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Case Report

Intraoperative Placement of an Absorbable Spacer Prior to Radiation Therapy for a Malignant Peripheral Nerve Sheath Tumor

Yuki Endo[a] Taichi Fukuzawa[a] Masahiro Irie[b] Hideyuki Sasaki[a] Hironori Kudo[a] Ryo Ando[a] Ryuji Okubo[a] Saori Katayama[b] Masatoshi Hashimoto[a] Kosuke Sato[a] Masahito Tachibana[c] Hidekazu Aoki[d] Masayuki Araya[e] Koichi Hirabayashi[f] Shoji Saito[f] Hidekazu Masaki[e] Yozo Nakazawa[f] Yoji Sasahara[b] Motoshi Wada[a]

[a]Department of Pediatric Surgery, Tohoku University Graduate School of Medicine, Sendai-shi, Japan; [b]Department of Pediatrics, Tohoku University Graduate School of Medicine, Sendai-shi, Japan; [c]Department of Gynecology and Obstetrics, Tohoku University Graduate School of Medicine, Sendai-shi, Japan; [d]Department of Diagnostic Radiology, Tohoku University Graduate School of Medicine, Sendai-shi, Japan; [e]Proton Therapy Center, Aizawa Hospital, Nagano, Japan; [f]Department of Pediatrics, Shinshu University School of Medicine, Nagano, Japan

Keywords

Absorbable spacer · Malignant peripheral nerve sheath tumor · Radiation therapy · Proton beam therapy

Abstract

A 7-year-6-month-old female was diagnosed with a pelvic malignant peripheral nerve sheath tumor and lymph node metastases. Tumorectomy was performed after four cycles of chemotherapy. A 33-mm cystic lesion was observed around the left iliac muscle after three cycles of postoperative chemotherapy, and proton beam therapy (PBT) was recommended. She was referred for absorbable spacer (AS) placement. The left ovarian appendage (OA) was resected due to the direct tumor infiltration. The right OA was fixed to the uterosacral ligament. The AS was fixed to the lateral pelvis. The PBT (70.3 Gy relative biological effectiveness) was performed successfully with the AS, and she also had the reproducing possibility due to prevention of severe irradiation damage of the right OA. AS eliminated the surgical removal of spacers and enabled us high-dose PBT for residual tumor without severe irradiation damage including infertility.

Correspondence to:
Motoshi Wada, wada@ped-surg.med.tohoku.ac.jp

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Introduction

Intraoperative surgical spacer placement (SSP) creates a space between the tumor and the surrounding organs before radiation therapy. This is useful for irradiating curative doses while reducing radiation injury to the adjacent organs. A case of a locally residual malignant peripheral nerve sheath tumor (MPNST) was treated with SSP using an absorbable spacer (AS) made by polyglycolic acid (NESKEEP; Alfresa Pharma Corporation, Japan).

Case Report

A female aged 7 years and 6 months presented with a lower abdominal mass and was referred to our hospital (Fig. 1a). Pelvic MPNST with mediastinal lymph node metastases was diagnosed. Tumorectomy was performed after four cycles of chemotherapy with vincristine, ifosfamide, and doxorubicin regimen. After three cycles of the postoperative vincristine, ifosfamide, and doxorubicin regimen, residual lesions were observed around the left iliac muscle. Magnetic resonance imaging (MRI) revealed a 33-mm cystic lesion infiltration on the ventral side of the left iliac muscle (Fig. 1b, c). Positron emission tomography-computed tomography revealed a cystic lesion, and its caudal side had increased fluorodeoxyglucose uptake with a maximum standardized uptake value of 3.4 (Fig. 1d, e). Proton beam therapy (PBT) was recommended for residual pelvic MPNST lesions. The patient was then referred to our department for AS placement to protect the reproductive function and intestinal tracts surrounding the tumor.

SSP was performed. The colon was mobilized to create a desired space within the pelvic cavity. The left ovarian appendage (OA), which showed tumor infiltration, was resected. The right OA (ROA) was preserved and fixed to the sacral uterine ligament with two attached markers (Fig. 2a). An AS was placed and fixed in the lateral pelvis (Fig. 2b) to maintain the intestinal tract, uterus, and ROA away from the irradiation field (Fig. 2c).

