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# Post-mastectomy radiation therapy in Poland syndrome with left breast cancer: A case report

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**Abstract.** Poland syndrome is a rare congenital malformation characterized by unilateral chest wall hypoplasia, ipsilateral hand abnormalities, and associations with several malignancies. The present study reports a case of a woman in her 60s with Poland syndrome who presented with infiltrating ductal carcinoma of the left breast and unilateral chest wall hypoplasia. The patient underwent mastectomy with reconstruction using a transverse rectus abdominis musculocutaneous (TRAM) flap, followed by post-mastectomy radiation therapy (PMRT). PMRT after TRAM flap reconstruction was feasible, with acceptable lung and heart doses, no radiation pneumonitis and no local recurrence at 5.5 years of follow-up. This case makes a significant contribution to the literature by demonstrating successful PMRT following TRAM flap reconstruction in a patient with Poland syndrome and concurrent breast malignancy.

## Introduction

Poland syndrome is a rare congenital malformation characterized by unilateral chest wall hypoplasia and ipsilateral hand abnormalities with an estimated incidence of one in 30,000-100,000 live births (1,2). Several studies have reported an association between Poland syndrome and various malignancies, including leiomyosarcoma, leukemia, lymphoma, lung cancer, gastric cancer, head and neck tumors, and neuroblastoma (3-10). In particular, many cases of breast cancer occur in female patients with Poland syndrome (11-30).

The role of radiation therapy (RT) in the multidisciplinary treatment of breast cancer has been well-established. Breast-conserving therapy typically constitutes partial mastectomy followed by postoperative RT, and post-mastectomy RT (PMRT) is administered to patients at high risk for recurrence after total mastectomy. RT leads to moderate but definite reductions in breast cancer and overall mortality (31). The significance of PMRT techniques for breast cancer complicated by Poland syndrome is similar to that of RT after general mastectomy. However, PMRT in Poland syndrome is believed to be associated with higher risks of radiation-induced pneumonia and coronary events than those associated with common PMRT techniques because of chest wall hypoplasia (22).

We treated a woman in her 60s with Poland syndrome (characterized by the absence of the pectoralis major, pectoralis minor, serratus anterior, and ribs) and infiltrating ductal carcinoma of the left breast with unilateral chest wall hypoplasia. Because of concerns regarding complications, such as surgery-associated pulmonary hernia, mastectomy with primary closure of the skin and soft tissue defect of the left chest wall was performed using a transverse rectus abdominis musculocutaneous (TRAM) flap, followed by PMRT.

This is the first case report to discuss the feasibility of PMRT after TRAM flap reconstruction in a patient with severe Poland syndrome. PMRT after TRAM flap reconstruction was feasible in this case, with acceptable lung and heart doses, no radiation pneumonitis, and no local recurrence at 5.5 years. These findings may provide valuable clinical insights regarding the selection of RT for patients with similar pathological conditions.

## Case report

A woman in her 60s was diagnosed with a congenital malformation known as Poland syndrome. In July 2019, she was referred to the Kawasaki Medical School Hospital (Kurashiki City, Japan). Sonography revealed a solid hypoechoic lesion

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*Abbreviations:* CT, computed tomography; DIBH, deep inspiration breath hold; EC, epirubicin and cyclophosphamide; ESTRO, European Society for Therapeutic Radiology and Oncology; NCCN, National Comprehensive Cancer Network; PMRT, post-mastectomy radiation therapy; RT, radiation therapy; TRAM, transverse rectus abdominis musculocutaneous

*Key words:* Poland syndrome, left breast cancer, post-mastectomy radiation therapy, transverse rectus abdominis musculocutaneous flap

in the left upper breast. The patient had no family history of breast cancer or Poland syndrome. She experienced menarche in her early teens, underwent menopause in her early 50s, and experienced two full-term pregnancies in her late 20s. Her medical history included right ovarian cystectomy in her early 40s. She had no history of heart disease.

A physical examination revealed hypoplasia of the left chest wall with a normal nipple and the absence of the ipsilateral pectoralis major muscle. The left preaxillary folds were absent. Lifting of the left upper limb was limited by thoracic hypoplasia. Abnormalities were also observed in the left upper limb, including relatively poor growth of the limb segments, shortened distal segments of the left index finger and middle finger (Fig. 1), absence of the two distal segments of the left little finger, and limited movement of the left metacarpophalangeal, finger, and wrist joints. One mobile, hard, 10-mm lymph node was palpated in the left axilla. No skin ulcerations or edema were observed. The results of the initial hemogram and serum biochemistry test as well as tumor markers (carcinoembryonic antigen and cancer antigen 15-3) were within normal limits.

