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Review

Multicatheter interstitial brachytherapy for breast cancer

Curiethérapie interstitielle du cancer du sein

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ABSTRACT

Brachytherapy remains the best irradiation technique to deliver a high dose in a small volume. Breast brachytherapy is part of the arsenal of therapy in the management of breast cancer. In this article, we present the technical data related to multicatheter interstitial brachytherapy to the breast proceeding, from the implantation of the vectors to the treatment itself. The indications for brachytherapy in breast cancer are boost after whole breast irradiation, accelerated partial breast irradiation or selected patients with second ipsilateral breast tumor event. The results in terms of efficacy and toxicity are presented for each indication. Multicatheter interstitial breast brachytherapy remains a major technique for breast cancer treatment.

Mots clés :
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Surimpression
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RÉSUMÉ

La curiethérapie reste la meilleure technique d'irradiation pour délivrer une dose élevée dans un petit volume. La curiethérapie mammaire fait partie de l'arsenal thérapeutique dans la prise en charge du cancer du sein. Nous présentons dans cet article les données techniques relatives à la curiethérapie interstitielle du sein, allant de l'implantation des vecteurs jusqu'au traitement lui-même. Les indications de la curiethérapie dans le cancer du sein sont le complément d'irradiation du lit tumoral après l'irradiation totale du sein, l'irradiation partielle et accélérée et le second traitement conservateur lors d'une rechute homolatérale. Pour chaque indication, les résultats en termes d'efficacité et de toxicité sont décrits. La curiethérapie interstitielle mammaire reste une technique primordiale pour le traitement du cancer du sein.

1. Introduction

Breast cancer is by far the most common cancer in women worldwide with an estimated 1.67 million new cancer cases diagnosed in 2012 (25% of all cancers) [1]. Brachytherapy, the implantation of radioactive sources in a body cavity or tumor, is perhaps "the most conformal type of radiation treatment" as reported in a recent issue of the *New England Journal of Medicine* [2]. Breast brachytherapy is part of the arsenal of therapy in the management of breast cancer.

Brachytherapy is a local treatment therefore with local perspectives. In patients with early breast cancer who undergo breast-conservative surgery and receive radiation therapy to the whole breast, a boost to the tumor bed reduces the risk of local recurrence [3,4]. Indeed, brachytherapy by allowing dose escalation has been shown to be a good option for the boost to the tumor bed with excellent local control and cosmetic results [5].

Furthermore, accelerated partial breast irradiation using multicatheter brachytherapy after breast-conservative surgery is as effective as adjuvant whole breast irradiation for carefully selected patients with early breast cancer [6]. It is an attractive treatment

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strategy, not only to shorten the course of radiation therapy from 3–7 weeks to 2–5 days but also to very effectively reduce radiation exposure to the breasts, the skin, the lungs and the heart.

In addition, in case of ipsilateral breast tumor recurrence after a previous radio-surgical conservative treatment a second breast conservative treatment combining salvage lumpectomy and post-operative reirradiation using interstitial implants is possible. It is an alternative to mastectomy and has been shown to be feasible and effective in preventing second local recurrence with an overall survival rate at least equivalent to those achieved with salvage mastectomy [7]. Multicatheter interstitial brachytherapy is not only the oldest method with the longest follow-up time but it is obviously an extraordinary precise, versatile and variable treatment method [8]. This article will focus on multicatheter interstitial brachytherapy techniques and indications.

2. Technical points

2.1. Catheter insertion

According to the Paris System, a square or triangular arrangement is reasonable [9] (Fig. 1). Perioperative insertion allows an easier positioning of the catheters. Postoperative insertion allows on its side a better determination of the clinical target volume with a pre- and postimplant treatment planning ideally [10,11]. However, each brachytherapy team will decide the type of implant according to their own environment (Table 1).

2.2. Target definition and delineation

Surgical clips are needed to properly determine the target volume. A CT scan is acquired for treatment planning. It begins with the determination of an estimated target volume taking into account initial imaging (mammography, ultrasound, MRI), the scar, the position of the clips and the importance of surgical margins. The clinical target volume is defined as estimated target volume plus corresponding total safety margins it means 20 mm minus surgical margin, but at least 10 mm (Fig. 2). The thoracic wall and the skin (usually a thickness of 5 mm) must not be a part of clinical target volume. For the planning target volume, no additional margin is necessary if the tumor bed and clips are clearly visible. In case of uncertainties, additional margins of 5 to 10 mm can be delineated [12,13].