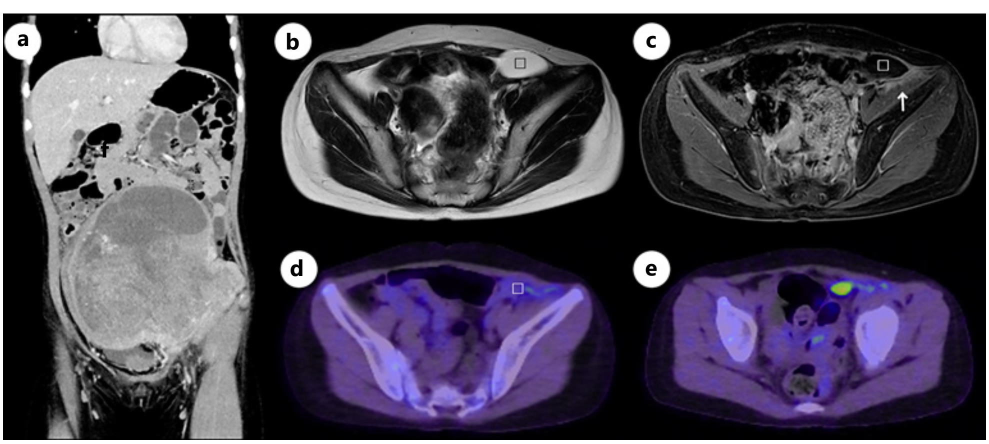

Fig. 1. a Contrast-enhanced CT before chemotherapy and tumor resection. The enlarged tumor was 14 cm × 13 cm in the abdominal pelvis. **b** MRI after tumor resection and postoperative chemotherapy shows a cystic lesion (33 mm, indicated as □) with high signal intensity on T2-weighted images and (**c**) low signal intensity on gadolinium-enhanced T1-weighted images, and this cystic lesion infiltrates the ventral side of the left iliac muscle (indicated arrow). **d**, **e** PET-CT after tumor resection and postoperative chemotherapy shows increased FDG uptake around the caudal side of the cystic lesion where it is in contact with the left iliac muscle (SUV max 3.4). MRI, magnetic resonance imaging; PET-CT, positron emission tomography-computed tomography; FDG, fluorodeoxyglucose; SUV, standardized uptake value; □, cystic lesion.

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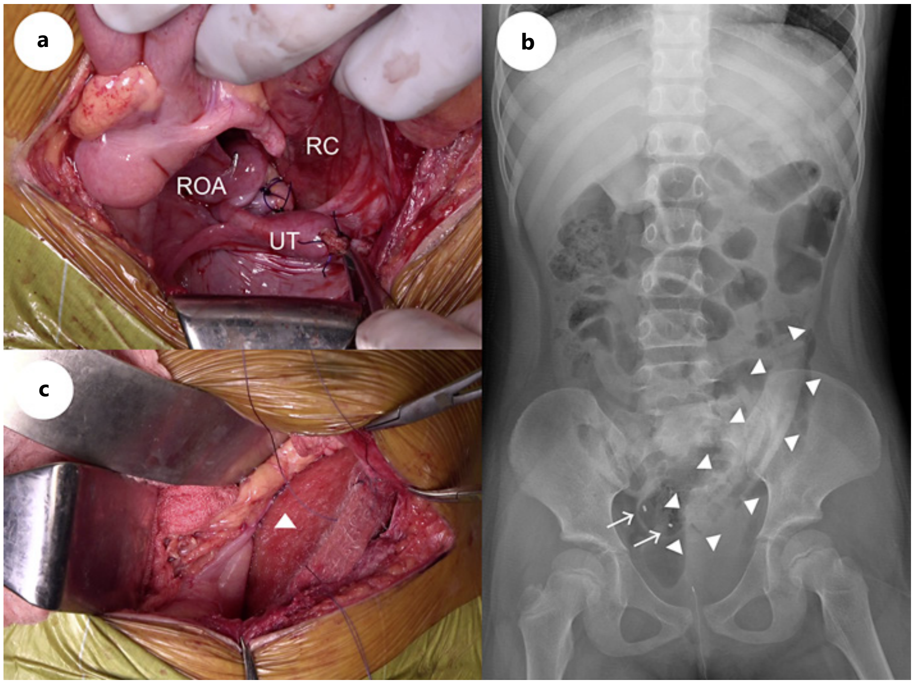

Fig. 2. Surgical findings. The patient's colon was mobilized to secure space within the pelvic cavity. **a** The left OA was sacrificed due to the direct tumor infiltration. The ROA was preserved and fixed to the sacral uterine ligament. **b** An AS was placed and fixed in the lateral pelvis. **c** Postoperative abdominal X-ray of the pelvis showing detection of the AS and the ROA (arrows indicating attachment markers). RC, rectum; UT, uterus; ROA, right ovarian appendage; AS, absorbable spacer (NESKEEP) indicated with Δ.