The tumor was characterized by general hypoechogenicity on ultrasonography. A Doppler examination revealed abundant blood flow in and around the tumor, which was approximately 39x14 mm (Fig. 2A). The involved axillary lymph nodes, which were approximately 10 mm, also appeared hypoechoic (Fig. 2B). Ultrasonography also revealed the absence of the left pectoralis major muscle. The initial computed tomography (CT) examination indicated the absence of the pectoralis major, pectoralis minor, and serratus anterior muscles and ribs 2-5 (Fig. 3A). Magnetic resonance imaging revealed a contrast-enhanced mass in the left upper inner and left upper outer quadrants (Fig. 3B). Fluorodeoxyglucose positron emission tomography confirmed axillary lymph node involvement with no evidence of metastatic disease (Fig. 3C).

The major axis of the primary lesion was 39 mm. Axillary lymph node metastasis on the ipsilateral side was observed without distant metastases. According to the Union for International Cancer Control TNM classification of malignant tumors, 8th edition (32), the clinical stage was cT2N1M0, corresponding to stage IIB, luminal B. This diagnosis guided decisions regarding neoadjuvant chemotherapy. She initially received neoadjuvant chemotherapy including epirubicin and cyclophosphamide (EC therapy). However, it was changed to nab-paclitaxel because EC therapy caused an allergic reaction. Four cycles of nab-paclitaxel were administered. Capecitabine was used in this case because of the residual lesion and prolonged time (6 months) required for TRAM flap engraftment. After surgery, capecitabine was administered for 6 months; thereafter, PMRT was performed. No concomitant therapy was administered during PMRT. Endocrine therapy (Anastrozole 1 mg/day) was continued after PMRT. The treatment course for this case is summarized in Fig. 4.

The surgical treatment plan for this case was mastectomy and axillary lymph node dissection. The thoracic deformity was severe; therefore, immediate chest wall reconstruction was performed to prevent pulmonary hernia and for cosmetic reasons. Because the patient did not wish to have additional children, we decided to perform simultaneous autologous tissue reconstruction using a TRAM flap to provide a sufficient amount of tissue for the degree of anterior chest depression

Figure 1. Image of the patient. The left index finger and middle finger are shortened (inside the red circle).

and extensive thoracic deformity (33). The patient underwent left total mastectomy with axillary dissection and immediate TRAM flap reconstruction. The complete absence of the pectoralis major, pectoralis minor, and serratus anterior muscles was noted during surgery. No evidence of insufficient blood flow or graft failure in the TRAM flap was observed postoperatively, and the patient's condition improved.

A pathological examination revealed invasive carcinoma of no special type of the breast, with the following findings: a maximum invasion diameter of 38 mm with lymphovascular invasion (+) and histological grade 2 (Fig. 5A). Estrogen receptor was positive (40% positive rate; Allred score, PS4 + IS1=TS5), whereas progesterone receptor was negative (0%; Allred score, PS0 + IS0=TS0). Human epidermal growth factor receptor type 2 was negative (score 1+), and Ki67 labelling index was 45.6% (Fig. 5B-E); the histological effects of primary systemic therapy were mild. Axillary lymph node metastasis was positive (Level I+II: 3/14 and Level III: 1/3; total: 4/17) (34). The TNM classification (8th edition) was ypT2, ypN2a, M0, G2, R0, C4, ypStage IIIA (32).

In this case, pathological examination revealed four axillary lymph node metastases (ypN2a); therefore, PMRT was performed according to the National Comprehensive Cancer Network (NCCN) Clinical Practice Guidelines (35). The patient was informed of the common adverse events after PMRT (such as dermatitis, pneumonia, cardiac events, and secondary cancers) as well as the effects of RT on the TRAM flap (such as flap necrosis caused by insufficient blood flow and cosmetic deterioration caused by wound dissection and fibrosis), and consent for treatment was obtained.

The patient was placed in the supine position with both arms elevated, and a torso immobilization device was used. We used the XiO® RT planning system to create treatment area contours and outlines from the three-dimensional CT images, to create two-dimensional treatment plans based on the treatment area contours that were created, and to calculate the dose distribution in the body. Free-breathing CT was used to develop a treatment plan. The patient was immobilized with both arms secured during acquisition of the CT scans

