

REVIEW ARTICLE

# THREE-DIMENSIONAL PERIOPERATIVE HIGH DOSE RATE INTERSTITIAL BRACHYTHERAPY IN SOFT TISSUE SARCOMA IN MODERN ERA

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## ABSTRACT

*Soft tissue sarcomas (STSs) are a typical group that differs from one of the tumours with distinct histopathological subtypes. It is estimated in 21% of all malignant diseases in children, and less than 1% of all adult malignancies [1]*

*Adjuvant radiation is well-established for the conservative treatment of soft tissue sarcomas.*

*The National Cancer Comprehensive Cancer Network guidelines recommend that postoperative radiotherapy be administered to most patients with sarcomas of the soft tissues of the extremities and upper extremity. When only low-dose (LDR) brachytherapy (BT) is used, 45-Gy doses are used in patients with severe oedema. In cases where margins are positive, a combination of 50 Gy beam radiotherapy (EBRT) and 16-20 Gy of LDR brachytherapy or equivalent high-dose rate (HDR) is warranted. This range of radiation concentrations produces a five-year cell control rate of 75-90% [3 - 14].*

*LDR brachytherapy has been a frequently used method [15 - 23], and reports of high-dose (HDR) brachytherapy are very small in number [24 - 27]. However, HDR brachytherapy is widely used due to better compliance with radiation safety policies, more complex radiation planning and the possibility of outpatient treatment.*

*Keywords: Soft tissue sarcoma, Perioperative Brachytherapy*

**INTRODUCTION:** BT is the best form of conformal radiotherapy. With a planned increase in volume, the central hypoxic nucleus acquires a larger dose that indicates the harmony in context to dose painting within the target tissue while sparing the organs at risk. This minimally invasive procedure provides an excellent standard of treatment for STSs treatment. Catheters implants are usually inserted during surgical removal of the lesion, allowing for the insertion of a catheter aimed at covering of the target site and protection of vulnerable organs.

BT studies are short and convenient for patients. The limitations of BT in the treatment of sarcomas are usually in very large target volumes, a restriction on catheter placement due to organs at risk and of exposure to nerve leading to nerve damage.

**AIMS & OBJECTIVES:** The aim of the study is to review brachytherapy guidelines and study the importance of brachytherapy in treatment of soft tissue sarcoma in current era with emerging radiation techniques.