On postoperative day 3, it was confirmed that the AS was placed in an ideal position on CT (Fig. 3a, b). The postoperative course during this time was successful. The patient was transferred to another institute on postoperative day 5, and PBT (70.3 Gy relative biological effectiveness in 36 fractions) was performed as planned (Fig. 3c, d). The patient has been in remission for 7 months after PBT.

Discussion and Conclusion

Radiation therapy irradiates the tumor but simultaneously damages the surrounding normal tissue. PBT has made it possible to reduce exposure to the surrounding normal organs while maintaining the antitumor effects of radiation therapy [1]. The use of PBT for childhood cancer has been covered by public insurance in Japan since April 2016. This is expected to increase in the multidisciplinary treatment of pediatric malignant tumors. PBT has relatively strong adverse events in the surrounding organs [2]; therefore, it is necessary to improve the therapeutic effects and reduce the occurrence of adverse events.

Intraoperative SSP creates a space between the surrounding organs and the tumor before radiation therapy. A nonabsorbable Gore-Tex spacer was developed for this purpose in 2005 [3]. However, there was a risk of tissue adhesion, infection, and foreign body reactions. Besides, posttreatment removal was required. Surgical removal of the spacer can burden the patient and delay any planned postradiation therapy treatments, such as chemotherapy.

The use of an AS (SpaceOAR System; Boston Scientific Corporation, Marlborough, MA, USA) for radiation therapy of prostate cancer has been covered by public insurance in

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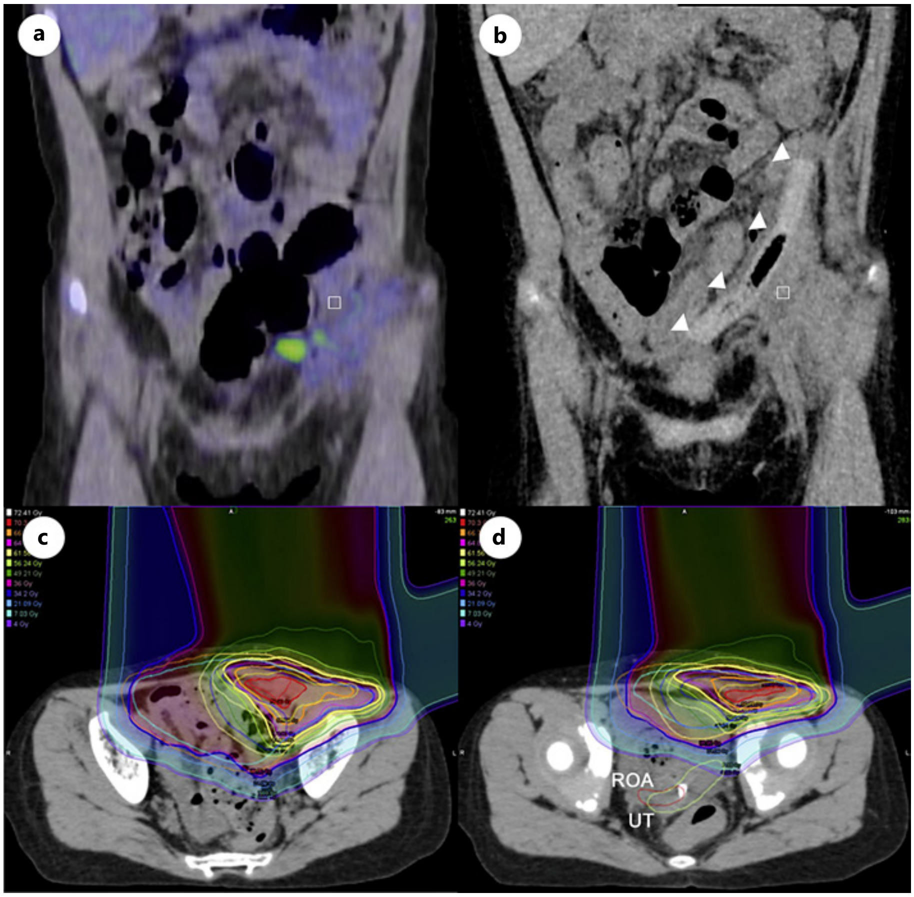

Fig. 3. a Pre-SSP-operative PET-CT. FDG uptake around the cystic lesion in contact with the left iliac muscle. **b** CT on the 3rd day after the SSP operation. The intestinal tract, UT, and ROA were away from the irradiation field. **c**, **d** Dose distribution map of PBT delivered using pencil beam scanning for the residual lesion of pelvic MPNST. □, cystic lesion; Δ, absorbable spacer (NESKEEP); UT, uterus; ROA, right ovarian appendage; PET-CT, positron emission tomography-computed tomography.