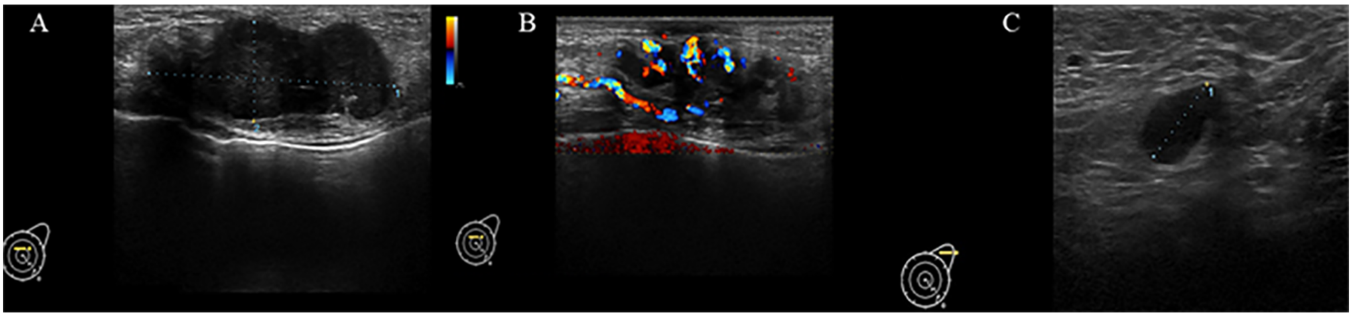


Figure 2. Ultrasonography images of the patient. (A) Preoperative ultrasonography image showing a solid hypoechoic mass with a measurement of ~39x14 mm in the glandular layer of the left breast. (B) Abundant blood flow in and around the tumor detected during Doppler examination. (C) Preoperative ultrasonography image showing tumescent lymph nodes in the left axillary fossa with a maximum size of ~10 mm.

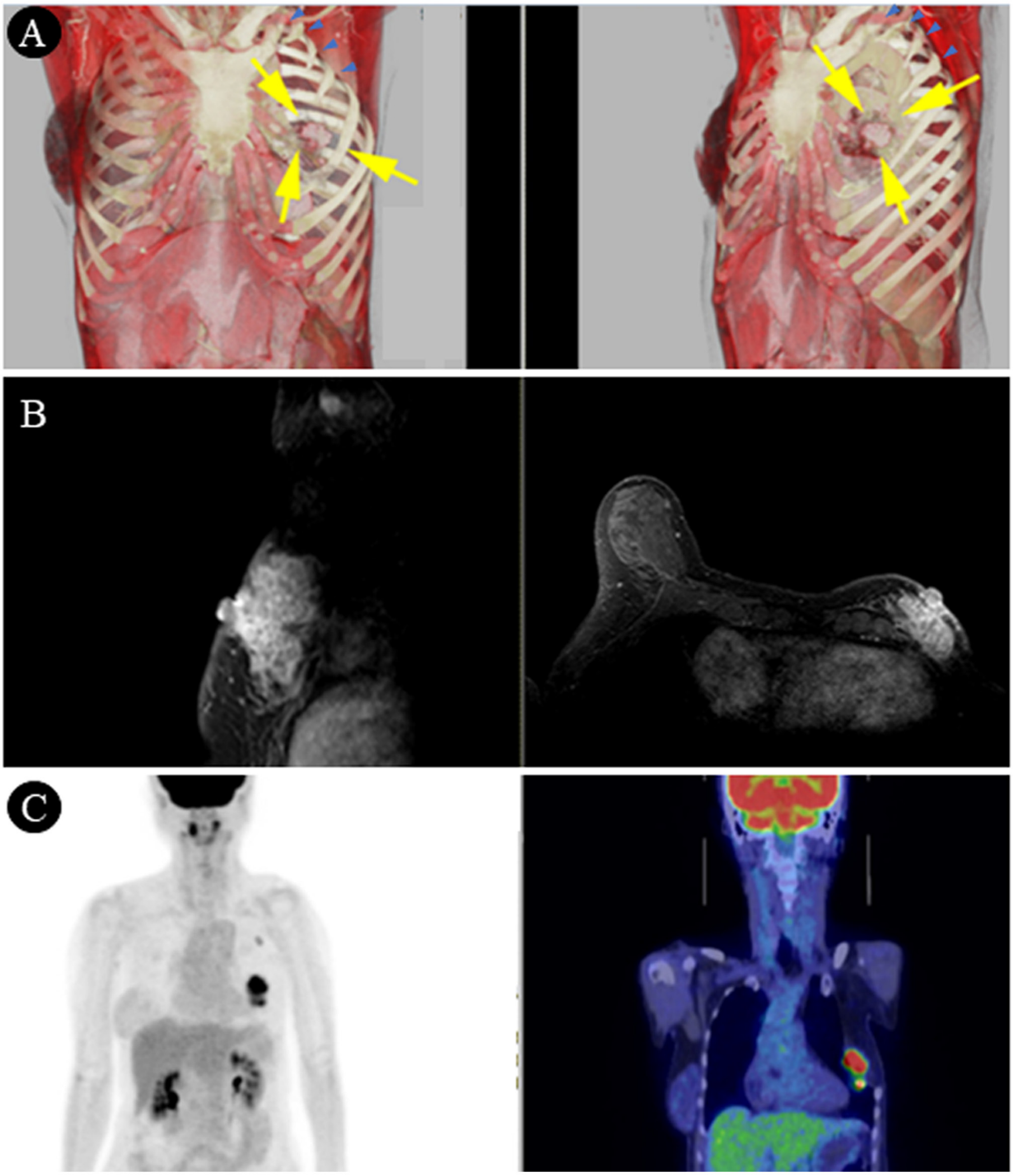


Figure 3. CT, contrast-enhanced MRI and 18F fluorodeoxyglucose PET images. (A) Preoperative three-dimensional CT (volume-rendering imaging) image showing hypoplasia of the left chest wall (arrow: pectoralis major; arrowhead: ribs 2-5). (B) MRI image of breast cancer in the left anterior-central region. (C) PET/CT images before surgery. No distant metastases other than the primary tumor and axillary lymph node metastasis is evident. PET, positron emission tomography; CT, computed tomography; MRI, magnetic resonance image.

