Remote Afterloading Hish Dose Rate (HDR) Endobronchial Brachytherapy

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Authors described the remote afterloading endobronchial brachytherapy (EBBT) technique using the microSelectron HDR Ir-192 and the Asan Medical Center experience. Total 28 EBBT in 9 patients were performed since November 1989 and 24 EBBT in 8 patients were emploiyed for palliation and 3 EBBT in 1 patient was treated curatively. Authors observed a significant relief of obstructive symptom with tumor regression in 7 patients out of 8 who were treated palliatively but one of them died of pulmonary congestion in 3 weeks after EBBT. One patient with prior therapy of extensive electrocautery expired within 1 day after 2nd EBBT procedure with massive hemorrhage from the lesion. EBBT procedure has been tolerable and can be performed as an out-patient.

Key Words: HDR, EBBT, Lung CA

INTRODUCTION

Airway obstruction by central tracheobronchial tumor presents serious morbidity and deterioration in the quality of life. Kernan described the implantation of radon seeds into the endobronchial tumor through a rigid bronchoscope in 1933 and concluded that this was an effective treatment for this new disease entity[1]. The incidence and mortality rates of lung cancer have risen steadily and nowadays this is the leading cause of cancer death. In the wake of laser surgery and flexible bronchoscope in 1980s, controlling airway obstruction by tumor became more interesting issue and low dose rate, manual afterloading brachytherapy was utilized in the early 1980s[2,3].

With the availability of higher activity iridium-192 source and computer controlled remote afterloading brachytherapy system, HDR-EBBT has become widespread over the past 5 years[4~8]. In this paper, authors described the technique for EBBT and reviewed our experience.

MATERIALS AND METHODS

Indications for EBBT included the palliative and curative patients; symptomatic patients from the endobronchial cancer documented by bronchoscope and biopsy who failed the conventional radiotherapy, for palliative EBBT and potentially curable, unresectable lung cancer with small intrathoracic extrabronchial disease for curative EBBT that is given as a boost after conventional radiotherapy.

A total 28 EBBT procedures were performed in 9 patients for one year. 8 patients were treated palliatively and one patient curatively.

The age range of the patients was 29 to 77 years with a mean of 59 years. There were 6 males and 3 females. All of them had the histology of squamous cell carcinoma and two of them had the primary of the tracheal cancer. Karnofsky performance scale ranged from 80 to 30 at the time of EBBT. All patients underwent the bronchoscopic assessment to evaluate the feasibility for EBBT. Olympus flexible bronchoscope was employed under sedation and topical anesthetics.

1. Procedures and Technique for EBBT with Microselectron-HDR Iridium-192

1) The procedure is explained to the patient and NPO is instructed after midnight on the day prior to the procedure.

2) The bronchoscope and placement of the endobronchial catheter are performed under cardiac monitor and pulse oximeter. They can be performed in the bronchoscopy suite or in the simulator room with portable bronchoscopy unit.

3) Personnel involving the procedure include the pulmonologist, radiation oncologist, nurse and fluoroscopy technologist.

4) The patient is premedicated with demerol 50

mg I.M. and atropine 0.5 mg I.M. and kept the vein open with D5W.

5) Lidocaine viscous 2% spray is used for topical anesthesia, two to three puffs to the oropharynx for transoral approach, to the nostril for nasal approach. 1% lidocaine and 0.25% bosmin 1~2 cc can be used in the tracheobronchial tree for topical anesthesia during the bronchoscopy procedure.

6) Olympus BF-1T20 or BF-2T10 flexible bronchoscope is used and for afterloading applicator, 5 or 6 French (inner diameter 1.7 mm, 2.0 mm respectively) 100 cm long, teflon catheter is used depending upon the curvature of the treatment and availability of the bronchoscope; iridium source can run better in 6F catheter at extreme curvature and BF-2T20 can not accommodate 6F catheter.

7) Under direct visualization, the tip of the bronchoscope is placed preferably at the distal aspect of tumor but the catheter in the biopsy channel of the bronchoscope can be pushed beyond the tumor to assure the distal margin of the treatment. The guidewire is inserted in the lumen of the catheter which is introduced through the biopsy channel of the bronchoscope and then, the bronchoscope is slowly withdrawn, simultaneously feeding the catheter through the channel so that the distal end seen under fluoroscopy, remains static in the lung. The guidewire serves as an extension length of the catheter because the length of catheter is not long enough to enable the bronchoscope to be withdrawn over it without losing the end.

