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# The technique of craniospinal irradiation of paediatric patients in supine position

**Pavel Šlampa[1], Zuzana Seneklova[1], Jiri Simicek[1], Renata Soumarova[1], Petr Burkon[2], Ludmila Burianova[2]**

*[1]Masaryk Memorial Cancer Institute, [2]St. Anneīs University Hospital, Brno, Czech Republic*

***Background.*** *Postoperative radiation therapy has significant impact on local control and overall survival of paediatric patients with brain tumours but an irradiated volume is often a controversial issue. Our aim was to describe a new technique of craniospinal irradiation as a postoperative treatment in patients with the risk of relapse of brain tumours as well as to estimate the side effects of such craniospinal irradiation.*

***Patients and methods.*** *In the last 4 years, 17 paediatric patients under 15 years of age with medulloblastoma (8) ependymoma (6) and glioblastoma (3) received postoperative craniospinal axis radiotherapy by a new technique developed in our departments. This technique is based on irradiation in supine position with the use of asymmetric jaws of the linear accelerator.*

***Results.*** *Radiotherapy was well tolerated and dose-reduction was not needed in any case. Skin reactions were mild in all patients. The gastrointestinal and haematological toxicity was mild to moderate (WHO grade I-II).*

***Conclusion.*** *The proposed new technique of craniospinal irradiation is advantageous in terms of side effects and could be recommended to be widely used. Craniospinal irradiation in supine position is an alternative method to the treatment in prone position. The evaluation of the effectiveness was limited by a short follow-up interval.*

*Key words: brain neoplasms – radiotherapy; radiotherapy – methods; supine position; child*

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Correspondence to: Pavel Šlampa, M D, PhD, Head, Department of Radiation Oncology, Masaryk Memorial Cancer Institute, Zl. kopec 7, 656 53 Brno, Czech Republic; Fax: +420 5 4313 1117; E mail: slampa@mou.cz

## Introduction

The primary treatment of choice of the brain tumours is surgery. Combination of treatment modalities is preferred in the treatment of medulloblastomas, ependymomas and gliomas. Postoperative radiation therapy has significant impact on local control and overall survival. In general, postoperative radiotherapy has been reported to improve the outcome. Meta-analyses of the patients irradiated postoperatively have revealed a prolongation of the 5-year survival rate by 20-30 % (ependymomas) and 60 % (medulloblastomas). An irradiated volume is often a controversial issue, especially regarding irradiation of the spinal axis after resected intracranial ependymomas and gliomas. In this study, we report a new technique for craniospinal irradiation developed in our departments.[1-6]

## Patients and methods

Between January 1997 and March 2001 a total number of 17 (medulloblastoma 8, ependymoma 6, glioblastoma 3) paediatric patients aged under 15 years (median age 6.6 years) were treated in the Departments of Radiation Oncology, St. Anne's Hospital and Masaryk Memorial Cancer Institute in Brno. Surgical resection was performed in all patients. All tumours were histologically proved and were localized infratentorially in the posterior fossa. In the indicated cases, chemotherapy was administered after radiotherapy. All of the patients were irradiated with a dose of 24-36 Gy to the whole craniospinal axis and with a dose of 50-54 Gy to the tumour bed (30-36 Gy "high risk", 24-30 Gy "standard risk" group). In cases with residual tumour a total irradiation dose up to 58-60 Gy was delivered. A new radiotherapy technique using asymmetric jaws of the linear accelerator was employed in all patients.

The development of modern accelerators enables the use of asymmetric jaws in whole brain irradiation in order to minimise the risk of damage of critical areas in close proximity to the target volume, and to diminish the risk of overdosage at the border of the adjacent fields in the area of the irradiated spinal canal (Figure 1).[7-10]

The definition of the planning the target volume:

1) Whole brain: this volume encompasses the whole brain with 1 cm safety margin. The lower limit of the frontal area must be 5 mm below the frontal sinus and 1 cm below the temporal lobes. In front of vertebra $C_2$, 5 mm are required.
2) Spinal axis: the inferior limit must be vertebra $S_{2-4}$. The lateral safety margin of 5 mm is required regarding the lateral process. ICRU 50 point of the whole brain is on the mid axis of the target volume and that of the spinal axis is on the axis of medullar cord (Figure 2). Treatment planning was based on a series of about 20-25 consecutive CT slices. The use of three-dimensional treatment planning is a standard method.