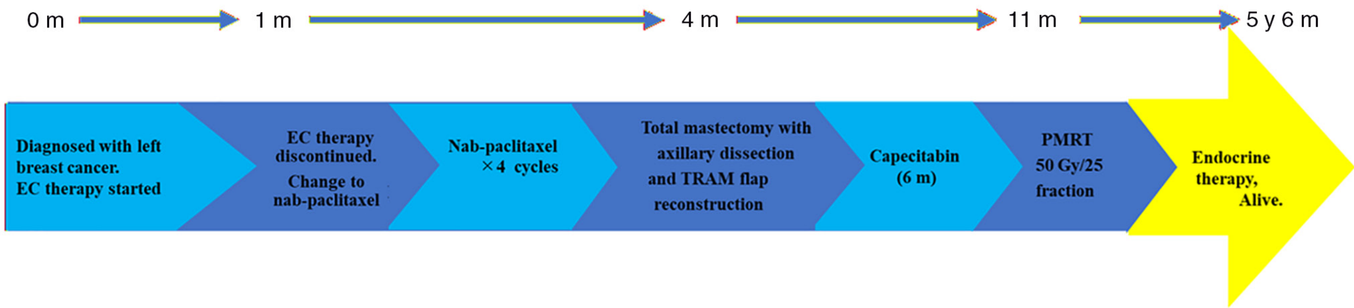


Figure 4. Timeline summarizing the main events of the present case. EC, epirubicin and cyclophosphamide; TRAM, transverse rectus abdominis myocutaneous; PMRT, post-mastectomy radiation therapy; m, month; y, year.

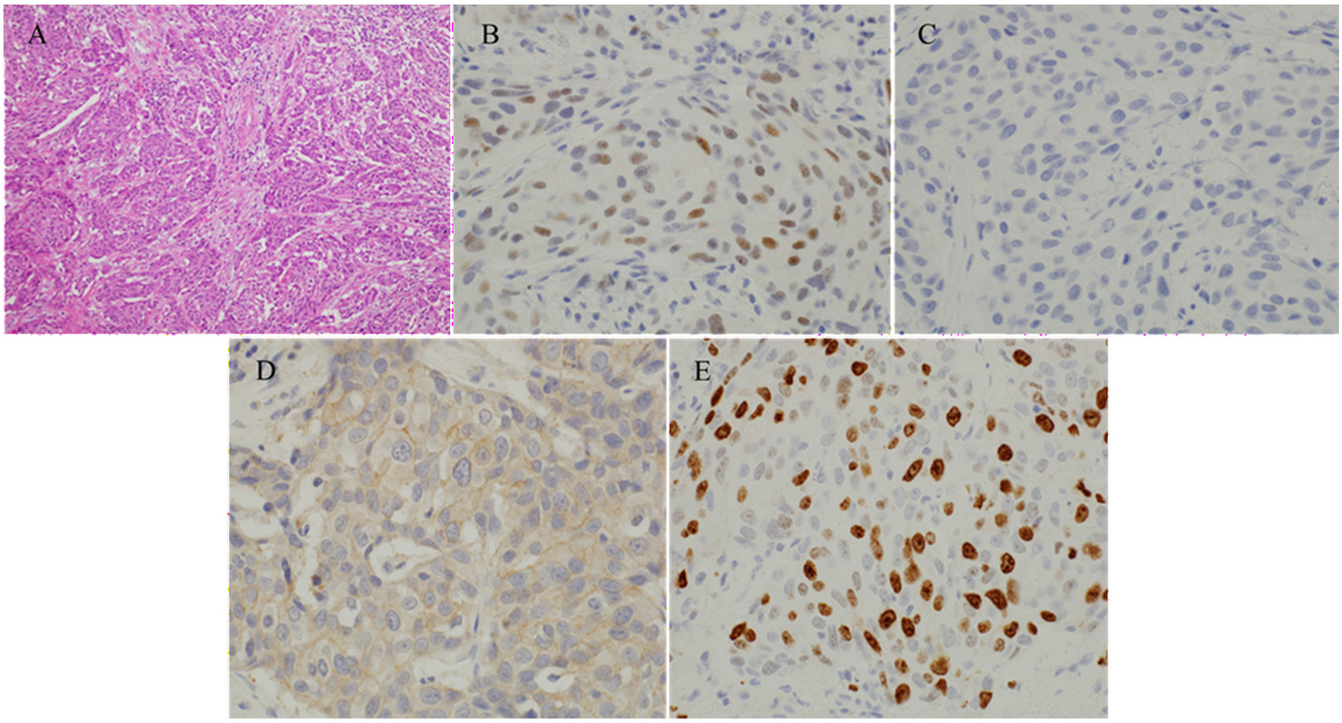


Figure 5. Pathological findings. (A) Pathological results indicating the diagnosis of invasive ductal carcinoma (magnification, x10). (B) Positive estrogen receptors (magnification, x20). (C) Negative progesterone receptors (magnification, x20). (D) Negative human epidermal growth factor receptor type 2 (score, 1+) (magnification, x20). (E) The Ki67 labelling index is 45.6% (magnification, x20).