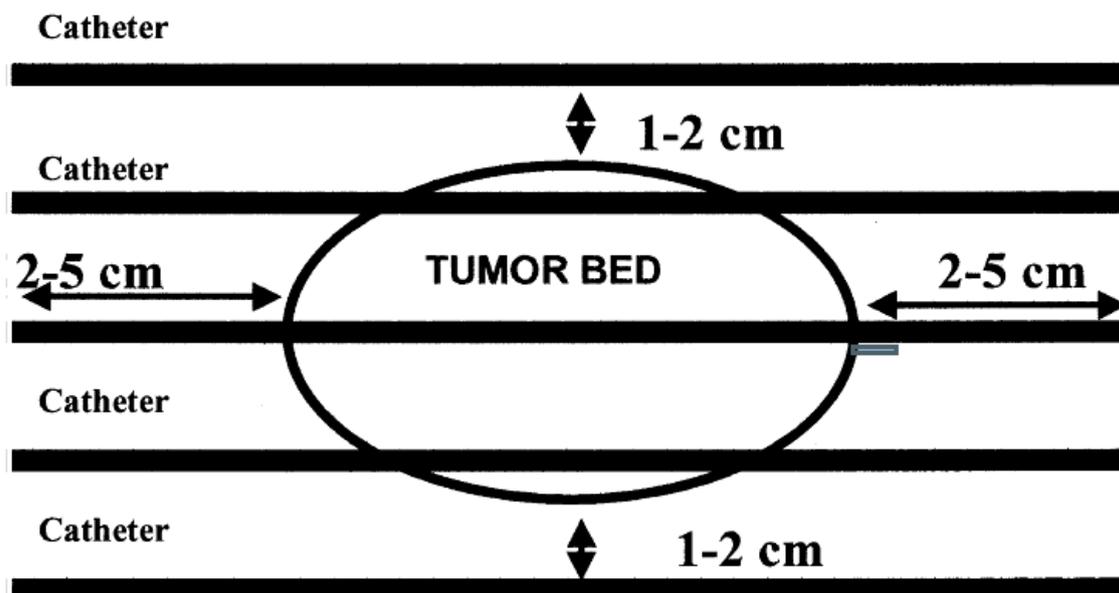
**MATERIALS & METHODS:**

**INDICATIONS:** BT is indicated as monotherapy in which the tumor is at an advanced grade, completely excised, smaller than 10 cm in dimensions with an even post-operative tumor bed. BT is combined with EBRT in all other cases.

**PROCEDURE:** Brachytherapy is usually performed as an intraoperative (HDR-intraoperative radiation therapy [IORT]) or postoperative background. The most common method used for STSs treatment is to place internal BT catheters during surgery by radiation oncologist as the tumor is well defined during surgery and the location of common sensitive structures is under adequate visibility placement geometry. The placement of radio-opaque clips has proven to work for defining organs at risk.

**TARGET VOLUME:** should include a surgical bed and a margin. The sites of the scar and drain are usually not included. There is a consideration of 2 cm craniocaudal margin and 1-2 cm radial margin by STS BT.

**CATHETER PLACEMENT:**



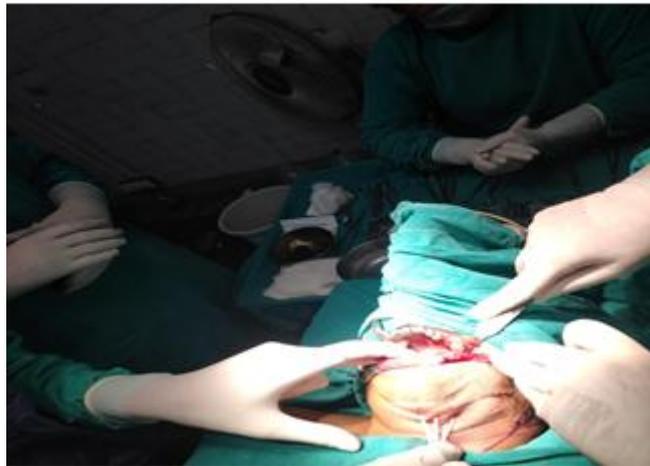
**Fig1: Catheter placement for single plane implant**

The implants transmit through hollow needles to the skin and soft tissues. The distance from the incision to the entrance of the catheter should be at least 1-2 cm.

Single plane fittings can be used if there is complete removal of the tumor (R0 / R1) and fascial plane barriers certify omission of deeper catheters. The capacity of the target volume

and the number of catheters depends on the size and location of the target. A single plane installation usually requires closer space than several installations.

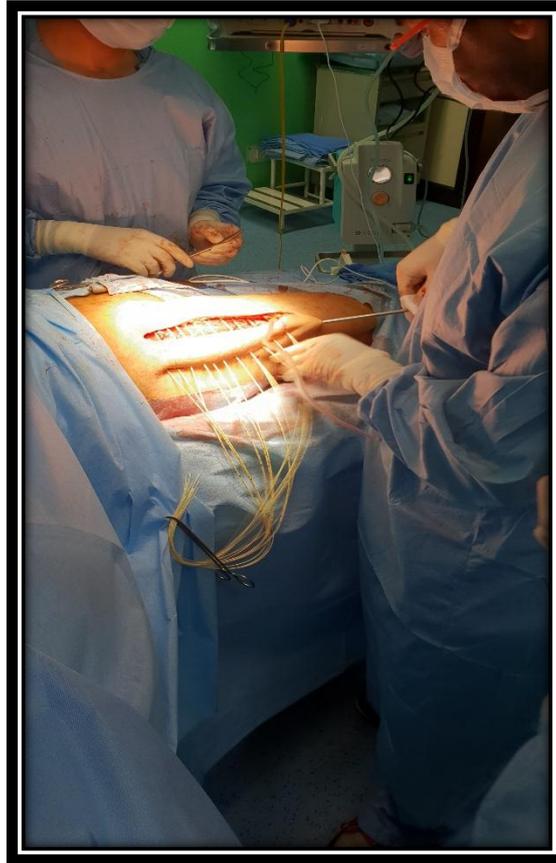
Catheters can be installed parallel or perpendicular to incision site. Catheters and planes are placed at intervals of 1-1.5 cm to ensure adequate dosimetry. Accurate catheter positioning is important for treatment and dosimetry. Wound closure can also affect geometry with greater mobility, so it should be done to keep in mind the satisfaction of the clinic-directed volume (CTV).



