Development of Detachable IORT Table for Colorectal Cancer

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In spite of remarkable improvement of surgical skills and anesthesia, local failure still occurred in 36–45% of locally advanced colorectal cancer after curative resection with or without pre-or post-operative irradiation.

Intraoperative radiation therapy(IORT) is the ideal modality which resectable lesions are removed surgically and the remaining cancer nests are sterilized by irradiation during a surgical procedure. Therefore, the excellent local control without the damage of the adjacent normal tissues can be achieved.

In IORT, judicious set up of the treatment cone on the treatment surface of the patient is required for accurate and homogenous dose distribution within treatment field, especially on the slopping surface of sacrum and pelvic sidewall which are the common sites of the local recurrence in rectal cancer. For this purpose, adequate coordination of gantry rotation and table tilting are essential. Adjusting gantry rotation is not difficult but tilting of the table is impossible inconventional treatment couch.

Department of Therapeutic Radiology in Yeungnam University Medical Center developed the IORT table for colorectal cancer which is easy to set up and detach on the Linac treatment couch within 5 minutes. The range of tilting with head-up and head-down is about 30 degree which is efficient and easy-to-use, not only for IORT but also for colorectal surgery.

So far, authors performed IORT with newly developed treatment table in 2 patients with rectal cancer and we found that this newly developed table could contribute in improving the dose distribution of IORT and surgical procedure for colorectal cancer.

Key Words : Colorectal cancer, Detachable, tilting IORT table.

INTRODUCTION

Intraoperative Radiation Therapy (IORT) is the large, single dose of irradiation on the tumor bed directly during operation.

Abe[1] described that the benefits of IORT resulted from 1) direct visualization of the lesion, 2) accurate determination of the irradiated site, 3) physical removal of all or part of the dose-limiting normal organs from the treatment field, and 4) possible delivery of cancerocidal dose with less morbidity of normal tissue.

For the achievement of these benifits, accurate determination of the target volume is essential which cover all primary sites and possible tumor burden lymphnodes micro-and macroscopically.

To deliver homogenouse dose to the estimated target volume efficiently, exact adjustment of treatment cone on the surface of the target area and exact alignment of the beam axis through the treatment cone are required[2].

In IORT for colorectal cancer, target area is located usually in three-dimensionally slopping pelvic wall or sacrum, which is the most common site of local recurrence in rectal or rectosigmoid cancer. Therefore, very judiceous set-up of the treatment cone is important for homogenous dose distribution on the target areas. In addition, table tilting at least 20 degree up and down from horizontal plane is essential for convenient surgery of gantry rotation and table tilting with accurate beam axis through the treatment cone.

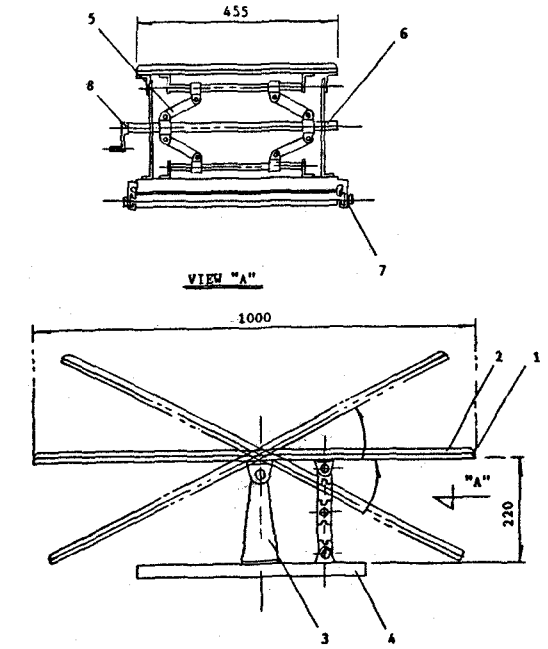
Gantry rotation is feasible in most treatment machine but tilting of the treatment table with head-up or head-down is impossible in Linac treatment couch.

Department of Therepeutic Radiology in Yeungnam University Medical Center has developed a IORT table which can tilt 30° with head-up or down and set-up or detach on the conventional treatment couch within 5 minutes. We can perform not only IORT exactly, but also colorectal surgery very easily without newly developed IORT table. We will describe the design and rationale of our IORT table.

MATERIAL & METHOD

From Sep. 1992 to Mar. 1993, Department of Therapeutic Radiology & Oncology in Yeungnam University Medical Center has developed simple, but very convenient IORT table which is useful not only for IORT but also for operation of colorectal cancer.