for RT planning. Each of the target volumes (the chest wall and supraclavicular lymph node regions) was delineated on the treatment planning CT scans using radiopaque catheters. The target volumes and lymph node contours for breast cancer were defined in accordance with the target contouring guidelines published by the European Society for Therapeutic Radiology and Oncology (ESTRO) (36).

Irradiation was performed using the following steps. The irradiation field shared the same isocenter and was divided into two parts. The first part included the chest wall, including the mastectomy scar and axillary lymph node regions (levels I, II, and III). Levels I, II, and III were determined according to the ESTRO target contouring guidelines (36). The second part included the supraclavicular lymph node regions. Then, these two irradiation fields were connected using the half-field technique. The chest wall and supraclavicular lymph node regions were irradiated using 4-MV X-rays.

Additionally, the chest wall was irradiated using a partially wide tangential field (37) with the dorsal surface of the radiation field aligned to prevent radiation from spreading to the lungs and heart, similar to whole-breast irradiation in breast-conserving therapy. Furthermore, a 5-mm bolus was used to optimize the skin dose because of the effect of build-up. The total dose delivered to the chest wall was 50 Gy in 25 fractions; a 5-mm bolus was applied during the first 13 fractions (25 Gy) and omitted during the remaining 12 fractions (25 Gy). Finally, the dose within the high-dose area (≥110%) was reduced using the field-in-field technique.

We prescribed 50 Gy in 25 fractions to the reference points of each of the two irradiation fields; each reference point was selected to avoid the skin build-up region and thoracic cavity while representing the prescription dose.

A 20-mm space was set at the anterior margin of the beam in consideration of setup uncertainty, potential respiratory

