, significance differences were found in the overall SCAR scores and the NRS scores between two groups. Thus, according to our research, the scars of thoracoscopic surgery can achieve considerable cosmetic effects and patient satisfaction in Chinese population. Patients undergoing cardiac surgery through totally thoracoscopic approach with appropriate indications can get satisfactory scar appearance.

Abbreviations

SCAR
Scar Cosmesis Assessment and Rating
NRS
Numerical Rating Scale
VSS
Vancouver Scar Scale
POSAS
Patient and Observer Scar Assessment Scale
MSS

Manchester Scar Scale
NYHA class
New York Heart Association functional classification
BMI
body mass index

Declarations

Ethics approval and consent to participate

This study was approved and monitored by the ethics committee of the Fujian Union Hospital, China, and adhered to the Declaration of Helsinki. Written informed consent was also obtained from the patient or a relative of the patient.

Consent for publication

Not applicable.

Availability of data and materials

Data sharing not applicable to this article as no data sets were generated or analyzed during the current study.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

X-FD and L-CH designed the study, participated in the operation, and drafted the manuscript. Q-CX and Z-HZ collected the clinical data and performed the statistical analysis. L-WC and D-ZC provide technical support. All authors read and approved the final manuscript.

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Figures

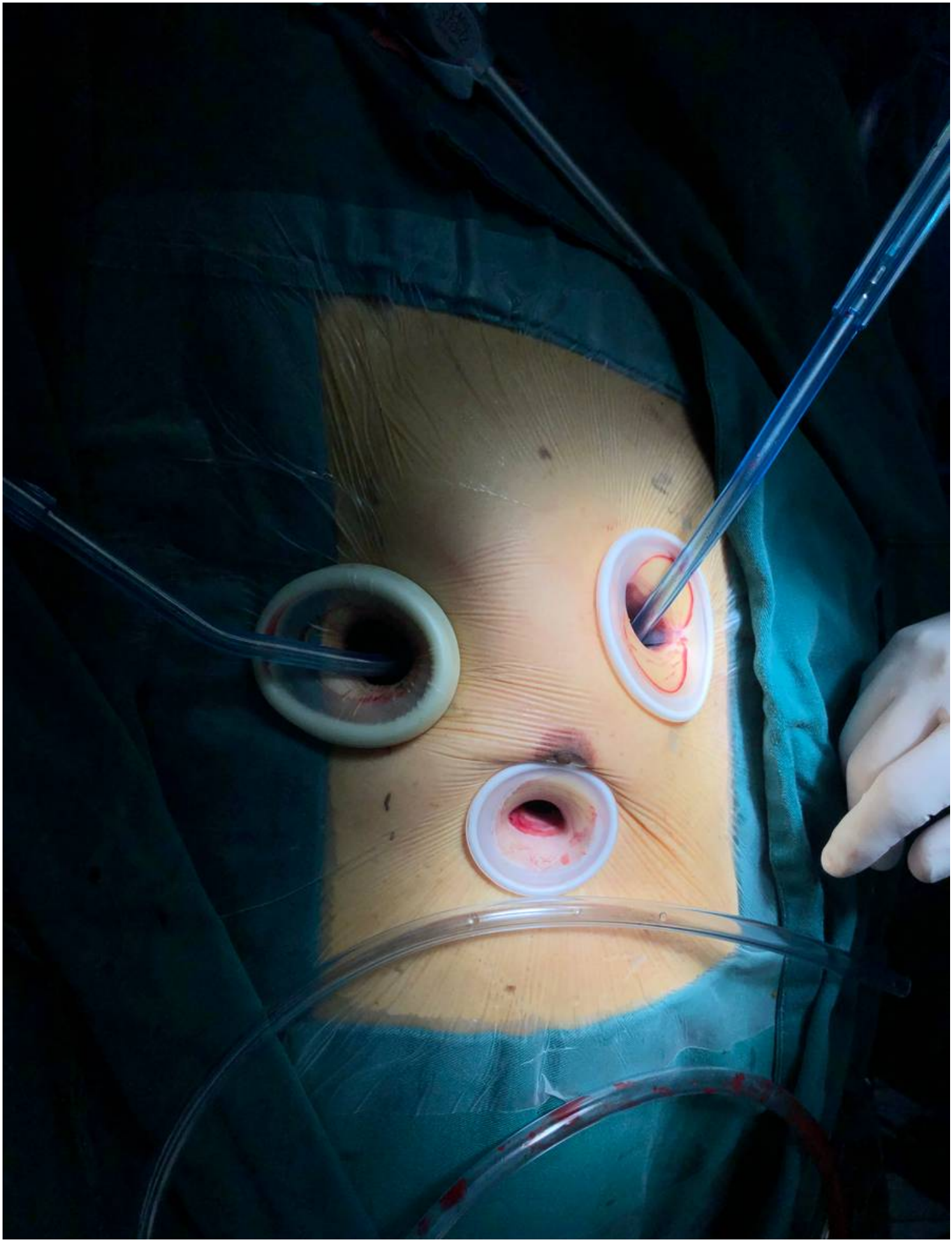

Figure 1

Totally thoracoscopic incision with soft tissue retractor in place.

Figure 2

Sutured incision after the totally thoracoscopic cardiac surgery.

Scar spread 2, Erythema 1, Dyspigmentation 1, Suture marks 0, Hypertrophy 1, Overall impression 0

Figure 3

The application of the SCAR scale in study cases of the totally thoracoscopic group.

Figure 4

Postoperative view of reluctant chest scar hypertrophy.