ISSN: 2755-0176

Journal of Cancer Research Reviews & Reports

Case Report

Open Access

3D Conformal Radiotherapy for Nephroblastoma: Unusual Technique in Dalal Jamm Hospital

Papa Macoumba Gaye[1], Mouhamadou Bachir Ba[1], Ousseynou Sarr[1], Latifatou Gueye[1], Ndella Diouf[2] and Fatou binetou Diagne[2]

[1]Radiotherapy department at Dalal Jamm Hospital Dakar-Senegal

[2]Pediatric-oncology department of Aristide Ledantec hospital Dakar-Senegal

ABSTRACT

Nephroblastoma is the most common kidney tumor in children, accounting for 6% of all pediatric tumors. This tumor most commonly occurs between one and five years of age with a peak incidence around three and a half years. Multidisciplinary treatment combining neo-adjuvant chemotherapy followed by surgery and radiotherapy has achieved an overall survival of 90% at 10 years. This radiotherapy is optimal when it makes it possible to deliver an optimal dose of radiation while preserving the healthy developing organs in this subject. Conformational intensity modulation radiotherapy (IMRT) by linear accelerator or helical tomotherapy and hadrontherapy make it possible to respect this principle. These irradiation techniques were not available in our practice setting. We used a three-dimensional conformational radiotherapy technique for pan-abdominal irradiation of a nephroblasm while respecting the dosimetric constraints required in IMRT. Indeed, a rigorous optimization of three-dimensional conformational radiotherapy by a good delineation of the volumes of interest and a multiplication of the irradiation beams makes it possible to approach new radiotherapy techniques in terms of dose coverage, compliance with dosimetric constraints with reduction secondary cancer risk associated with low doses.

***Corresponding author**
Papa Macoumba Gaye, Radiotherapy Department of the CHU Dalal Jamm in Guédiawaye, UCAD, Dakar –Senegal E-Mail: macoumba.gaye@gmail.com

Received: August 15, 2020; **Accepted:** August 21, 2020; **Published:** August 26, 2020

Keywords: Radiotherapy, conformal, nephroblastoma.

Introduction

Nephroblastoma, or Wilms tumor, is the most common kidney tumor in children, most commonly occurring between one and five years of age with a peak incidence around three and a half years. Multidisciplinary treatment (chemotherapy-surgery-radiotherapy) allows an overall survival of 90% at 10 years (1). Intensity-modulated radiation therapy (IMRT) either with a particle accelerator or with helical tomotherapy can deliver an optimal dose of radiation while preserving healthy developing organs in this subject (2). This irradiation technique was not available in our practice setting. We report the case of a nephroblastoma treated by a three-dimensional conformational radiotherapy (RC3D) technique with respect to the dose constraints decreed by the IMRT.

Observation and Method

This was a 5-year-old patient with no pathological history with up-to-date vaccination status who presented with symptoms that had progressed over the past 5 months consisting of increased abdominal volume, pain and abdominal discomfort. Ultrasound then abdominal CT scan revealed a solidocystic mass of left renal origin, which may be related to a nephroblastoma (fig 1).

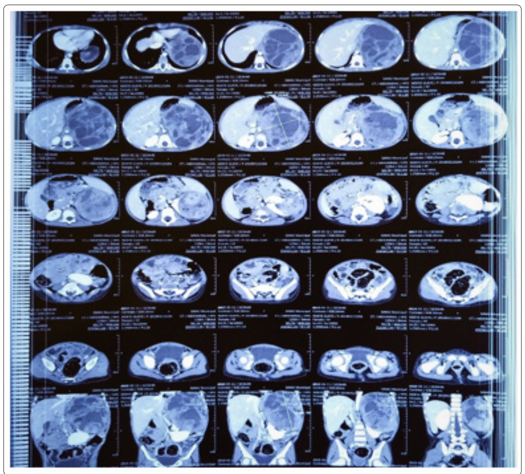

Figure 1: Abdominal CT scan showing a left renal solidocystic mass suggesting nephroblastoma

She had neo-adjuvant chemotherapy with three courses of Vincristine, Adriamycin and Actinomycin D followed by an enlarged left total nephrectomy with node dissection and the anatomopathological examination of the operative part found a predominantly blastematous nephroblastoma (60%) with capsular breakage and lymph node involvement. The lesion was classified stage III of the SIOP. The chemotherapy was completed in seven courses with adjuvant vincristine and Adriamycin. At first, she had not received radiotherapy and 5 months later, she presented an evolutionary disease at the level of the nephrectomy compartment (fig 2).