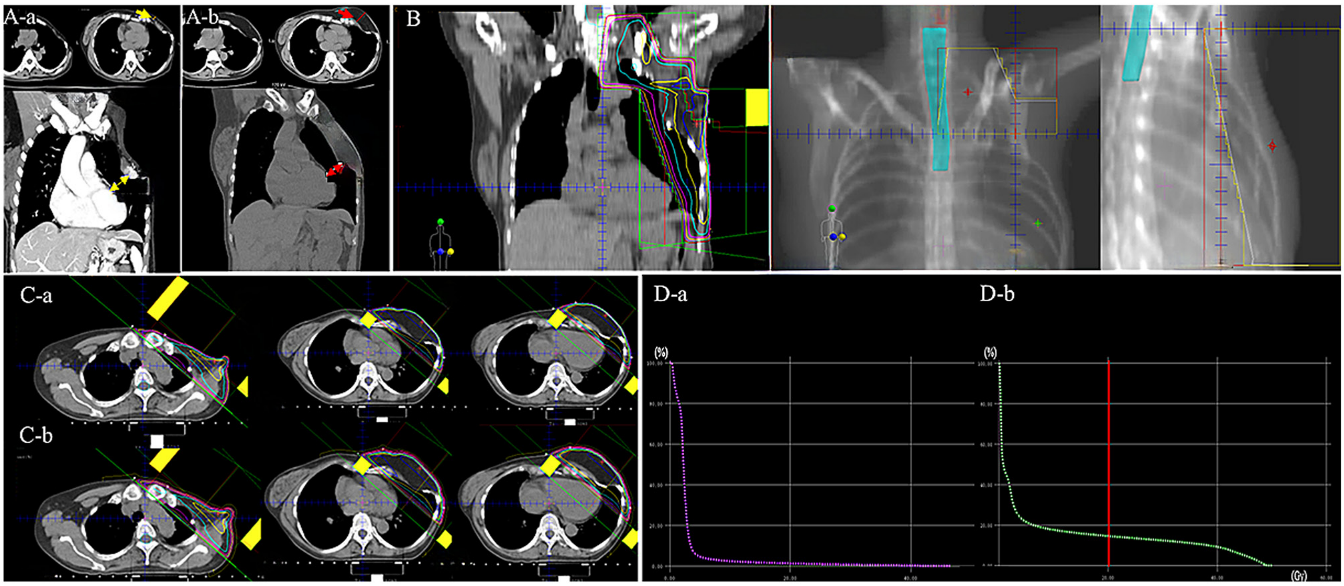


Figure 6. Irradiation method and dosimetric treatment. (A) CT images (axial section, coronal section) following total left mastectomy with axillary dissection and immediate TRAM flap reconstruction. The chest wall is thin, and the distance between the chest wall and heart is similar to that before surgery. Chest wall thickness (A-a) before TRAM flap reconstruction and (A-b) after TRAM flap reconstruction (axial images, yellow arrow: 0.6 cm, red arrow: 2.5 cm, yellow double arrowhead: 2.3 cm, red double arrowhead: 2.6 cm). (B) Radiotherapy field. RT was administered to the chest wall at 50 Gy in 25 fractions (six portals) using bolus and field-in-field tangential techniques and to the supraclavicular and infraclavicular lymph node areas at 50 Gy in 25 fractions (one portal) with 4-MV X-rays. Then, these two irradiation fields were connected using the half-field technique. A dose distribution of 50 Gy in 25 fractions is the prescribed total dose (coronal section). The central lung distance on the central axis plane is within 3.0 cm, thus meeting our institutional standards. (C) Final treatment plan including the tilting technique. A dose distribution of 50 Gy in 25 fractions is the prescribed total dose with or without the 5-mm bolus (axial section). The X-ray beam was arranged such that the 95% isodose line (yellow line) covered the remaining chest wall at the level of the sixth and seventh ribs and extended perpendicularly from the skin surface. A 5-mm bolus was used to optimize the skin dose while considering the effect of build-up: (C-a) Upper section: Without the bolus, 21 Gy in 25 fractions; (C-b) lower section: With the bolus, 25 Gy in 25 fractions. (D) The DVH shows the doses to the heart: (D-a) Mean heart dose, 2.74 Gy to the heart; (D-b) V20 dose of 14.6% to the lungs indicated by the red line. CT, computed tomography; TRAM, transverse rectus abdominis myocutaneous; RT, Radiation therapy; DVH, dose-volume histogram.

motion, and breast swelling during RT (38). In this case, image-guided verification could not be performed because real-time monitoring devices, including spirometry-based active breathing coordinators and video-based real-time position management systems, were not available at that time. The daily setup was verified using body surface and portal images obtained using linac-graph. Care was taken to ensure that the midline of the chest wall was not crossed and that the junction of the two irradiation fields did not overlap; irradiation was performed under free breathing. Respiratory motion was accounted for by setting the distance from the leading edge of the radiation field to the skin surface at 20 mm. The dose distribution was then adjusted so that the 95% isodose line was placed at the remaining chest wall at the level of the sixth and seventh ribs and extended perpendicularly from the skin surface.

Irradiation of the internal thoracic lymph node region was considered (35) because four axillary lymph nodes were positive and the tumor was located toward the center; however, it was not included to minimize the radiation dose to the heart. An irradiation boost was not administered because no findings suggested positive margins.

Ultimately, after completion of capecitabine administration, RT was administered to the chest wall at 50 Gy in 25 fractions (six portals) using bolus and field-in-field tangential techniques as well as to the supraclavicular and infraclavicular lymph node areas at 50 Gy in 25 fractions (one portal) with 4-MV X-rays. Pre-operative and post-operative CT images, treatment plans, and a dose-volume histogram are shown in Fig. 6A-D. The chest wall thicknesses, measured as the vertical distance from the skin surface to the remaining chest wall at the level of the sixth and seventh ribs, were 0.6 and 2.5 cm before and after TRAM flap reconstruction, respectively (Fig. 6A). Additionally, CT images obtained after simultaneous TRAM flap reconstruction following left mastectomy showed no significant difference in the distance from the chest wall to the heart (Fig. 6A). In accordance with the treatment plan, the left lung was partially included in the high-dose region, and the bilateral lung V20 was 14.6%, thus meeting our institutional standards; furthermore, the mean heart dose was 2.74 Gy, which corresponded to the low-risk group in the European Society of Cardiology 2022 guidelines (Fig. 6D) (39).

Other dosimetric constraints in PMRT performed at our hospital included the spinal dose (maximum dose: 47 Gy in terms of the equivalent dose in 2-Gy fractions) and the humeral head dose (maximum dose: 50 Gy in terms of the equivalent dose in 2-Gy fractions). Furthermore, the V25 and V5 to the heart were 0.99 and 4.56%, respectively, and the mean values of V10 and V5 of the ipsilateral lung were 42.57 and 52.19%, respectively. The maximum and mean doses to the contralateral lung were 25.28 and 17.04 Gy, respectively, in terms of the equivalent dose in 2-Gy fractions. Because the planning target volume (PTV) and PTV margins were not applied, the lung field was defined as the anatomical lung.