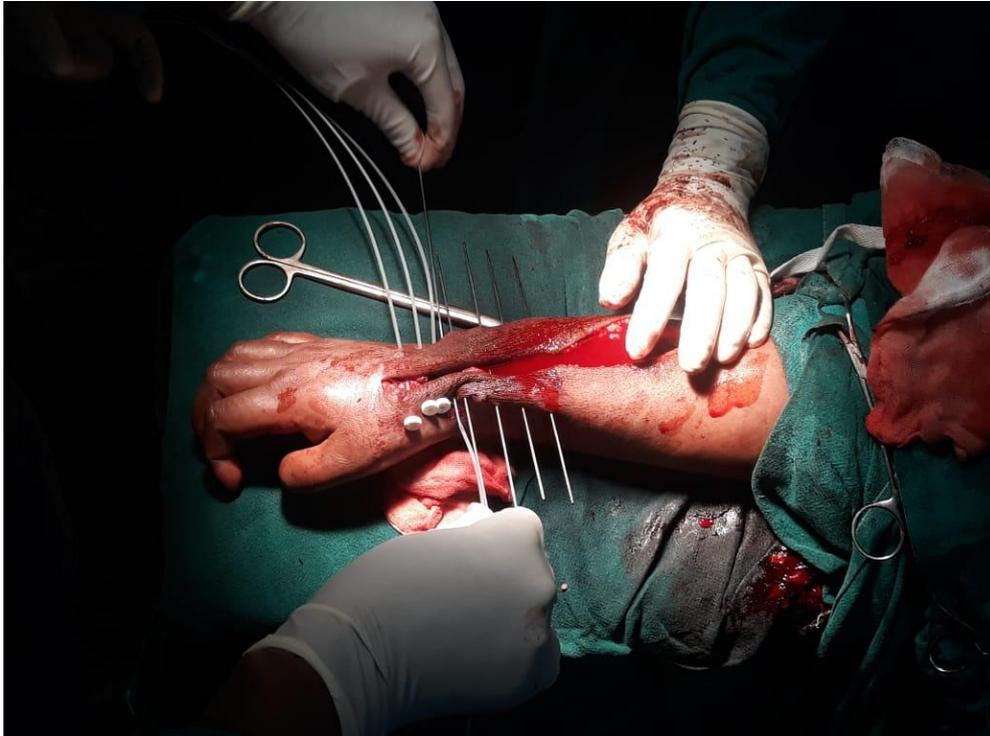
**Fig 2: Interstitial catheters, GGSMCH**