Table plate was made of 2cm thick bakelite (Fig. 1 #1). The mattress of the table top was made of 2cm thick sponge with leather cover to reduce the weight of IORT table as possible as we can(Fig. 1 #2). The size of the table is 455mm × 1000mm(width × length) and total



No	PARTS NAME	Q'TY	MAT'L	REMARK
1	TABLE	1	BAKLITE	
2	SEAT	1	LEATHER	
3	FRAME	1set	A6061	
4	BED	1	〃	
5	LINK ASSY	1set	〃	
6	SHAFT	1	SUS	
7	CLAMP ALLY	1set	A6061	
8	HANDLE	1	SUS	

Fig. 1. Design of the detachable IORT table.

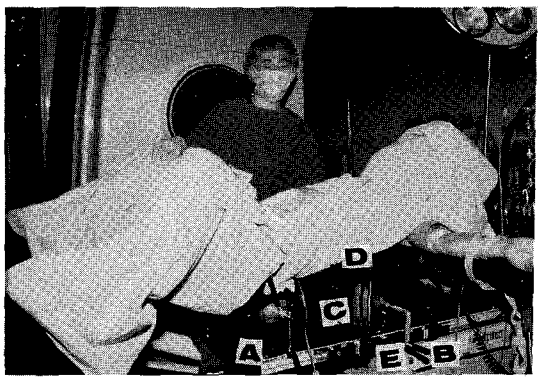


Fig. 2. Illustration of set-up & tilting of detachable IORT table with side-handle
A : Linac table
B : Tilting handle acid gear box
D : IORT table on Linac table
E : Cramping bolt

out table is about 45kg which does not break the horizontal balance of the treatment couch even though it is set-up on any side of distal part of the Linac treatment couch. Table tilting can be controlled by link assembly(Fig. 1 #5) which is operated by handle(Fig. #8 & Fig. 2 B) with shaft(Fig. 1#6). This table can be set-up and detached to the Linac treatment couch by 2 bolts on the specially designed side rails(Fig. 1 # 7 & Fig. 2 E).

RESULT

All set-up and detaching procedure of our IORT table could be performed quickly within 5 minutes by control of 2 bolts on the both side rails. The range of tilting is about 30 degree, which is enough for accurate adjustment of IORT cone with keeping exact beam axis on the 3-dimensionally slopping pelvic wall or sacrum by coordination of gantry rotation and convenient colorectal surgery. This tilting of the table is easily controlled by side handle without disturbing surgeon's activity.

Total weight of the our IORT table is about 45kg, which could keep horizontal balance of treatment couch. Lithotomy position during operation and IORT procedures could be kept without any difficulties with head-up or head-down tilting of the table(Fig. 2).

We performed IORT in 2 cases of rectal cancer without newly developed IORT table since last May, all members of IORT team are satisfied in performing IORT for colorectal cancer(Fig. 3) with our IORT table.

DISCUSSION

In spite of remarkable improvement of surgical skills, reported locoregional failure is still remained as 36-45% in B_3 or C_3 Modified Astler-Coller stages of rectal cancer even after pre- or post-operative radiation therapy[3]. IORT is proposed as an ideal modality which resectable lesions are removed surgically and remaining tumor nests are sterilized by irradiation during surgical procedure and results in better local control with minimal complications. we reported the excellent local control with comparable complication rate in IORT of gastric and colorectal cancer in other publications[4-6].

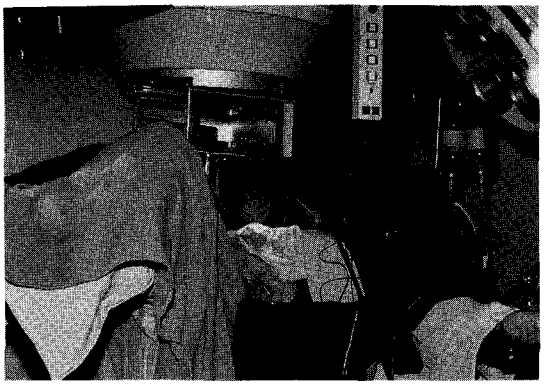


Fig. 3. View of IORT with detachable table.

For performing IORT with results, all procedure including operation and irradiation should be performed in one room, without moving the anesthesized patient[7]. If the anesthesized patient should move from the operating room to radiation treatment room, which most institutions used to, many disadvantages may not be avoid such as incorrect estimation of targeting area, unnecessary procedures for wound approximation and reopen, changing all operation linnen or equipments and anesthesia stress during patient's transportation even though the distance between operating room and irradiation room is very short.

