International Journal of Surgery Case Reports 87 (2021) 106391

Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.elsevier.com/locate/ijscr

Case series

Characteristics of dynamic magnetic resonance imaging for shoulder stiffness in postoperative breast cancer patients: A preliminary case series

Tomohiro Saito [a,*], Hideyuki Sasanuma [b], Yuki Iijima [a], Katsushi Takeshita [a]

[a] Department of Orthopedic Surgery, Jichi Medical University, Tochigi, Japan
[b] Department of Orthopedic Surgery, Tochigi Medical Center, Tochigi, Japan

ARTICLE INFO

Keywords:
Case series
Shoulder stiffness
Postoperative breast cancer
Dynamic MRI
Abnormal enhancement
Abnormal blood flow

ABSTRACT

Introduction and importance: Shoulder stiffness in postoperative breast cancer causes a decrease in their quality of life. However, the underlying pathology is not fully understood, and no study has investigated the dynamic magnetic resonance imaging (MRI) findings in these patients. Therefore, the current preliminary study aimed to investigate the dynamic MRI findings in patients with shoulder stiffness occurring after breast cancer surgery.
Methods: We retrospectively analyzed the electronic medical records of postoperative breast cancer patients with shoulder stiffness, dated from January 2015 to December 2020. The baseline characteristics, breast cancer treatment methods, range of active shoulder motion, and location of the abnormal enhancement on dynamic MRI were assessed.
Results: The mean age of the patients was 57.8 ± 6.1 years (range, 47–63 years) and the mean duration of shoulder symptoms was 5.6 ± 3.6 months (range, 2–12 months). An abnormal enhancement of the rotator interval and axillary pouch was observed on dynamic MRI of all the included patients.
Conclusion: This study presents the first case reports of the dynamic MRI findings in postoperative breast cancer patients with shoulder stiffness. All patients had abnormal enhancement of the rotator interval and axillary pouch.

1. Introduction

Breast cancer is the most common malignant disease in women worldwide. Between 2010 and 2012, the lifetime probability of developing female breast cancer was 12.3%, or approximately 1 in 8, and between 2005 and 2011, the 5-year relative survival was found to be 89% [1]. The increase in life expectancy in women with breast cancer has emphasized the need for improved quality of life, during or after breast cancer treatment [2]. Shoulder stiffness is one of the most common complications in patients undergoing breast cancer surgery. One study reported that the incidence of shoulder stiffness after breast cancer surgery was 3.8% [3]. As shoulder stiffness causes restricted range of motion and pain, the quality of life after breast cancer surgery drops precipitously. Therefore, appropriate management of shoulder stiffness after breast cancer surgery is necessary. However, the pathology of shoulder stiffness after breast cancer surgery is not yet fully understood.

Shoulder stiffness is divided into two types: primary or secondary shoulder stiffness.

As shoulder stiffness in postoperative breast cancer has a known cause, it is considered to be secondary shoulder stiffness [4]. Currently, there are three dynamic magnetic resonance imaging (MRI) studies on shoulder stiffness [5,6,7]. In these three studies, irrespective of the type of shoulder stiffness, all patients with shoulder stiffness had abnormal blood flow in the rotator interval and axillary pouch on dynamic MRI. However, no study has investigated the dynamic MRI findings of shoulder stiffness in postoperative breast cancer patients yet. In our center, we encountered five cases of shoulder stiffness in postoperative breast cancer patients, and performed dynamic MRI in these patients.

2. Materials and methods

The institutional review board of the ethics committee at our institution approved the study (protocol 20-155). The data of postoperative breast cancer patients with shoulder stiffness treated at our institution from January 2015 to December 2020 were retrieved from the electronic medical database and analyzed retrospectively. The inclusion criteria were (1) postoperative breast cancer, (2) shoulder pain with limited active and passive shoulder range of motion (ROM) in at least

* Corresponding author at: Department of Orthopedics, Jichi Medical University, 3311–1 Yakushiji, Shimotuke, Tochigi 329–0498, Japan.
E-mail address: tr-saitou@kkf.biglobe.ne.jp (T. Saito).

https://doi.org/10.1016/j.ijscr.2021.106391
Received 20 August 2021; Received in revised form 3 September 2021; Accepted 4 September 2021
Available online 25 September 2021

three directions (forward flexion [FF] ≤ 100°, external rotation at the side [ER] ≤ 10°, and internal rotation [IR] ≤ L5) that applies to the frozen phase of shoulder stiffness [4], and (3) assessment with dynamic MRI. The exclusion criteria were (1) rotator cuff tears, (2) calcifying tendinitis, (3) osteoarthritis, and (4) previous shoulder surgery. During the study period, we identified eight postoperative breast cancer patients with shoulder stiffness. Among them, five patients met the inclusion criteria. Three patients hadn't undergone dynamic MRI and were thus excluded.