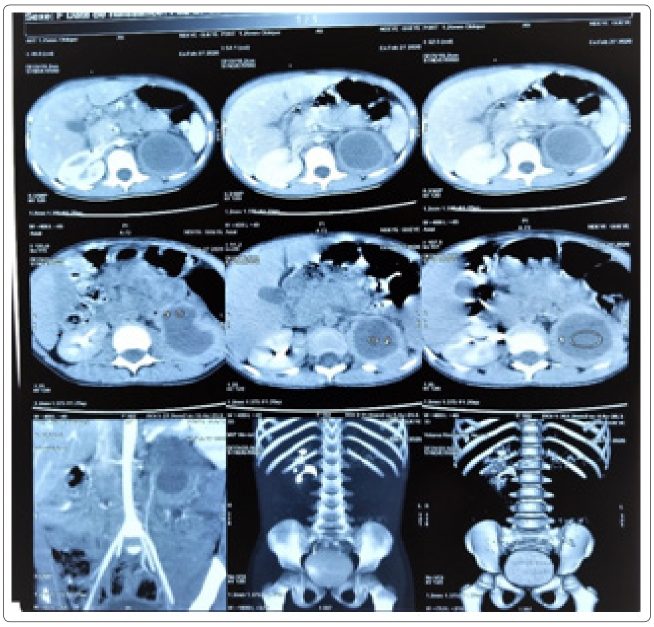

Figure 2: Abdominal CT scan showing progressive continuation after the first enlarged left total nephrectomy with dissection

After a new negative extension workup, she underwent revision surgery with resection in healthy margins. Three-dimensional conformational radiotherapy (RC3D) has been indicated as an adjuvant. After a simulation scan with 3 mm sections from the sternal fork to the pelvic diaphragm, we delineated the organs at risk such as both lungs, heart, liver, right kidney, spinal cord and vertebrae as well as the target volumes by defining three dose levels:

1. A target abdomen volume in toto corresponding to PTV 1 (Planning Treatment Volume) with a prescribed dose of 10.5 Gy in 7 fractions of 1.5 Gy per fraction.
2. A left flank target volume corresponding to PTV 2 at a dose of 15 Gy, this PTV 2 is included in PTV 1 and an additional dose of 4.5 Gy in 3 fractions has been added.
3. A target volume of the left renal compartment of the site of the evolutionary disease corresponding to PTV 3 at a dose of 19.5 Gy, This volume is also included in PTV 1 and PTV 2 and an additional dose of 4.5 Gy has been added.

Six beams were used in ballistic planning and the dosimetry is carried out in three stages:

-For the 10.5 Gy PTV, two oblique beams were used for this planning:
An oblique beam angulation of the Arm 312°, Rotation of the collimator 0°, Rotation of the base of the table 0°.

An oblique beam angulation of the 135° Arm, Rotation of the collimator 0°, Rotation of the base of the table 0°.

These two beams are shaped around the 10.5 Gy PTV with a margin of 0.3 cm using the blades and treated with an energy of 10 MV, and a weighting 52.33% and 47.67% respectively of the prescribed dose.

-For the PTV 15 Gy two oblique beams were used for this planning
An oblique beam angulation of the Arm 328°, Rotation of the collimator 356°, Rotation of the base of the table 0°;

An oblique beam angulation of the Arm 153.5°, Rotation of the collimator 2°, Rotation of the base of the table 0°.

These two beams are shaped around the PTV 15 Gy with a margin of 0.2 cm using the blades and treated with an energy of 6 MV, equal-weighted (50% each) of the prescribed dose.

-For the PTV 19.5 Gy two oblique beams were used for this planning.
An oblique beam angulation of the 332° Arm, Rotation of the collimator 0Ä, Rotation of the base of the table 0°.

An angled beam of the 154° Arm, Rotation of the collimator 0°, Rotation of the table base 0°.

These two beams are shaped around the PTV 19.5 Gy with a margin of 0.2 cm using the blades and treated with an energy of 6 MV, equal-weighted (50% for each beam) of the prescribed dose (fig 3).

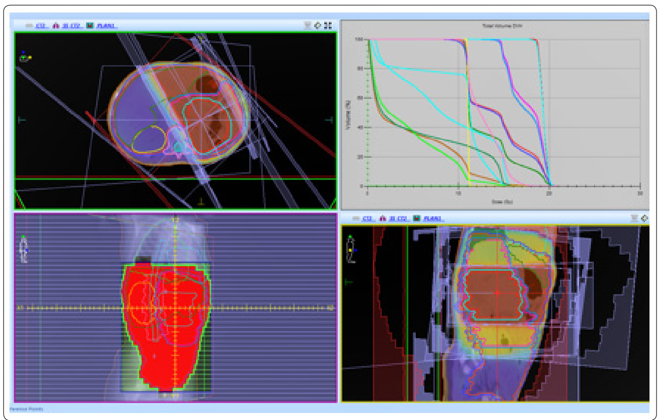

Figure 3: 6-field technique in 3D conformal radiotherapy

This dosimetric planning allowed the development of dose volume histograms (HDV) taking into account the dose constraints on target volumes and organs at risk for the entire treatment (table 1).