The patient noticed swelling in the lower abdomen and was diagnosed with an abdominal wall scar hernia. Laparoscopic

Table I. Characteristics of 25 cases of breast cancer with Poland syndrome reported in the literature.

| Author, Year | Patient no. | Age/Sex, years | Side | Histology | Stage | Treatment | Outcome | (Refs.) |
|---|---|---|---|---|---|---|---|---|
| Fukushima *et al*, 1999 | 1 | 57/F | R | IDC | T1N1M0, IIA | TM, ALDN | DF | (11) |
| Fukushima *et al*, 1999 | 2 | 53/F | L | IDC | T2N0M0, IIA | PM, ALDN | DF | (11) |
| Havlik *et al*, 1999 | 3 | 33/F | R | IDC + ILC | T2N0M0, IIA | TM, ALDN | N/R | (12) |
| Katz *et al*, 2001 | 4 | 42/F | L | IDC | T1N0M0, I | TM, ALDN, CTX | N/R | (13) |
| Okamoto *et al*, 2002 | 5 | 59/F | R | IDC | T1N1M0, IIA | PM, ALDN, CTX | N/R | (14) |
| Wong *et al*, 2004 | 6 | 51/F | L | DCIS | TisN0M0, 0 | TM | DF | (15) |
| Khandelwal *et al*, 2004 | 7 | 71/F | R | IDC+DCIS | T1N0M0, I | TM, ALDN | N/R | (16) |
| Tamiolakis *et al*, 2004 | 8 | 53/F | L | IDC | T1N0M0, I | TM, ALDN, CTX | N/R | (17) |
| Salhab *et al*, 2005 | 9 | 52/F | L | IDC + DCIS | T1N0M0, I | PM, SLNB | N/R | (18) |
| Uña *et al*, 2007 | 10 | 39/F | R | IDC | T1N0M0, I | PM, SLNB, CTX, HT, RT | N/R | (19) |
| Ji *et al*, 2008 | 11 | 58/F | L | IDC | T2N0M0, IIA | TM, ALND | DF | (20) |
| Wang *et al*, 2008 | 12 | 46/F | R | IDC | T2N1M0, IIB | TM, ALND, CTX, RT | DF | (21) |
| Caussa *et al*, 2009 | 13 | 43/F | L | IDC | T3N1M0, IIIA | TM, ALND, CTX, HT, RT | N/R | (22) |
| Zhang *et al*, 2011 | 14 | 43/F | L | IDC | T1N3M0, IIIC | TM, ALND, CTX | DF | (23) |
| Yesilkaya *et al*, 2011 | 15 | 39/F | L | IDC | T2N0M0, IIA | TM, ALND, CTX, HT | DF | (24) |
| DeFazio *et al*, 2018 | 16 | 69/F | L | DCIS | T1N0M0, I | (1) PM, SLNB, RT (2) PM | Recurrence DF | (25) |
| DeFazio *et al*, 2018 | 17 | 37/F | R | R DCIS/ L IDC | R TisN0M0, 0 L T1N0M0, I | B TM, B SLNB | DF | (25) |
| Huang *et al*, 2018 | 18 | 74/F | L | IDC | T3N0M0, IIB | TM, ALND, HT | DF | (26) |
| Huang *et al*, 2018 | 19 | 60/F | L | IDC | T4N1M0, IIIB | TM, ALND | DF | (26) |
| DeFazio *et al,* 2019 | 20 | 62/F | R | IDC | T2N0M0, IIA | B TM, SLNB, CTX | DF | (27) |
| Cuadrado *et al*, 2023 | 21 | 39/F | R | IDC | T1N0M0, I | PM, SLNB, CTX, RT, HT | DF | (28) |
| Cuadrado *et al*, 2023 | 22 | 48/F | R | IDC | T4N0M0, IIIB | TM, SLND, CTX, HT | DF | (28) |
| Guo *et al*, 2024 | 23 | 47/F | R | IDC | T2N0M0, IIA | TM, ALND, CTX | DF | (29) |
| Bumbu *et al*, 2024 | 24 | 81/F | R | DCIS | T2N1M0, IIB | TM, ALND, HT | DF | (30) |
| Current case | 25 | 63/F | L | IDC | T2N1M0, IIB | CTX, TM, ALND, RT, HT | DF | - |

F, female; R, right; L, left; IDC, invasive ductal carcinoma; TM, total mastectomy; ALND, axillary lymph node dissection; DF, disease-free; B, bilateral; CTX, chemotherapy; DCIS, ductal carcinoma in situ; ER, estrogen receptor; HER-2, human epidermal growth factor receptor-2; HT, hormonal therapy; ILC, invasive lobular carcinoma; LN, lymph nodes; N/R, not reported; PM, partial mastectomy; PR, progesterone receptor; C, contralateral; SLNB, sentinel lymph node biopsy; RT, radiation therapy; MC, mucinous carcinoma.

abdominal wall scar hernia repair was performed 1.5 years after TRAM flap reconstruction.

Successive therapies were scheduled. Treatment with anastrozole (1 mg/day) was scheduled for 10 years. The patient's condition remained stable for 5 years and 6 months following PMRT. The only observed adverse drug reaction was acute radiation dermatitis (grade 2 according to the Common Terminology Criteria for Adverse Events version

5.0), whereas acute fatigue, esophagitis, and pneumonia were not observed (40). In the late phase, radiation pneumonia, coronary events, late flap changes (e.g., fibrosis and volume loss), chest wall pain, shoulder range-of-motion impairment, or lymphedema were not observed.