In the whole brain and cervical spine irradiation (with the caudal border $C_3$-$C_4$ ), two opposite lateral fields were chosen with shielding blocks of the eye bulbs; the spinal cord was irradiated with two direct posterior fields. After reaching 33 % and 66 % of the planned dose, the size and the borders of the adjacent fields in the area of the spine were modified (Figure 3). It was necessary to include the whole vertebral volumes in the irradiated volume in order to diminish the risk of postirradiation scoliosis of the spine. Patients were lying in supine position and were fixed by a vacuum body immobiliser and ORFIT head mask. With the use of the vacuum body immobiliser, the applied depth dose decreased by 1-2 %. This irradiation technique caused a tolerable increase of the superficial skin dose with regard to the total dose applied to the planning

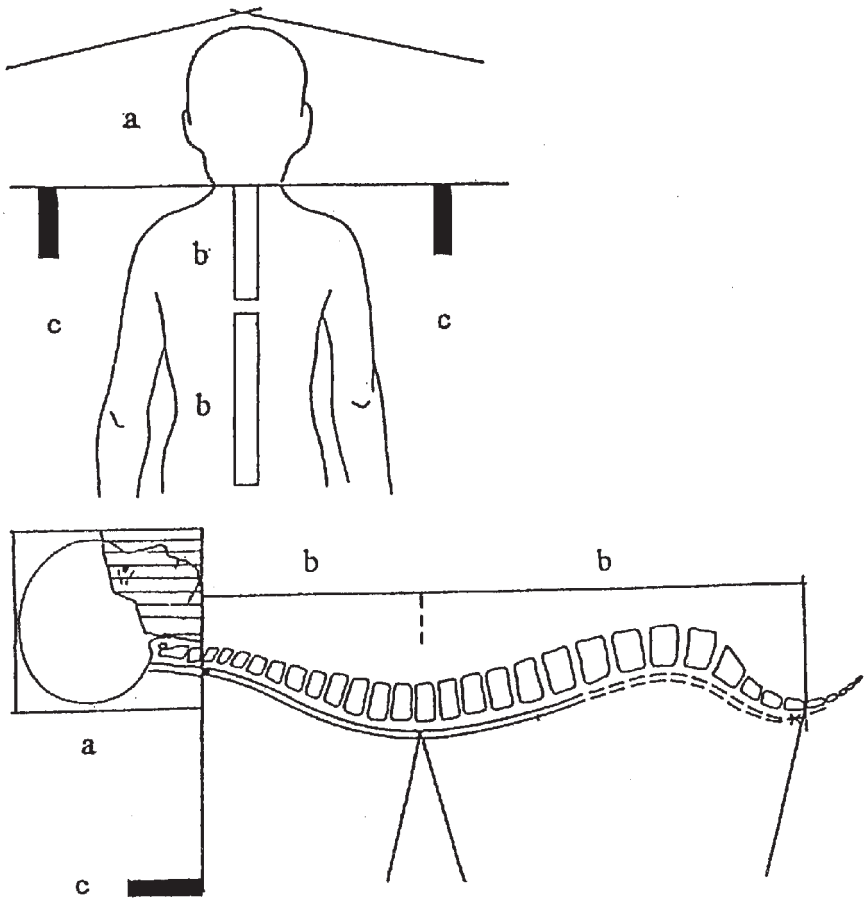


**Figure 1**. Modified technique of craniospinal irradiation with the use of two opposite lateral fields (individual shielding blocks of the eye bulbs and the face part of the skull) (a), and two direct fields (b), with the use of the asymmetric jaws (c). (Linear accelerator, X-ray, 6 MV).

target volume. Irradiation was performed using standard fractionation (5 fractions per week) with a single dose of 1.5-1.8 Gy for craniospinal axis by photon beam (6MV) of the linear accelerator. It was necessary to determine exactly the position of the child on the treatment table by laser beams and the optical pointer of the irradiation device.

