*Review Article*

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# Anesthesia for Brachytherapy: A Review

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**Abstract**

Radiotherapy is a commonly employed and an important modality of treatment for cancer with about 50 % of the patients receiving radiotherapy during their course of treatment.[1] Two major categories for the application of radiation are external beam radiation and brachytherapy.[1] Brachytherapy is derived from the greek word brachys meaning "short distance".[2] Brachytherapy is administered by inserting a radiation source inside a specific cancer site which needs anesthesia, analgesia and muscle relaxation. The theory behind brachytherapy is to deliver low intensity radiation over an extended period to a relatively small volume of tissue covering the tumour area and sparing the surrounding normal tissue. The demand for anesthesia in brachytherapy is increasing nowadays. Anesthetic management is crucial because it poses a number of challenges for the anesthesiologist. Patients for brachytherapy are often elderly and are high risk patients with multiple co morbidities, brachytherapy for head and neck malignancy may pose the problem of difficult airway, to achieve a stable position of the applicators and implants immobilization is essential.[3] Brachytherapy often has an unpredictable procedural duration. Transportation of the anesthetized patients to different radiological suite is a typical challenge.[3] Various modalities of anesthesia employed include general, spinal, combined spinal epidural anesthesia and local anesthesia with sedation. Anesthesiologist play a major and an important role in the ongoing challenge to provide an optimal treatment conditions for brachytherapy.

**Keywords:** Anesthesia; Brachytherapy; Radiotherapy treatment for cancer.

## Introduction

Radiotherapy is a commonly employed and an important modality of treatment for cancer with about 50 % of the patients receiving radiotherapy during their course of treatment.[1] Two major categories for the application of radiation are external beam radiation and brachytherapy.1 Brachytherapy is derived from the greek word brachys meaning "short distance".[2] Brachytherapy is administered by inserting a radiation source inside a specific cancer site which needs anesthesia, analgesia and muscle relaxation. The theory behind brachytherapy is to deliver low intensity radiation over an extended period to a relatively small volume of tissue covering the tumour area and sparing the surrounding normal tissue. The demand for anesthesia in brachytherapy is increasing nowadays. Anesthetic management is crucial because it poses a number of challenges for the anesthesiologist. Patients for brachytherapy are often elderly and are high risk patients with multiple co morbidities, brachytherapy for head and neck malignancy may pose the problem of difficult airway, to achieve a stable position of the applicators and implants immobilization is essential.[3] Brachytherapy often has an unpredictable procedural duration. Transportation of the anesthetized patients to different radiological suite is a typical challenge.[3] Various modalities of anesthesia employed include general, spinal, combined spinal epidural anesthesia and local anesthesia with sedation.

Anesthesiologist play a major and an important role in the ongoing challenge to provide an optimal treatment conditions for brachytherapy.

*Indications*[4,5]

***Radical Radiation***

1. Skin malignancies( BCC, SCC)
2. Head and neck malignancies.
3. Carcinoma cervix.
4. Carcinoma prostate.

***After Surgical Excision with Cancer Chemotherapy***

1. Head and neck malignancies
2. Carcinoma breast
3. Carcinoma Esophagus
4. Carcinoma Anal canal.

***Postoperative***

1. Carcinoma endometrium
2. Carcinoma cervix
3. Carcinoma breast

***Palliative***

1. Bronchogenic carcinoma
2. Biliary duct malignancy
3. Carcinoma cervix
4. Recurrent tumours.

*Patient Selection*

The appropriate selection of patients determines the key success to brachytherapy treatment. Patients with multiple co morbid conditions who have specific considerations and relative contraindications are not considered ideal candidates for brachytherapy. Alcohol dependence, electrolyte abnormalities, neurological deficits, poor cardiopulmonary reserve, poor mentation, anemia, thrombocytopenia are certain co morbidities which pose real anesthetic challenges which may prolong post operative recovery[2] and preoperative optimization and other modalities of treatment should be offered to the patient. Patients should be explained about the procedure preoperatively and should be taught about self careneeds to be given by themselves including feeding through nasogastric tube, tracheostomy stoma care etc. uncontrolled diabetes, hypertension, vascular disorders and end stage liver disease are certain conditions associated with bone and soft tissue complications after an implant. Also the location of the tumour, extent of the tumour, size and function of the organ are also to be evaluated for the appropriateness of the treatment. Any tumour eroding the bone is considered as contraindication for brachytherapy because of potential risk of osteoradionecrosis.[6] Similarly radiotherapy for very large tumour may not also be feasible because of the poor coverage of the tumour while placing implants and catheters.

*Different Types of Brachytherapy*

1. *Based on the duration of implant*

Temporary- dose is delivered over a short period of time and the source are removed after the prescribed dose has been reached. The duration of treatment will depend on many factors including rate and dose of delivery, type and location of the tumour. Most of the brachytherapy treatments are temporary.

