Kidney-autotransplantation before Radiotherapy: A Case Report

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Abstract. Background: A 28-year-old man suffering from a Ewing tumour arising from the 9th-11th ribs with infiltration of neuroforamina without distant metastases was planned to receive radiotherapy following primary intralesional surgery and induction chemotherapy. Due to pleural infiltration and effusion, a hemithorax irradiation with a sequential boost to the primary tumour site had to be administered. Different treatment planning variants failed to provide sufficient radiotherapy planning in view of target volume coverage and avoidance of organs at risk, especially due to high calculated radiation doses potentially compromising the left kidney. Materials and Methods: To prevent left kidney organ exposure, an autotransplantation of the left kidney into the right fossa iliaca was performed. An infiltration of the kidney was initially excluded. Results: Postoperatively, a renal scintigraphy showed a normal function of both kidneys allowing sufficient radiotherapy treatment planning. Target volume coverage was easily obtained using a combination of hemithorax irradiation and a sequential boost by an intensity-modulated-radiotherapy technique. Conclusion: In difficult individual treatment situations, surgical transpositions as well as organ autotransplantation might be useful in reducing radiotherapy organ dose levels.

Multimodal therapy including polychemotherapy, surgery and radiotherapy has resulted in survival rates of more than 60% for patients with Ewing tumours without metastases at the time of initial diagnosis (1). Within this multimodal therapy approach, a sufficient local therapy including surgery and/or radiotherapy plays a pivotal role to achieve high local control and survival rates (1-3). In some tumour localizations, only marginal or intralesional resections can be performed. For these patients, radiotherapy as a definitive treatment remains the only chance for achieving adequate local therapy (2, 4). However, the goal of complete tumour eradication through the delivery of high radiation doses must be balanced by the necessity of minimizing the doses applied to normal tissues (5-7). Hence, the radiation doses have to be restricted in some cases, although this may compromise local control. Several new treatment techniques such as intensity-modulated radiotherapy (IMRT) or proton therapy have been introduced as high conformal radiotherapy options to escalate radiotherapy doses, or to reduce doses to organs at risk (8, 9). However, in some cases there is still a risk for radiation-induced organ damage and failure. In the present paper, we report an uncommon option taken in order to reduce radiation doses to organs.

Case Report

A 28-year-old man suffering from a Ewing tumour of the 9th-11th rib on the left side had been referred to our Department of Radiotherapy. The tumour infiltrated the autochthonous spinal muscles, the pleura, as well as the neuroforamina of the thoracic vertebrae 9-12 (Figure 1). Due to infiltration of the neuroforamina and subsequent neurological symptoms, surgery was immediately performed after initial magnetic resonance imaging (MRI) scans before the confirmation of the diagnosis. However, the tumour could not be resected completely. After histological confirmation of Ewing tumour and additional staging revealing no distant metastases, induction chemotherapy according to the EURO-Ewing-99 protocol of the German Society of Pediatric Oncology (GPOH) was applied (6 cycles of VIDE polychemotherapy: vincristin, ifosfamide, doxorubicin, etoposide). Definitive local radiotherapy was planned paralleling the subsequent 7 VAC (vincristin, actinomycin D, cyclophosphamide) courses. During radiotherapy, actinomycin D had to be replaced by etoposide. Due to the initial infiltration of the pleura and pleural effusion, a hemithorax irradiation with 19.5 Gy cumulative dose to the lung (single dose 1.5 Gy) followed by
a sequential boost to the primary tumour region up to 54 Gy had to be administered (2, 10, 11). Initial 3-dimensional treatment planning was performed consisting of an anterior-posterior/posterior-anterior (ap/pa) field technique for the hemithorax irradiation in the cranial part (non-coplanar with a table angle of 90° to achieve a straight field border at the caudal end) and a conventional 3-dimensional treatment plan in the caudal part (central beam blocking at the cranial field border for field addition). This was planned to be followed by a 3-dimensional planned multiple field technique. However, this technique resulted in unacceptable doses to organs at risk, especially for the left lung and the left kidney. Therefore, additional treatment variants using IMRT were evaluated. However, these techniques still resulted in very high doses at organs at risk, especially for the left kidney and the left lung (Figure 2A).