Our department has been performed IORT in 69 patients since 1988. All process were performed on the treatment couch of Linear accelerator in Linac room. In our experiences of IORT, gastric cancer has no specific difficulties because target area is relatively flat. But in IORT of colorectal cancer, for performing operation itself, head-up and head-down tilting of the table at least 20° is required which is impossible by ordi-

nary Linac treatment couch. In area in rectal or rectosigmoid cancer is in usally 3 dimensionally slopped pelvic wall or sacrum, of treatment cone on slopping target area is very important because the treatment cone has 3 major roles such as 1) collimator of the electrons, 2) delineation of treatment volume, 3) function as a retractor for normal tissue by preventing normal tissue sliding in the treatment field by respiration or spontaneous movement especially in slopping surface of pelvic wall[8].

These suggested that good alignment of IORT cone is essential for accurate and homogenous dose distribution on the target area and adequate protection of normal tissue.

Willett et al.[9] reported that treatment cone is not enable good apposition to slopping surface in the pelvic wall even by bevelled end.

Jones et al.[2] observed that misalignment exceeding 1 degree from cone axis resulted in over 5% of dose difference in the field and he insisted that permitting alignment inaccuracy should be less than 0.3 degree.

Patta and Suntharalingam[10] emphasized that rotational accuracy should be kept within 0.5 degree difference for better dose uniformity in the treated volume. They also addressed that good alignment of cone could be achievable by gantry rotation and set up of the patient with modified operating table, and all those procedure should be precise and quick.

IORT cone which we developed is very handy and convenient for clinical use and reported in other publication[5,11].

But for operation of colorectal cancer and adjusting treatment cone to slopping surface of pelvic wall or sacrum are very difficult, because tilting of the table with head-up or head-down is impossible in conventional Linac treatment couch, At first for solving these problem, we tried to use the ordinary operationg table, but adjusting SAD or SSD was impossible because of the limited height of the table. In addition, cephalad, caudad, and bilateral shifting of the table could not be possible, this precluded exact performance of IORT.

From Sept. 1992 to Mar. 1993, we developed IORT table which can be tilted 30 degree with head-up and down. This table can be easily set up and detached on the conventional Linac treatment couch by only 2 bolts within 5 minutes. Total weight of the IORT table is 45kg which keep the horizontal balance of treatment couch. Lithotomy position of the patient can be easily set up without disturbing surgeon's activity.

So far, we performed 2 cases of IORT in rectal cancer with newly developed IORT table and we cannot find any inconvenience in performing IORT with this table. We have a confidence that our newly developed table can be contributed to perform IORT for colorectal cancer in near future.

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=국문초록=

장착-탈거 및 경사각 조절이 가능한 대장직장암의 수술 중 방사선 치료대의 개발

영남대학교 의료원 치료방사선과 생의공학과*

김 명 세 • 이 준 하*

연구목적 : 국소재발을 줄이면서 합병증을 최소화하기 위한 방법으로 제안된 수술중 방사선 치료(IORT)는 육안으로 치료 범위를 확인 할 수 있는 이점이 있으나 조사 선축의 각도와 치료과 치료면의 거리 등이 조금만 틀려도 조사야의 선량에 차이가 있을 뿐 아니라 조사방사선의 동질성(Homogeneity)에도 영향을 미치게 된다. 직장암의 경우 조사 부위가 대부분에서 3차적인 경사면을 가진 골반벽이 됨으로 치료 cone의 정확한 Set-up은 적절한 gantry의 회전과 치료대(treatment couch)의 tilting이 조화되어야만 가능하다. gantry의 회전은 어느 기계에서나 가능하나 치료대의 tilting은 대부분에서 불가능함으로 영남대학교 의료원 치료 방사선과에서는 상하로의 tilting이 30°까지 가능할 뿐 아니라 기존 치료대에 장착과 탈거가 5분이내에 쉽게 될수 있는 치료대를 개발하기 위함.

재료 및 방법 : IORT 치료대는 2cm 두께의 bekelite로 2cm 두께의 sponge를 leather로 싸서 수술대에 피나 기타용액이 스며들지 못하게 하였고 전체의 무게가 45kg을 넘지 않도록 하여 치료대의 양끝에 장착할 경우, 치료대의 수평이 유지되도록 하였다. 상하 경사각은 30°를 유지토록 하였고 lithotomy position에서도 side handle을 사용하여 경사각 조절이 가능토록 하였다.

결과 및 결론 : 1992년 9월부터 1993년 3월까지 여러번의 수정을 거친 후 대장 직장암의 IORT에 사용하고 있으며, 3차원적인 골반벽에의 정확한 접근(approach)이 가능할 뿐 아니라 기존 방사선 치료대에 장착과 탈거가 5분 이내에 가능하며, 상하 경사각 30° 정도로의 조절이 수술이나 마취에 전혀 영향을 주지 않는 상태에서 자유로이 조절 되므로 향후 대장직장암의 IORT에 크게 공헌할 수 있을 것으로 사료됨.

주요단어 : 장착과 탈거, 경사각 조절, 대장-직장암, 수술중 방사선 치료(IORT).