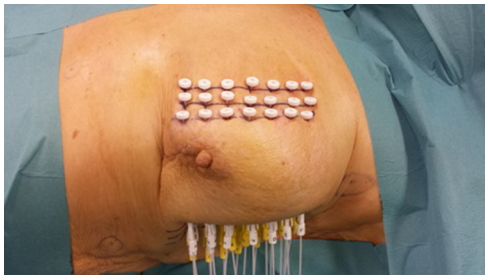

Fig. 1. Multicatheter interstitial brachytherapy techniques for breast cancer: catheter insertion.

Table 1
Multicatheter interstitial brachytherapy techniques for breast cancer: criteria for implants selection.

Criteria	Perioperative	Postoperative
Patient's comfort	General anesthesia	Local anesthesia
Duration of maintenance of catheters	10–15 days	4–5 days
Radiotherapist's comfort	General anesthesia	Local anesthesia
Clinical target volume determination	+	+++
Modification of the indication	+	+++
Catheters insertion	+++	++

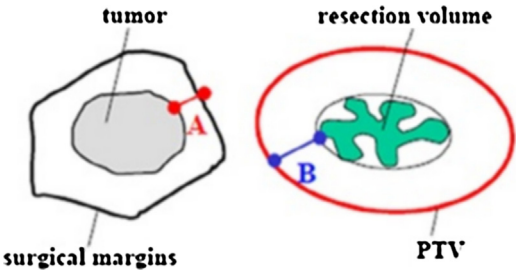

Fig. 2. Multicatheter breast interstitial brachytherapy: schedule of estimation of safety margins [12]. A. Minimal resection margin. B. Safety margin, > 20 mm minus A. PTV: planning target volume.

2.3. Dosimetry

In order to select an appropriate isodose for which a certain absolute dose value should be prescribed, the dose distribution has to be uniquely normalized. The dwell times are calculated on the basis of volumetric dosimetric constraints. In high-dose rate or pulsed-dose rate, geometric optimization for volume implants should keep the dose non-uniformity ratio (V100/V150) below 0.35 (0.30 ideally) [6]. The planning target volume that receives 100% of the prescribed dose must be greater than 90% (coverage index $\geq$ 0.9), with a V150% (volume receiving 150% of the dose prescribed) less than 30% and a V200% (volume receiving 200% of the prescribed dose) less than 15% with a dose non-homogeneity ration (V150/V100) < 0.35 (0.30 ideally). The maximum acceptable dose to the skin should be less than 70% of the prescribed dose.

2.4. Treatment

Depending on the dose rate used, the treatment can be done in an outpatient in a bunker (high-dose rate) or hospitalization in a radioprotected area (pulsed-dose rate). Dose and fractionation depends on indication.

Removal of catheters is painless and requires no anaesthesia but must be performed under strict aseptic conditions. Local treatment care must be performed and a follow-up should be done at one month and then every 6 months.

3. Indications

3.1. Boost after whole breast irradiation

After conservative surgery, a whole breast irradiation followed by a boost to the tumor bed significantly improve local control rate [3,4]. Brachytherapy is a good option for the boost with excellent local control and cosmetic results. In the study of the European Organization for Research and Treatment of Cancer, where nearly 10% of patients had brachytherapy as a boost technique, 2.5% of recurrences were observed after brachytherapy against 4.7% after electron irradiation and 4% after photon irradiation, but the difference was not significant. Cosmetic results are excellent/good in 80% of patients [14].

Recommendations have been edited by the Groupe Européen de Curiethérapie de l'European Society for Radiotherapy and Oncology (GEC-ESTRO) for patient selection [15].

Many schedules exist, for example for high-dose rate brachytherapy 2 × 4–6 Gy, or 3 × 3–5 Gy scheduled twice per day, with an interval between fractions of at least 6 hours, and a total treatment time of 1 to 2 days, or a single fraction of 7 to 10 Gy. For

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