Permanent – also known as seed implantation. Involves placing small LDR radioactive seeds, or pellets in the tumour or treatment site or leaving them there permanently to gradually decay. Eg. Prostate seed implants

2. *Based on the source position*

Interstitial- the sources are placed directly in the target tissue of the affected site, such as prostate or breast.

Contact- involves placement of the radiation source in a space next to the target tissue.

Intracavitary- a body cavity such as cervix, uterus or vagina.

Intraluminal- such as the trachea or oesophagus

Surface- externally such as the skin

Intravascular- blood vessels.

*3. Based on the dose rate*

Low dose rate (LDR)- emit radiation at a rate of 0.4-2gy/hour. Commonly used for cancers of the oral cavity, oropharynx, sarcomas and prostate.

Medium dose rate (MDR) characterized by a medium rate of dose delivery, ranging between 2-12gy/hour.

High dose rate (HDR)- when the rate of dose delivery exceeds 12gy/hour.

Pulsed dose rate (PDR)- involves short pulses of radiation typically once an hour, to stimulate the overall rate and effectiveness of LDR treatment.

**Table 1:** Sources of Radiation[4,5]

| Symbol | Half Life | Energy | Availability | Others |
|---|---|---|---|---|
| Cesium$^{137}$cs | 30.17 yrs | 0.662 mev | Encapsulated in a stainless steel sheaths most widely used for gynaecologicl cancers | |
| Cobalt$^{60}$co | 5.26 yrs | 1.17 mev | In the form of wire encapsulated in a sheath of platinum | Available as pellets also |
| Iridum$^{192}$ir | 30.17 yrs | 73.8 days | Available in the form of seeds for LDR | Also used in the form of a wire. |
| Iodine$^{125}$i | 59.6 days | 35.5 mev | Only available as seeds. They are usually inserted in the tumour volume using special delivery guns. | Only Used for permanent implants |

Brachytherapy sources are usually encapsulated contacting radioactivity, providing source rigidity, absorbing any alpha and for photon emitting sources. Sources stores must provide protection against environmental conditions, be only for radioactive materials, provide sufficient shielding, be resistant to fire and be labelled. (Table 1)

*Preoperative Assesment*

Careful and detailed present history, history of previous illness, associated comorbidities, drug therapy, radiation, chemotherapy, previous surgery,anesthesia complications and drug allergy are very important. A thorough physical examination of all the systems should be done. All patients for head and neck brachytherapy may have fibrosis of the tumour region due to previous radiation or surgery and all such patients coming for every sitting of brachytherapy are considered as difficult airway and should be assessed each time since the chance of fibrosis and necrosis may get worsened with each radiation. Airway examination including mallampati grading, lacation of trachea, presence of stidor guide the anesthesiologist in deciding about the plan of anesthesia.

*Investigations*

Preoperative investigations include Hemoglobin, Random blood sugar, Platelet count, Chest xray, ECG, Urine examination. Elderly patients with co morbid conditions needs to be investigated with liver function tests, renal function tests and pulmonary function test and echocardiogram.

*Non Operating Room Anesthesia Objectives (Nora)*

Understanding that the standards of anesthesia care and patient monitoring are the same regardless of location.

- To remember that the key to efficient and safe remote anesthetic management relies on open communication between the anesthesiologist and non-operating room personnel.
- Realize that remote locations have different safety concerns, such as radiation and powerful magnetic fields.

***Special problem of NORA***

- Limited working place, limited access to the patient,
- Use of outdated ,old equipment with minimal or no maintenance service
- Less familiar with the management of patients
- Lack of skilled personnel, drugs and supplies.

*ASA Guidelines*[7]

a reliable oxygen source with backup

a suction source

waste gas scavenging

sufficient space for the anesthesia care team

- adequate monitoring equipment to meet the standards for basic anesthetic monitoring
- emergency drugs, and other emergency equipment
- a self-inflating hand resuscitator bag
- a means of reliable two-way communication to request assistance
- sufficient safe electrical outlets
- compliance of the facility with all applicable safety and building codes
- adequate patient and anesthesia machine illumination with battery- powered backup
- Appropriate postanesthesia management should be provided.

- emergency cart with a defibrillator
- Adequately trained staff to support anesthesia team

*Equipments Check (Soapme)*[8]

S (suction) – Appropriate size pre sterile disposable suction catheters and functioning suction apparatus.

O (oxygen) – Reliableuninterrupted oxygen source with a functioning flowmeter. At least one spare E-type oxygen cylinder for back up In case of central supply failure.