Baseline characteristics including age, body mass index, affected side, and presence of diabetes mellitus or thyroid disease were recorded. In addition, the type of surgery; history of lymph node dissection, radiotherapy, adjuvant treatments including chemotherapy, antihormone therapy or targeted therapy; active shoulder ROM (AE, ER at side, and IR of thumb vertebral level); and the duration of shoulder symptoms were recorded. The abnormal enhancement on dynamic MRI in the late phase was also investigated.

All patients underwent 3 T MRI (Skura; Siemens Medical Systems, Erlangen, Germany). After a bolus intravenous injection of gadolinium-chelated contrast material, three-dimensional fast low-angle images (repetition time, 3.1 ms; echo time, 1.26 ms) were obtained in the oblique coronal plane every 9 s for a total of 3 min. The late phase was defined as 153 s after the initiation of imaging. Reporting on the clinical parameters of the case was done in line with the SCARE 2018 criteria [8].

3. Results

The mean patient age was 57.8 ± 6.1 years (range, 47–63 years) and the mean duration of shoulder symptoms was 5.6 ± 3.6 months (range, 2–12 months). Baseline characteristics and breast cancer treatment methods are summarized in Tables 1 and 2. The shoulders of all the patients were in the frozen phase and revealed abnormal enhancement of the rotator interval and axillary pouch on dynamic MRI (Table 3).

3.1. Case presentation

3.1.1. Case 1

A 63-year-old woman had undergone partial mastectomy and axillary lymph node dissection for breast cancer, followed by radiotherapy for the breast and supraclavicular lymph nodes. As adjuvant treatments, chemotherapy and targeted therapy were administered. After surgery, the patient had shoulder pain and gradually progressive shoulder stiffness for 12 months. Her active range of shoulder motion was as follows: anterior elevation: 90°, external rotation at side: 10°, and internal rotation, buttock. Dynamic MRI at 18 s (early phase) showed pale enhancement after intravenous gadolinium injection, and at 81 and 153 s (middle and late phase, respectively) showed strong enhancement of the rotator interval and axillary pouch after intravenous gadolinium injection (Fig. 1).

4. Discussion

This study presents the first case series demonstrating the dynamic MRI findings in patients with shoulder stiffness post breast cancer surgery. All patients were found to have abnormal enhancement of the rotator interval and axillary pouch.

The pathology of shoulder stiffness in postoperative breast cancer is not yet fully understood. One study reported arthroscopic findings of shoulder stiffness associated with a variety of etiologies [9]. Regardless of etiology, the majority of patients showed red synovitic proliferative material around the long head of the biceps tendon and below the anterior capsule. This synovitic proliferative material is observed as an abnormal enhancement on dynamic MRI. In this case series, all included patients had abnormal enhancement of the rotator interval and axillary pouch on dynamic MRI. Therefore, one of pathologies underlying shoulder stiffness in postoperative breast cancer may be abnormal blood flow in the rotator interval and axillary pouch.

So far, three studies have investigated the dynamic MRI findings in patients with shoulder stiffness due to frozen shoulder, rotator cuff tear, and calcifying tendinitis [5,6,7]. In these studies, shoulder stiffness that met the ISAKOS criteria for the frozen phase of shoulder stiffness had abnormal blood flow in the rotator interval and axillary pouch on dynamic MRI [4]. In this case series, all examined shoulders met the ISAKOS criteria for the frozen phase of shoulder stiffness, and had abnormal blood flow in the rotator interval and axillary pouch on dynamic MRI. From these studies, it is possible to deduce that abnormal blood flow in the rotator interval and axillary pouch by dynamic MRI may be an imaging characteristic of the frozen phase of shoulder stiffness as per the ISAKOS criteria, regardless of the etiology of shoulder stiffness.

This study was a preliminary case series, and further studies with more patients are needed to confirm the current findings.

5. Conclusion

This study presents the first case series on dynamic MRI findings in postoperative breast cancer patients with shoulder stiffness. All patients were found to have abnormal enhancement of the rotator interval and axillary pouch.