As the tip of the bronchoscope emerges from the nasal cavity or oral cavity, the catheter is grasped and held in position until the bronchoscope is completely removed. Then the catheter is taped to the nose or perioral area to prevent movement at the proximal end. To assure the catheter position, the bronchoscope is reintroduced if the fluoroscopy is not avilable in the bronchoscopy suite and the position of the catheter is fluoroscoped in the simulator.

8) To stabilize position of the catheter in the lung, the distal end of catheter can be anchored by pushing to the point of wedging but patient complaines of chest pain and there is the risk of puncture. We found the movement of catheter is nil if it is taped properly and handled carefully and we recommend not to wedge the catheter.

9) Dummy sources are inserted into the catheter and orthogonal simulation films are taken and define the treatment volume. The treatment window can be programmed anywhere within the last 27 cm of the catheter with 48 dwell positions (if dwell interval of sources are 0.5 cm, maximum 23.5 cm can be treated within 27 cm from the distal end of the catheter for HDR-microSelectron). Actual length of catheter from the unit indexer is measured with check ruler which has to be less than 995 mm because the source travels maximum 995 mm from the indexer of the unit.

10) Nucletron planning computer can optimize the dwell position and dwell time of the sources to fit the isodose curve in the target volume and store the treatment data on the program card which is used to program the microSelectron.

11) Position the patient comfortably in the EBBT room and adjust the position and height of the head of the unit to connect the catheter to the proper channel of the unit. The microSelectron cannot send out the source unless the catheter is correctly connected with proper fit-connector.

12) Program the microSelectron by using a pro-

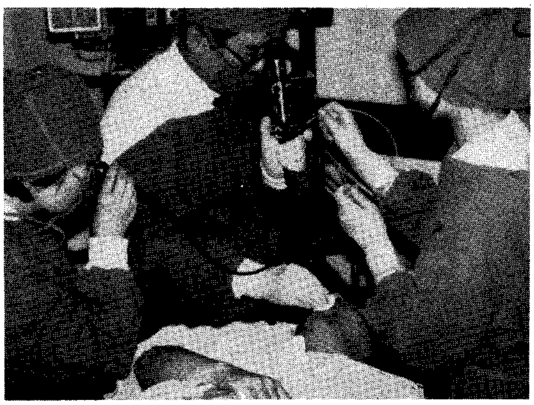


Fig. 1. Introduction of a catheter through the biopsy channel of the bronchoscope.

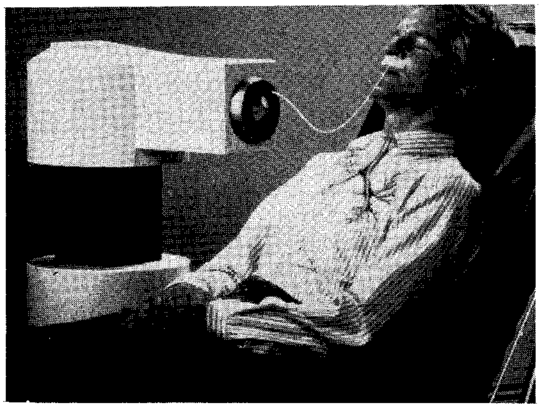
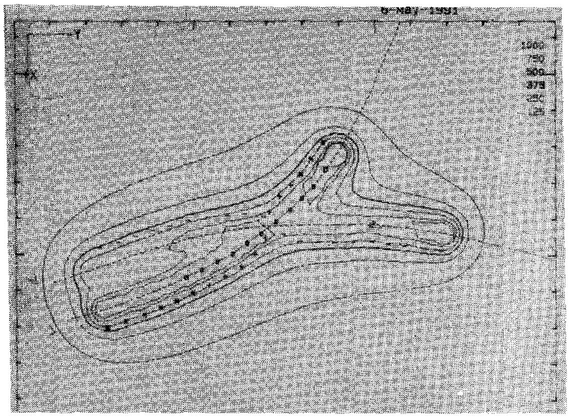


Fig. 2. Photograph of the microSelectron-HDR Ir-192 with a simulated patient undergoing EBBT.