To counter this setting, an unusual solution was found by kidney autotransplantation. Tumour infiltration of the kidney was excluded. The kidney autotransplantation was performed in analogy to living donor transplantations (12, 13). The left kidney was transplanted into the iliac fossa. Postoperatively, a renal scintigraphy showed normal kidney function for both kidneys, enabling good radiotherapy treatment planning in view of doses to organs at risk, as well as target volume coverage. In a first series, hemithorax irradiation using ap/pa fields including the target volume for the boost in the caudal part was applied without field divisions. Five fractions a week with single doses of 1.5 Gy (lung dose) were given to a cumulative dose of 19.5 Gy. In a second series, a sequential boost to the initial tumour volume with a safety margin was applied using an IMRT technique. Using this technique, a cumulative dose of 45 Gy was transferred to the pre-treatment tumour volume including a safety margin with single doses of 1.7 Gy. This technique included an integrated boost to the high-risk area, with daily fractions of 2.1 Gy up to a total dose of 51.5 Gy. The maximal dose to the spinal cord was limited to 50 Gy. To include the cranial part of the surgical scar without higher doses to organs at risk, a small electron field was added to the cranial field border of the boost plan. A vacuum cushion was used to reduce positioning errors during the whole therapy. Figure 2 shows the dose volume histograms of the lungs and the kidneys prior to (A) and after (B) kidney transplantation. After kidney transplantation, the doses to all organs at risk would be markedly reduced.

The treatment was applied without further problems. Due to leucopenia during combined chemotherapy and radiotherapy (during hemithorax irradiation), radiotherapy had to be ceased for a couple of days. There were no major acute side-effects and the patient was performing well at the end of radiotherapy. However, four weeks after the end of radiotherapy, the patient had a radiation recall skin reaction including an erythema and dry desquamation within the radiation field. This reaction immediately appeared after the first chemotherapy cycle containing actinomycin D after radiotherapy and resolved within two weeks. Currently, 18 months after end of radiotherapy, the patient is in complete remission and does not suffer from any side-effects.

Discussion

We report a very uncommon case of dose reduction to organs at risk in radiotherapy. The transposition of organs prior to irradiation therapy has mainly been performed for ovarian protection in pelvic radiotherapy (14-17). Ovariopexy reduces the radiation dose to the ovary exposed to pelvic irradiation. This surgical procedure positions the ovary out of the high-dose area of irradiation and may therefore reduce radiation-associated side-effects to the reproductive organs. However, the value of ovary transposition still remains unclear (18). The surgical transposition of other organs has rarely been described. To our knowledge, there are no reports describing the surgical transposition of a kidney. Radiation nephropathy (19, 20) as well as pneumonitis or radiation-induced pulmonary fibrosis (6) are well-recognized potential consequences of irradiation. In the present case, the function of the left kidney and major parts of the right kidney would have been impaired due to the high radiation doses. Special new radiation techniques such as IMRT were unable to provide a solution for this problem. However, as kidney autotransplantation increases other risks such as bleeding, infection, arterial stenosis or general kidney damage, such a treatment approach has to be restricted to special individual cases. Due to risk–benefit considerations for this case, we decided to perform kidney autotransplantation.
The presented method of organ transposition may reveal an option for other patients suffering from sarcomas or other tumours of the retroperitoneum. However, tumour infiltration of the kidney has to be excluded prior to the operation. A further option during transplantation could be the implantation of place-holders (e.g. silicon breast prostheses, parts of the omentum majus, or removable tissue expanders) to avoid the translocation of small bowel parts into the high-dose irradiation area. In the present situation, such a procedure was not performed because of the rather small high-dose area within the abdomen and the risk of fibrosis.

Figure 2. A) DVH analysis of the best treatment plan variant before kidney autotransplantation. There are high doses to the organs at risk, especially the left kidney and the left lung. B) DVH analysis of the treatment plan following kidney transplantation. There is a reduction and tolerable result regarding the doses to organs at risk.
Conclusion

In difficult individual treatment situations, surgical transpositions as well as organ autotransplantations may be useful to reduce organ radiotherapy dose levels.

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References


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