Table 1: Treatment plan with dosimetric constraints on target volumes and organs at risk

Statistics | Display

Structure	Volume (cm³)	Min. Dose (Gy)	Max. Dose (Gy)	Mean Dose (Gy)	Cold Ref. (Gy)	Volume < (cm³)	Volume < (%)	Hot Ref. (Gy)	Volume > (cm³)	Volume > (%)	% in Volume	Is in SS	Heterogeneity Index	Conformity Index
CTV 15	783.390	11.191	20.800	17.645				14.606	**775.556**	**99.00**	100.00	yes	1.35	
CTV 19.5	186.399	17.956	20.536	19.353				18.588	**184.535**	**99.00**	100.00	yes	1.07	
CTV T 10.5	2736.552	6.745	21.033	14.292				10.191	**2709.186**	**99.00**	100.00	yes	1.85	
Carbon Fiber	9404.307	0.000	0.000	0.000							99.76	no	1.00	
Coeur	187.032	0.809	15.867	8.582				**20.000**	0.000	0.00	100.00	yes	14.90	
Contour externe(Unsp.Tiss.)	4336.530	0.021	20.014	4.391							99.63	no	71.03	
Foam Core	7746.588	0.000	0.000	0.000							99.76	no		
Foie	617.076	9.535	20.681	13.022				**20.000**	8.086	1.31	100.00	yes	1.81	
ME	17.877	0.376	15.215	9.595				**30.000**	0.000	0.00	100.00	yes	26.37	
PTV 10.5	3097.053	3.175	21.033	14.131				10.556	**2942.200**	**95.00**	100.00	yes	1.87	
PTV 15	949.647	11.086	20.800	17.426				14.731	**902.165**	**95.00**	100.00	yes	1.36	
PTV 19.5	249.711	16.809	20.536	19.344				18.664	**237.225**	**95.00**	100.00	yes	1.07	
Poumon Droit	330.153	0.150	15.306	4.222				**15.000**	0.619	0.19	100.00	yes	38.91	
Poumon gauche	255.378	0.152	16.142	5.299				**15.000**	4.532	1.77	100.00	yes	58.07	
Rein droit	75.879	10.843	11.390	11.073				**12.000**	0.000	0.00	100.00	yes	1.03	
vertebres	134.037	9.670	18.856	12.889				**15.000**	25.095	18.72	100.00	yes	1.48	

During these 13 radiotherapy fractions, only grade I digestive toxicity like diarrhea was noted.

Discussion

Nephroblastoma is the most common kidney tumor in children and accounts for 6% of all pediatric tumors. More than 75% of patients are under 5 years old . About 25% of these tumors will undergo abdominal radiotherapy and / or metastatic sites .

Postoperative abdominal radiotherapy should be started within 14 days of surgery, as any delay in starting radiotherapy has an impact on overall survival . Performing this radiotherapy is complex, due to the consideration of preoperative tumor volumes and the movement of the abdominal organs postoperatively (3-6). In localized and lateralized forms, three-dimensional conformational radiotherapy with two opposing beams is a standard, and it has not been shown that three-dimensional conformational irradiation by multiple beams or even conformational radiotherapy with intensity modulation, is of benefit compared to irradiation with two antero-posterior beams, while the long-term sequelae of abdominal irradiation with a two-dimensional technique are low (3). In large pelvic or median forms of nephroblastoma and in case of pan-abdominal irradiation of the nephroblastoma as in our patient conformational radiotherapy with intensity modulation either by particle accelerator or by helical tomotherapy, and proton therapy may be recommended, for allow better protection of the remaining kidney, especially in the event of pan-abdominal irradiation, and the pericardium in the event of bi-pulmonary irradiation . However, a better definition of the target volumes by defining dose levels and a multiplication of the entry points for RC3D can make it possible to reduce the irradiation of the organs at risk, mainly the contralateral kidney, the pericardium and the vertebrae by a homogeneous distribution of the dose and reduction of the dose gradient of intensity modulated irradiations as well as the low dose problem, which could increase the theoretical risk of second cancer .A rigorous optimization of the three-dimensional conformational radiotherapy by a good delineation of the volumes of interest and a multiplication of the irradiation beams makes it possible to approach new radiotherapy techniques in terms of dose coverage, compliance with dosimetric constraints, especially in sub-Africa. -Saharan where the transition from two-dimensional to three-dimensional radiotherapy has just been completed (7-9).

Conclusion

Three-dimensional conformational radiotherapy remains a standard in adjuvant irradiation of localized forms of nephroblastoma and better optimization of this technique by careful delineation of target volumes and multiplication of beams in flank or abdomen irradiation in toto is required.

Conflicts of interest

The authors declare no conflicts of interest.

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