Table 1
Patients' baseline characteristics.

Case	Age (y)	BMI (kg/m^2)	Side	DM	Thyroid disease
1	63	17.9	L	–	–
2	47	17.0	R	–	–
3	63	21.1	R	–	–
4	55	31.6	L	+	–
5	61	24.1	L	–	–

BMI, body mass index; DM, diabetes mellitus; L, left; R, right;

Table 2
Patients' breast cancer treatment methods.

Case	Type of surgery	Lymph node dissection	Radiotherapy	Adjuvant treatments
1	Bp	ALND	Breast, SCL	Chemo, target
2	Bt	ALND	Breast, SCL, CW	Chemo, hormone
3	Bp	SLNB	Breast, tumor floor	Hormone
4	Bt	ALND	Breast, SCL, CW	Chemo, hormone
5	Bt	ALND	Breast, SCL	Chemo, hormone, targeted

ALND, axillary lymph node dissection; Bp, partial mastectomy; Bt, total mastectomy; chemo, chemotherapy, CW, chest wall; hormone, antihormone therapy; SCL, supraclavicular lymph; SLNB, sentinel lymph node biopsy; targeted, targeted therapy.

Table 3
Patients' clinical data and dynamic magnetic resonance imaging findings.

Case	ROM			Duration of shoulder symptoms	Location of enhancement on dynamic MRI	
	AE	ER	IR		RI	AP
1	90	10	B	12	+	+
2	85	0	L5	7	+	+
3	90	0	B	2	+	+
4	80	10	L5	4	+	+
5	90	0	L5	3	+	+

ROM, range of motion; AE, anterior elevation; ER, external rotation; IR, internal rotation; B, buttock; L5, 5th lumbar spine; MRI, magnetic resonance imaging; RI, rotator interval; AP, axillary pouch.

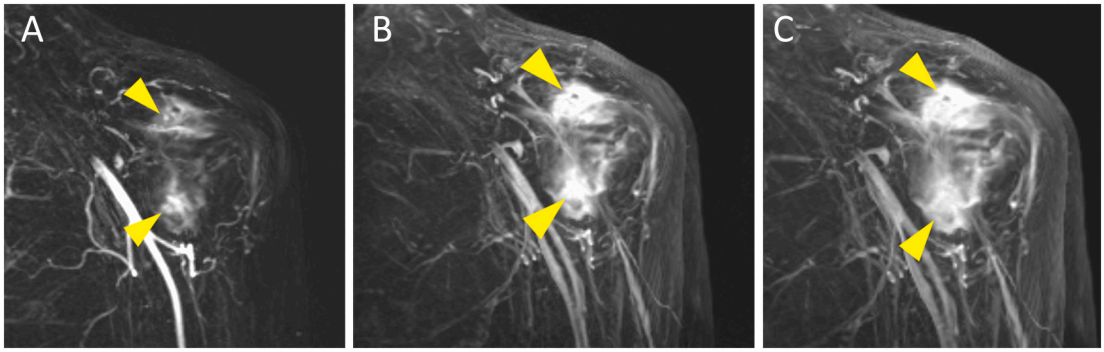

Fig. 1. (Case 1): A 63-year-old woman after breast cancer surgery.
A. Dynamic magnetic resonance imaging findings at 18 s (early phase) showing pale enhancement of the rotator interval and axillary pouch (arrowhead).
B. Dynamic magnetic resonance imaging findings at 81 s (middle phase) showing strong enhancement of the rotator interval and axillary pouch (arrowhead).
C. Dynamic magnetic resonance imaging findings at 153 s (late phase) showing strong enhancement of the rotator interval and axillary pouch (arrowhead).

Consent

Written informed consent was obtained from the patient for publication of this case series and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Ethical approval

The institutional review board of the ethics committee at our institution approved the study, waiving the requirement for formal written informed consent because of the retrospective nature of the study (protocol 20-155).

Sources of funding

All authors did not use any funding from any source.

Author contribution

T.S.: Performing the study, Literature review, writing – original draft.
H.S.: Literature review, case description and discussion
Y.I.: Literature review, case description and discussion
K.T.: Literature review, case description and discussion
All authors read and approved the final manuscript.

Guarantor

Dr. Tomohiro Saito

Registration of research studies

Not applicable.

Declaration of competing interest

All authors report no declarations of interest.

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