## Results

The prescribed dose of irradiation was delivered to all patients; dose reduction was not necessary in any of them. In October 2001 (date of evaluation), 8 out of 17 patients (47 %) were without any sign of disease and had no serious problems. Two patients presented significant neurological symptoms. Local relapse occurred in one patient, but was successfully treated by surgery. Six patients (35 %) died of local recurrence (5 of these 6 patients had partial resection).

Radiotherapy was well tolerated. Skin reactions were mild and were of grade 1 (WHO) in 15 (88 %) patients and of grade 2 in two (12 %) patients. Within three months after the completion of radiotherapy, these reactions disap-

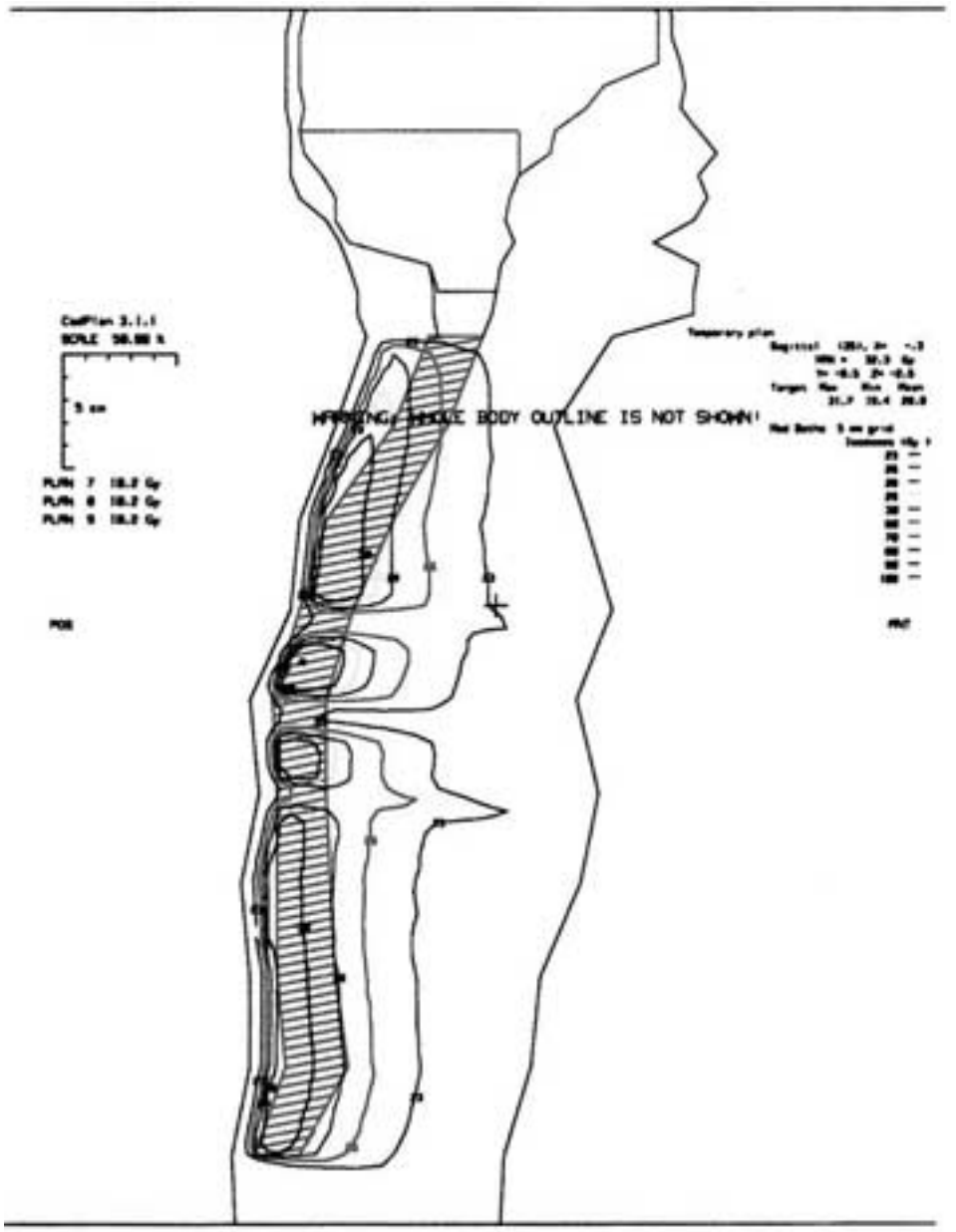


**Figure 2.** Isodose plan of irradiation spinal axis with two changes of the borders of the adjacent fields.

peared. The gastrointestinal and haematological toxicities were mild to moderate in all patients (WHO 1-2 gr.). Leucopenia grade I occurred in 70 % of patients, grade II in 18 %, trombocytopenia grade I in 35 %, diarrhoea grade I in 47 % and grade II 23 %, nausea in 47 %.

Further evaluation of the effectiveness of our therapy is not feasible due to the small number of patients and short follow-up interval.

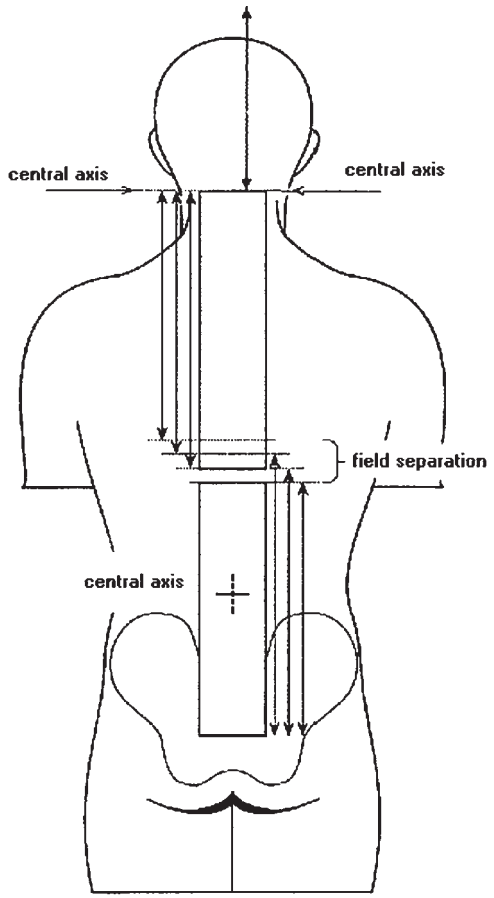


**Figure 3.** The radiation fields – scheme of the changes of the size.

## Discussion

Irradiation of the craniospinal axis is a part of the treatment modality of a number of malignant diseases. Patients are usually treated in prone position which is not as comfortable, reproductable, and as easily maintained as supine position.[5-7]

Acute skin, haematological and gastrointestinal reactions were comparable with those in patients irradiated in prone position.[11]

To minimise anaesthesia related risks, the irradiation in supine position would be preferable to standard prone position. The treatment in supine position would be more comfortable for adult patients as well.[12]

In this study, we presented a technique of craniospinal axis radiotherapy with the use of asymmetric jaws of the linear accelerator in order to minimise the risk of irradiation induced toxicity to healthy tissue and to overcome the risk of overdosage at the adjacent fields. It is necessary to use a three-dimensional treatment planning. The assessment of the effectiveness is limited by the short follow-up interval.[13,14]

In conclusion, our technique of craniospinal axis irradiation is advantageous in terms of tolerability and side effects. We believe that it deserves to be widely used.

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