**Fig 3: interstitial catheters insertion in head and neck sarcoma, GGSMCH**



**Fig 4: Interstitial brachytherapy catheters being positioned, GGSMCH**

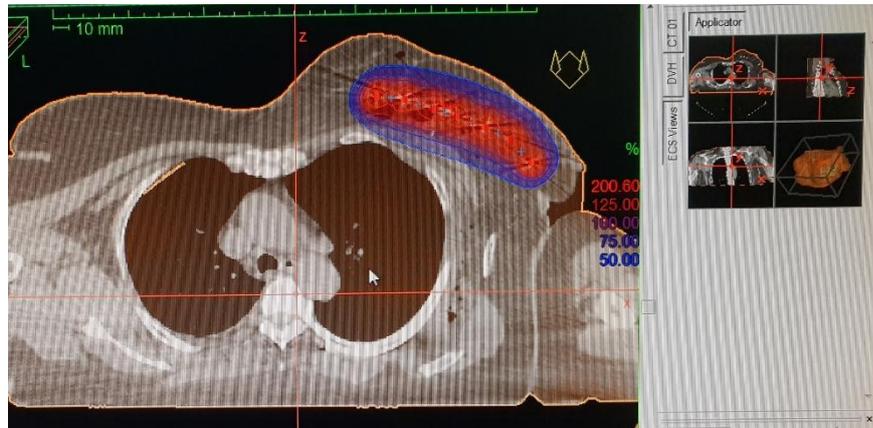


**Fig 5: Interstitial brachytherapy catheters being positioned, GGSMCH**

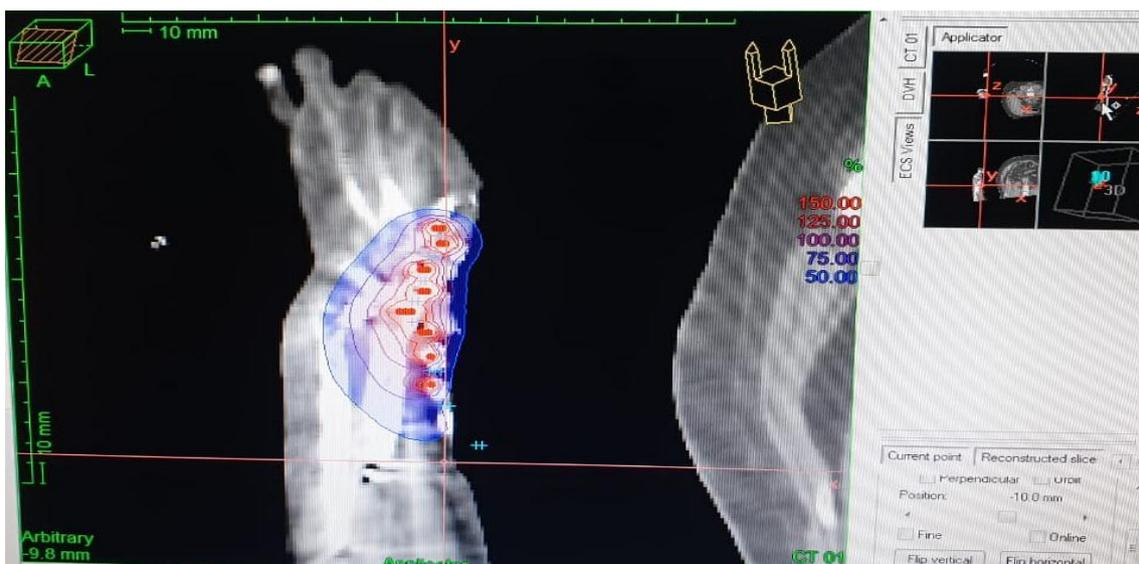
**SIMULATION AND DOSIMETRY:** CT simulation is the current standard of BT dosimetry for sarcomas. It is a three-pronged approach to planning. Opaque radio clips placed during surgery guide the process of making a CTV. In BT CTV and planning treatment

volume are equivalent. Normal tissue volume limits are represented as volumes in various volumes - D0.1cc, D1cc and D2cc. Radiation quality is rated as D90.

**Fig 6: Planning being done with interstitial catheters in situ, GGSMCH**



Efforts should be made to reduce the dose in the surgical incision to less than 100% doses unless it is considered as a high risk for tumour positivity at the margin. The volume on the skin should not exceed two thirds of the prescribed dose.



**Fig 7: Planning being done with interstitial catheters in situ, GGSMCH**

**TREATMENT DELIVERY:** treatment can be given as LDR or HDR BT. The durability and stability of the implanted catheters should be verified daily during the delivery of treatment. Post-BT complications should be carefully evaluated such as bleeding, scar dehiscence or infection as this requires a repeat of the treatment delivery. It is recommended 5 days to go through wound healing before starting treatment according to the American BT society.