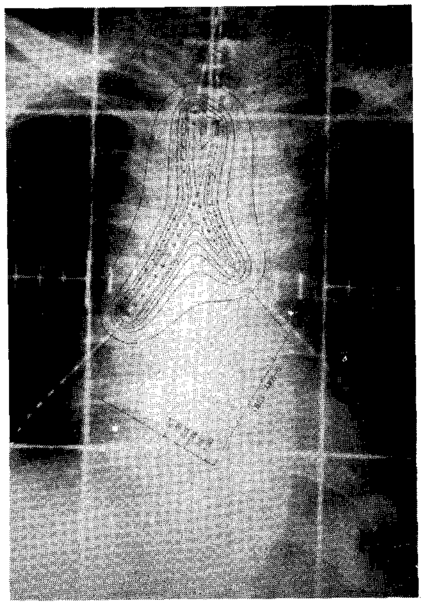


Fig. 3. Isodose curves and superimposed on a simulation film showing an endobronchial catheter and dummy sources.

gram card and check the program printout for dose per position, number of positions and position numbers.

13) Start the treatment and monitor the patient with audio/visual monitor and inform the patient often the progression of the treatment. When the start button is pressed on the control unit, the unit automatically carries out a check for any obstructions in the catheter before starting treatment.

14) Disconnect the catheter from the unit and remove the catheter from the patient. Monitor the patient for 30 minutes and discharge the patient home or patients room with next appointment for further EBBT or follow-up.

2. Asan Medical Center Experience

1) Curative EBBT

One patient who had a tracheal cancer with mediastinal lymphadenopathy was treated. Because of severe obstruction in the trachea, Neodymium-YAG laser surgery was performed twice and external beam therapy 60 Gy in 7 weeks was given. Mediastinal disease was regressed and follow-up bronchoscope showed fragile mucosa without any apparent tumor. EBBT 15 Gy in 3 fractions in 1 week (5 Gy/fraction at 0.5 cm depth from the source, 6 cm long target volume) was treated for a boost. Bronchoscopy was repeated in 14 months after completion of radiotherapy when she developed mutiple peripheral lung nodules and biopsy was taken from the area of the scarring and fragile mucosa but no tumor cell was found. She has been on chemotherapy and there is no evidence of local recurrence in 21 months.

2) Palliative EBBT

One and two catheters were used in 16 EBBT and 9 EBBT respectively and dose was prescribed to 5 Gy at 0.5 cm from the source in 20 EBBT, 8 Gy at 0.5 cm in 4 EBBT and 5 Gy at 1.0 cm in 1 EBBT Treatment time ranged from 1.5 minutes to 15 minutes depending upon the activity of the source and target volume.

7 patients out of 8 showed a significant relief of obstructive symptom and regression of the mass. The end point of theapy was the complete regression of lesion or maximum 10 fractions of EBBT with total dose 50 Gy but none of them achieved complete regression of the lesion. All of them completed EBBT prematurely except 1 patient who received 50 Gy in 8fx. One patient who showed a brief improvement right after 1st EBBT, declined the performance and refused 2nd EBBT, died of pulmonary congestion in 3 weeks after treatment. One patient with prior therapy of extensive electrocautery expired within 1 day after 2nd EBBT procedure with massive hemorrhage from the lesion.

