CT-Guided Brachytherapy (CTGB) versus Interstitial Laser Ablation (ILT) of Colorectal Liver Metastases

An Intraindividual Matched-Pair Analysis

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Purpose: To compare local tumor control after percutaneous tumor ablation by interstitial laser therapy (ILT) or CT-guided brachytherapy (CTGB).

Patients and Methods: In a matched pair analysis including 18 patients with 36 liver metastases of colorectal primary, both ILT and CTGB were performed in different lesions. The following matching factors were considered: (i) tumor size \(\leq 5\) cm, and (ii) execution of chemotherapy after tumor ablation. Primary endpoint was local tumor control.

Results: Treated lesions were identical in terms of tumor size and all matching criteria were fulfilled in all patients except for the performance of adjuvant chemotherapy. Median follow-up was 14 months (3–24 months) for both groups. Only five of 18 patients (28\%) demonstrated local tumor progression after CTGB, whereas in ten of 18 patients (56\%) tumor progression was found after ILT. Differences encountered were significant for all patients (\(p = 0.04\)), whereas in those who fulfilled all matching criteria (\(n = 14\)) the level of statistical significance was not reached (\(p = 0.23\)).

Conclusion: CTGB demonstrated superior local tumor control compared to ILT in long-term follow-up.

Key Words: CT-guided brachytherapy · Interstitial laser therapy · Liver

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**Introduction**

In recent years, percutaneous image-guided tumor ablation has evolved as a genuine alternative for the treatment of liver metastases of solid tumors [3, 9, 17, 26]. However, a size limitation of approximately 5 cm, adjacent large vessels or hyperperfusion of tumors responsible for adverse cooling effects, and location close to the liver hilum are disadvantages of thermal ablation [1]. CT-guided brachytherapy (CTGB) has overcome these limitations with promising results not only in liver tissue [6, 7, 10, 16, 20, 23–25, 28]. Currently, no clinical data is available comparing the effectiveness and local control (vs. time to progression) of these local tumor ablation techniques.

**Patients and Methods**

**Patient Identification**

18 patients (twelve men, six women, median age 66 years, range 49–82 years) with 36 metachronous liver metastases fulfilled the inclusion criteria with (i) solitary metastasis of colorectal primary at the time that each treatment was performed, and (ii) different time points for each treatment. 13 patients had received prior chemotherapy (first-line, n = 6, 33%; second-line, n = 5, 28%; third-line, n = 2, 11%). Twelve patients were treated with interstitial laser therapy (ILT) first and six with CTGB. The median time interval for the appearance of the second lesion was nearly equal for both groups (ILT = 10.6 months, CTGB = 8.9 months).

**Interventional Technique**

The technique of CTGB has been described in detail elsewhere [19] and was preferred for metastases located near large vessels or liver hilum. In short, the applicators were positioned under CT fluoroscopy followed by a single-dose irradiation of an iridium-192 source of 10 Ci using the high-dose-rate afterloading system.

The technique of ILT has also been described in detail [17, 26] and was preferred for metastases located in the liver periphery without contact to large vessels. In short, applicators were positioned under CT fluoroscopy followed by thermoaulation with a neodymium-yttrium-aluminum garnet laser with a wavelength of 1,064 nm monitored with thermosensitive GRE MRI sequences (TE/TR 3.9/102; flip 70°).

**Outcome Variables and Definitions**

All patients received follow-up MRI 3 days, 6 weeks, and every 3 months after tumor ablation as described previously [15, 19]. Local control after CTGB or ILT was defined by (i) absence of symmetric lesion growth (≥ 25% of the tumor volume) at any time during follow-up, and (ii) absence of asymmetric tumor growth in the vicinity of the treated lesion at any time during follow-up. Any new tumor with a center of mass ≤ 10 mm apart from the contour of the formerly treated lesion was considered local recurrence.

**Matching Factors**

In addition to the criteria given above, we considered the following matching factors per individual patient: (i) tumor size ≤ 5 cm, and (ii) execution of chemotherapy after tumor ablation. Previous authors identified 5 cm as a threshold for successful thermal ablation, although CTGB has proven feasibility also in larger tumor volumes [18, 26].

**Statistical Analysis**

The Wilcoxon test was employed to compare both treatment groups. The Kaplan-Meier method along with the log-rank test was applied for local control curves. To avoid potential bias resulting from unequal follow-up time, all patients with local tumor control > 2 years were censored at this point.

**Results**

**Patient Identification**

Among all patients 14 of 18 fulfilled all matching criteria. In four patients tumor size exceeded 5 cm for either ILT or CTGB (Table 1). However, the distribution of tumor size among all tumors treated by ILT or CTGB was identical (p = 0.8; CTGB: 3.8 cm, 1.0–6.0 cm, median 4.0 cm; ILT: 3.4 cm, 1.8–5.8 cm, median 3.2 cm), and all patients demonstrated full match in terms of performance of adjuvant chemotherapy (Table 1). There was one metastasis > 5 cm treated by ILT (technical limitation) which showed no recurrence in the follow-up period.

**Complications**

Complications after CTGB comprised pain (n = 3), dyspnea (n = 1), nausea (n = 1), and pleural effusion (n = 1). No major complications were recorded. Minor complications after ILT comprised pleural effusion (n = 2), pain (n = 2), subcapsular liver hematoma (n = 1), nausea and vomiting (n = 1). Again, no major complications were observed.

**Follow-up**

The median follow-up after initial intervention was 14 months (3–24 months) for both ILT and CTGB. Five of 18 patients demonstrated local tumor progression after CTGB. According to the Kaplan-Meier method local tumor control was 87%, 80%, and 72% at 6, 9, and 12 months, respectively. Local tumor progression after ILT was observed in ten of 18 patients. According to the Kaplan-Meier method local tumor control was 73%, 44%, and 36% after 6, 9, and 12 months, respectively (Figure 1).

**Statistical Analysis**

Differences encountered between local control after CTGB or ILT were significant for all patients (Figure 1; p = 0.04). In patients displaying full match, a significance level was not reached (Figure 2; p = 0.23).