## Discussion

For this case, we performed mastectomy with primary closure of the skin and soft tissue defect in the left chest wall using a TRAM flap, followed by a simultaneous PMRT. The TRAM flap improved lung herniation prevention and cosmetic outcomes without radiation pneumonia. To the best of our knowledge, this is the first clinical report to describe complications following TRAM flap reconstruction and technical execution of PMRT in left breast cancer that developed in the setting of unilateral Poland syndrome.

We reviewed the literature to investigate the clinical characteristics of breast cancer in Poland syndrome. The inclusion criteria for the PubMed search were English-language case reports and case series of breast cancer in patients with confirmed Poland syndrome published since 1999. The search identified 25 cases, including the current case (11-30). Patient age, laterality, tumor type, treatment modality, RT details, and outcomes were extracted and are presented in Table I. These included 12 cases of left breast cancer, 11 cases of right breast cancer, and one case of bilateral breast cancer (Table I). As previously reported, the incidence of breast cancer in Poland syndrome is three times higher on the right side (41); however, our study found no difference in the incidence of breast cancer on the left side and that on the right side in Poland syndrome. Additionally, RT was performed for six cases, including ours, and few studies have provided detailed descriptions of the irradiation method, dose, and reason for treatment.

Caussa *et al* (22) reported that PMRT in Poland syndrome is associated with higher risks of radiation pneumonia and radiation-induced cardiotoxicity than those associated with standard PMRT techniques because of chest wall underdevelopment. Specifically, these authors stated the following: ‘Therefore, PMRT with electron-beam radiotherapy is steadily being introduced’ and ‘Electron-beam RT to the chest wall and lymph nodes is suitable and safe for this rare patient group’ (22).

In this case, TRAM flap reconstruction was performed before PMRT to prevent lung hernia and to thicken the chest wall. We considered that electron beam RT of the chest wall would not achieve adequate dose distribution. Therefore, in this case, we decided to perform tangential X-ray irradiation of the chest wall and avoid the risks of radiation pneumonia and radiation-induced cardiotoxicity.

Ipsilateral breast cancer that occurs with left chest wall hypoplasia in Poland syndrome is expected to present major challenges for the RT treatment plan because the irradiation field includes part of the heart. This was evidenced in the study by Darby *et al* (42), who reported an association between the mean cardiac dose and serious coronary events with RT for breast cancer. Based on their report, we considered the importance of reducing the cardiac dose of postoperative RT for breast cancer, particularly for cases with unique anatomical anomalies such as this case, in which part of the heart on the left side of breast cancer was contained within the irradiation field. We addressed this issue using tangential irradiation and the field-in-field technique.

The NCCN Clinical Practice Guidelines in Oncology for Breast Cancer version 3.2024 consider the radiation dose to the heart as a key concern in left chest wall irradiation and recommend deep inspiration breath hold (DIBH) irradiation as an option for left breast cancer to minimize this radiation dose (35). Unfortunately, our hospital did not have the equipment necessary to perform DIBH irradiation at the time of treatment for this case; therefore, performing this procedure was not possible. We did not consider the use of intensity-modulated RT or volumetric-modulated arc therapy because our hospital is not equipped with linear accelerators or treatment planning devices to perform complex treatments, including PMRT; therefore, we performed three-dimensional conformal irradiation.

Another issue associated with cases involving immediate chest wall reconstruction is that RT increases the risks of complications in the reconstructed breast. Bristol *et al* compared the postoperative complications of the TRAM flap among 123 patients who underwent chest irradiation after mastectomy and 124 patients who did not and reported a higher rate of problems with wound healing of the skin flap in the irradiation group (43). However, the 2022 Clinical Practice Guidelines for Breast Cancer state that although RT for breast reconstruction using autologous tissue may cause increased fat necrosis and adverse cosmetic outcomes, no clear increase in major complications has been observed, and the impact on safety is minimal (44). The required 6-month period of capecitabine administration for the residual lesion may have been sufficient to achieve TRAM flap engraftment (Fig. 4).

According to a study by Darby *et al* (42), the incidence of major coronary events begins to increase within 5 years after RT and continues until 30 years after RT. Because the observation period for this case was 5 years and 6 months, continuous regular evaluations of cardiac shadow on chest radiography and cardiac function are required.

In conclusion, PMRT performed after TRAM flap reconstruction was safe and effective for our patient with Poland syndrome. Additional long-term follow-up is necessary to carefully assess any radiation-induced cardiotoxicity.

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## Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

## Authors' contributions

RT collected data and drafted the manuscript. RT and NI collected data. TM collected pathological images. RT, NI, YK, KM, SY, NT and KK participated in the study design. RT and KK confirmed the authenticity of all the raw data. KK supervised this study. All authors read and approved the final manuscript.

## Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Kawasaki Medical School (Kurashiki, Japan; approval no. 6725-00). The study was conducted in accordance with the principles of the Declaration of Helsinki.

## Patient consent for publication

Written informed consent was obtained from the patient for the publication of this case report.

## Competing interests

The authors declare that they do not have any competing interests.

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