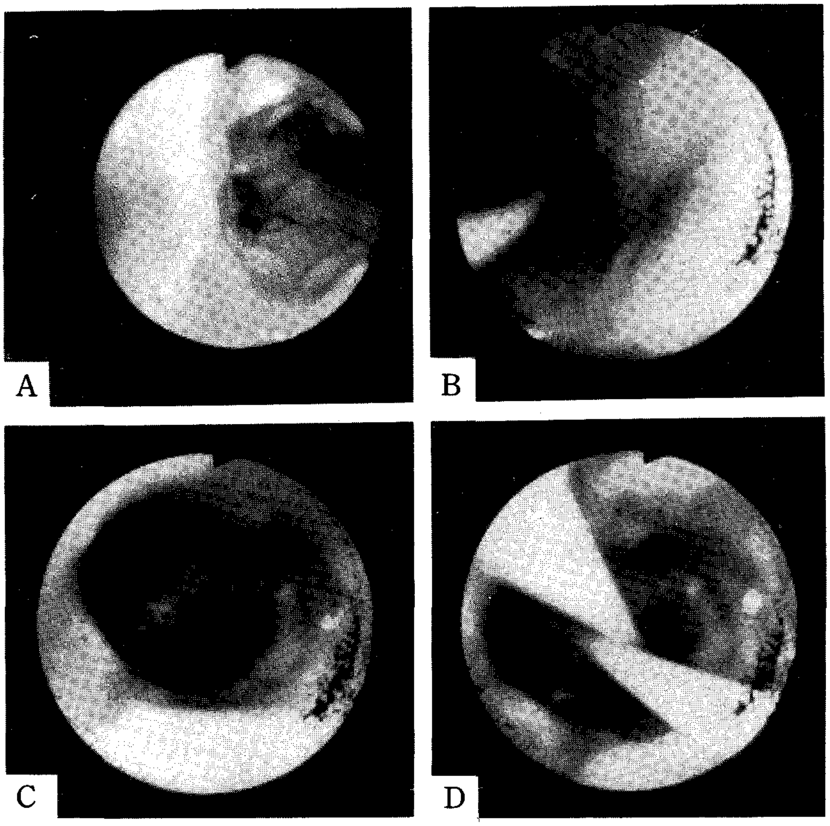


Fig. 4. Bronchoscopic views;

A. View of carina, pre-therapy: extensive fungating tumor obstructing left main bronchus completely.
B. Catheter positioned in the right main bronchus.
C. View after 4th EBBT-left main bronchus is partially open. There is considerable tumor regression.
D. Two catheters positioned in the right and left bronchus.

Table 1. Literature Review for HDR–EBBT and/or Nd–YAG Laser Therapy :

Reference	Treatment	Number of patients	Mean survival	Maximum survival
Speiser & Spratling (1989)[9]	EBBT	45	220 days	365 days
Kohek et al (1990)[10]	Nd–YAG+EBBT	81	234 days	16 months
Schray (1989)[11]	EBBT	40		
Schray (1989)	Nd–YAG+EBBT	61		
Miller & Phillips[12]	EBBT	67		120 days
Miller & Phillips	Nd–YAG+EBBT	21		120 days
Macha & Koch (1990)[13]	Nd–YAG+EBBT	188		7.5 months
Sutedja (1990)[14]	EBBT	34		
Stout (1990)[15]	EBBT		48% alive at 6 month 22% alive at 12 month	

DISCUSSION

Table 1 shows the literature review of the results of HDR-EBBT using EBBT alone or combined with Nd-YAG laser surgery[9~15]. Even though endobronchial brachytherapy has its limitations for the extrabronchial disease, EBBT can successfully treat endobronchial disease and significantly improve survival time and quality of life. Investigators report an 80%~85% of palliation rate but lack of standard means to document the response and toxicity in their reports, prevent any detail analysis for the efficacy of different dose schedule and dosimetry prescription.

Considering the patient comfort, safety factor for the operator and excellent control of radiation dose and treatment volume, remote afterloading HDR-EBBT has an advantage over the low dose rate brachytherapy. But this is a new technology and needs new radiobiologic principle for time and dose schedule. Large body of clinical data have been available lately but without standardization of dosimetry prescription, comparisons between various treatment schedules are exceedingly difficult. Higher dose per treatment and higher total dose appear to increase the complication of bronchial stenosis, fistula and hemorrhage in the literature where investigators report 3~4% complication rate. We have not observed any bronchial stenosis after treatment.

We need to follow these patients longer but we feel that our dosimetry prescription, 5 Gy per treatment at 0.5 cm from the source is well tolerated and may need to increase the dose per treatment by prescribing at 1.0 cm from the source. Authors plan to develop the dose seeking protocol starting from 5 Gy at 1.0 cm from the source, escalating the dose per treatment to 6 Gy, 7.5 Gy, 10 Gy for total dose of 30 Gy.

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＝국문초록＝

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기관지 폐색으로 호흡곤란을 유발하는 기관지내 악성종양을 치료하기 위한 방사선 치료방법으로 고선량 기관지내 근접치료법이 본원에서 시행되었다. 기관지 내시경 시술을 이용하여 근접치료용 관을 기관지 내로 삽입하며 microSelectron HDR Ir-192를 이용하여 고선량 근접치료를 시행하였다. 이 논문에서 저자들의 경험을 소개하고 이 새로운 근접치료 시술이 효과적이면서도 외래 환자로 통근치료도 가능할 정도로 용이하고 안전한 치료법으로 자세한 기술적인 점을 설명하고자 한다.