A (airway) – Size appropriate airway equipment:

P (pharmacy) – Basic drugs needed for life support

Drugs both for anesthesia and emergency drugs.

during emergency:

- Epinephrine (adrenaline)
- Atropine
- Glucose
- Naloxone (reversal agent for opioid drugs)
- Flumazenil (reversal agent for benzodiazepines)
- Hydrocortisone
- dexamathasone
- ephedrine
- furosemide
- iv fluids(crystalloids and colloids)

M (monitors):

- Pulse oximeter
- NIBP
- End-tidal CO2 (capnography
- Temperature(oropharyngeal, rectal and surface probes)
- ECG

E (equipment):

- Defibrillator with paddles

*Others Equipments*

Gas scavenging

- Safe electrical outlets (earthed)
- Adequate lighting (torch with battery backup)

*Anesthetic Techniques*

1. *Carcinoma Cervix:* Brachytherapy for ca cervix plays a pivotal role and is mainly applied as an intracavitary procedure in selected cases complimented by interstitial implants. Tumours which are confined to the cervix can be subjected to hysterectomy and patients who are unfit for surgery can be treated with radiotherapy.[9] For a long term many centers used the cervical slit sleeve which had a plastic tube drainage with holes that is inserted through cevix into uterus and sutured with the sleeve the cervix is dilated which is designed for fractionated treatment and remains in place throughout the course of treatment.[10] Intracavitary applications are temporary that are left in the patient for a specified time to deliver prescribed dose and is generally carried out as an outpatient procedure. General anesthesia, epidural or spinal anesthesia, consious sedation, paracervical block are various anesthetic techniques that are increasingly being applied. The advantage of the regional anesthesia over general anesthesia is that it can be continued as post operative analgesia and can be used for patients coming for multiple sittings. Disadvantage includes hypotension, multiple punctures, technical difficulties etc. the advantage of TIVA over other choices of anesthesia is that it can be done for patients coming on outpatient basis. The etiology of pain in a patient with cancer cervix coming for brachytherapy can be attributed to many. Due to the presence of applicators or rods in the uterine cavity the $T_{10}$-$L_1$ sympathetic 9 fibres are stimulated causing pain. Cervical dilatationand vaginal distension stimulates the parasympathetic fibres $S_2$-$S_4$ causing lower back pain. Packing of the vagina and its retaining suture through the labia stimulates afferents via the pudendal nerve of $S_{2\text{-}4}$. Patients may have an indwelling urinary catheter and discomfort may be aggrevated while moving. Inhalational anesthesia with nitrous oxide can be given to relieve discomfort of the applicant attachment or removal. Systemic opiods may also be given as patient controlled analgesia. Conscious sedation with fentanyl, midazolam or dexmedetomidine. Since it's a form of gynaecological procedure it is associated with increased incidence of PONV. NSAIDS can also be used as a part of multimodal approach to post operative analgesia. Recently two methods have been described which curtails repeated anesthesia for subsequent treatments.

First an indwelling cervical sleeve is inserted under anesthesia which remains in situ to allow subsequent introducation of uterine applicators without exposure to anesthesia. Secondly an osmotic dilator can also be used to dilate the cervix 10-12hrs before the insertion of the applicator.

2. *Head and Neck Implants:* Patients airway must be assessed preoperatively during each visit coming for head and neck brachytherapy or implant placement since they can pose airway problems due to prior radiation, or surgery causing fibrosis of the area. They may also have disease related malnutrition and chemotherapy related nausea, vomiting.[11] Neck movements might be restricted and everytime the airway has to be examined. Emergency airway crash cart should be kept ready. Patients should be preoxygenated, premedicated, induced and endotracheal intubation can be done. Some patients might require tracheostomy preoperatively. Nasogastric tube should be inserted and oropharyngeal packing is to be done. Eyes should be protected and maintenance can be achieved with oxygen, nitrous oxide, volatile agents and relaxants. Analgesia and airway should be given meticulous attension. Extubation is to be done after the patient is fully awake. Recently mental nerve blocks are being performed for high dose interstitial brachytherapy over the lip.
3. *Breast Implants:* These procedures are usually carried out under general anesthesia with either placement of a supraglottic airway device or endotracheal intubation while maintaining with oxygen, nitrous oxide, volatile agents and relaxants. Adequate postoperative analgesia is to be taken care of. Alternatively the procedure can also be done under pec 1(LA injection between pectoralis major and minor at 3rd rib level blocking the medial and lateral pectoral nerve) and pec 2 block(LA injection between pectoralis minor and serratus anterior at 3rd rib level)[12] with sedation which allows the advantage of continuation of postoperative analgesia and avoiding the complications of general anesthesia.Paravertebral blocks or thoracic epidural are also alternative approaches for anesthetizing such patients.
4. *Prostate Surgery:* The procedure can be carried out under TIVA with mask ventilation, spinal, epidural, combined spinal and epidural, local infiltration and pudendal nerve block.

Till date spinal or general anesthesia has been the standard of care. For the convenience of the patient the placement of the implants days the procedure is being carried out under subcutaneous infiltration and also the pelvic floor and prostate apex by infiltration.[13] When the needle tip reaches the prostatic base further infiltration is done in the intraprostatictrack.

## Conclusion

The successful anesthetic management of patients scheduled for brachytherapy needs careful, cautious planning and preparation of equipment and availability of vital signs monitors in addition to preoperative assessment and optimization and plan for individualized tailored anesthesia. Adequate intraoperative and postoperative analgesia should be given meticulous attention. Post procedural monitoring also is mandatory for the successful outcome.

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