Japan since May 2018 [4]. An absorptive material made from polyethylene glycol was placed between the prostate and rectum to reduce the potential radiation injury to the adjacent rectum. It does not require removal after radiation therapy, and it has been effective in preventing radiation-related complications in clinical trials done in the USA (NCT01538628). Recently, AS made by processing polyglycolic acid has been developed [5, 6]. This treatment has been covered by insurance for childhood cancer in Japan since December 2019.

MPNST is a soft tissue sarcoma with a predilection toward the trunk and limbs. Approximately half of MPNSTs occur among patients with neurofibromatosis type 1, while the remainder develop sporadically [7]. Recent studies identified that epigenetic abnormalities, such as polycomb repressive complex 2, are the cause of MPNST [8]. The standard treatment for MPNST is surgical resection; however, the tumor is highly malignant and carries a high risk of postoperative recurrence [9]. Moreover, MPNSTs are resistant to standard chemotherapy and radiation therapy [7]. Therefore, this type of sarcoma has a poor prognosis. On the other hand, the effects of chemotherapy, including doxorubicin and ifosfamide, and sufficient local irradiation (>55 Gy) have been reported to be therapeutic, even if surgical complete resection is not possible [10].

Since the tumor bed was large in this case, it was necessary to select pencil beam scanning instead of passive scanning by the PBT devices. The pencil beam scanning evenly distributes the dose to the tumor and creates a high-dose irradiation field that matches the tumor shape. It can also reduce damage to normal tissues compared to passive scanning [11]. Moreover, SSP allowed us to irradiate at high doses. The AS does not require removal after radiation therapy. Therefore, the burden on the patient is reduced, and the necessary treatment can be focused on. In this case, a residual lesion of MPNST developed in the pelvis and was deemed unresectable; however, SSP enabled us to approach a curative dose of PBT and induced remission without any severe adverse effects. Moreover, radiation-induced infertility is one of the most significant long-term adverse effects for female children with large pelvic tumor. So far, there are no effective methods to preserve the fertility for them, but in this case, PBT with the pencil scanning device and SSP of AS enabled us to deliver the sufficient irradiation dose to the residual tumor with limited radiation exposer less than 4 Gy for the ROA. Multidisciplinary care ensured successful treatment. Further studies are warranted, but AS is considered useful in the multidisciplinary treatment of pediatric malignant tumors since it eliminates the need for surgical removal of spacers after radiation therapy and enables more effective radiation therapy with less toxic strategy.

Acknowledgment

All authors attest that they meet the current ICMJE criteria for authorship. The authors would like to thank Editage (www.editage.com) for English language editing.

Statement of Ethics

This case report was approved by the Ethics Committee of Tohoku University Hospital (November 1, 2021, No. 23618). Written informed consent was obtained from the patient and parents for publication of the details of their medical case and any accompanying images. This report does not contain any personal information that can lead to patient identification. This report also followed the procedures of the Ethics Committee.

Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Author Contributions

Yuki Endo who wrote the manuscript is the main author, and Motoshi Wada is the corresponding author of the manuscript. Taichi Fukuzawa, Masahiro Irie, Hideyuki Sasaki, Hironori Kudo, Ryo Ando, Ryuji Okubo, Saori Katayama, Masatoshi Hashimoto, Kosuke Sato, Koichi

Hirabayashi, and Shoji Saito managed the patient while in the ward. Masahito Tachibana provided some advice on reproductive function. Hidekazu Aoki and Masayuki Araya were involved in diagnosis and radiation therapy. Hidekazu Masaki, Yozo Nakazawa, Yoji Sasahara, and Motoshi Wada were each department heads and approved all medical decisions. All authors treated the patient and approved the final manuscript.

Data Availability Statement

All data that support the findings of this study are included in this article. Further inquiries can be directed to the corresponding author.

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