**CATHETER REMOVAL:** all aseptic safety measures must be followed when removing the catheters.

**DISCUSSION:**

BT significantly improves local tumour control while reducing normal tissue dose, which translates into significant improvements in short term and long-term duration toxicity. Brachytherapy or “internal radiotherapy” is another form of accurate treatment, especially with the use of high-dose rate (HDR) techniques. A key strength of HDR brachytherapy is the ability to adapt the dose based on clinical characteristics, such focally increasing the dose to areas of highest concern of residual disease (e.g., close margins) while avoiding excess dose to normal structures (e.g., neurovascular structures) [28] Brachytherapy is a therapeutic approach, applicable to STS, with studies highlighting their benefits in improving local control with orthopaedic limb preservation surgery [29] Current guidelines describe its use in postoperative and intra-operative conditions, using the interstitial approach.

The local recurrence of sarcoma is primarily within the radiation field, [30] suggesting that most cell populations which remain to or recur after radiotherapy are primarily radioresistant. This difference in a / b ratio compared to other diseases gives the opportunity for hypo fractionated RT for increasing BED. Hypo-fractionated EBRT has been successfully described in preoperative [29,31–2] and postoperative setting [33]. Brachytherapy is also usually hypo fractionated (3-4 Gy twice a day) and allows for higher doses near catheters (e.g., a bed of implants), bringing BED to more than > 150% of the dose to small radioresistant cell pockets, which accelerates the killing of sarcoma cells.

In children, the amount of radiation to normal tissues can have long-term effects on growth and development. In paediatric sarcoma, there is evidence that BT monotherapy has local control similar to EBRT-BT, making BT monotherapy the preferred treatment option in this category [34 - 36].

A higher percentage of STS is found in the limbs (~ 50%) or superficial trunk (10-15%) [37]. With the transition to organ preservation, WLE and adjuvant RT have become the preferred treatment option. There is evidence that STS treated with adjuvant BT improved local control in the latter compared to non-extremity, trunk or shoulder STS [19, 38 - 9].

Retroperitoneal sarcoma accounts for approximately 15% of STS [37]. Given the proximity of retroperitoneal sarcoma to OARs, finding clear surgical marriages can be difficult. A Phase II study has shown that patients treated with EBRT and BT after surgery have a higher rate of Grade 4 toxicity (21%) and postoperative mortality (10%) within three months of surgery. These severe toxicities were limited to patients who received an increased dose escalation of BT in the upper abdomen [40]

Less than 10% of sarcomas are found in the head and neck [37]. Like all STS, surgery is the major treatment. However, WLE can be complicated in sarcomas in the head and neck due to their proximity to important anatomic structures [41]. Even during IMRT era, BT continues to play an important role in the treatment of head and neck cancer. LDR BT has historically been the " gold standard " for the internal radiation of head and neck cancer. Currently, there has been an increase in HDR BT showing local control in head and neck cancer along with toxic effects similar to LDR BT.

In cases of recurrence, Re-irradiation with adjuvant BT can save exposure of normal tissues to high doses, which may provide a lower rate of wound dehiscence than adjuvant EBRT alone. When adjuvant EBRT-BT treatment is given, re-radiation should be performed only after surgery with a new vascular tissue graft closure (i.e., free rotation / flap), which can

reduce the adverse after effects of radiotherapy in the previously exposed tissue and reduce toxicity [42].

**CONCLUSION** Brachytherapy is the quintessential component in the treatment of STS with data that supports the use of adjuvant BT to improve disease control following local resection. The use of BT monotherapy provides effective methods of saving normal tissue, suitable for high-grade localised diseases, re-radiation or paediatric categories. Combined with EBRT, BT enhancement provides a local control benefit for patients at high risk of recurrence (> 10 cm, recurrent, or close margins). It is important that the radiation oncologist and the surgeon work together to ensure accurate volume coverage and catheter placement with better odds for controlling and reducing toxicity.

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