The role of image guided ablation in the management of metastatic colorectal cancer

This special issue compiled of 10 selected articles describes the role of thermal ablation in the management of metastatic colorectal cancer with emphasis to liver and lung metastases and in the setting of oligometastatic disease. Finally, it provides a framework for future applications.

**Thermal ablation as local cure for colorectal liver metastases**

Although metasectomy for hepatic and lung colorectal metastases has historically been considered the preferred local therapy for selected patients with CRC metastases, image-guided ablation can be used as an alternative local therapy with similar oncologic outcomes to surgery and minimal risk for patients with limited volume and small size tumors [1]. Current guidelines recommend the use of thermal ablation as a single therapy or in combination with surgery in the treatment of limited hepatic or pulmonary metastases, as long as all visible disease can be eradicated [1]. A small randomized controlled trial (RCT) provided level one evidence about the positive impact of Radiofrequency ablation-RFA(-+hepatectomy) on patient survival, when used in addition to oxaliplatin based chemotherapy vs. Chemotherapy alone in patients with initially unresectable CRC hepatic disease [2]. Several papers from different investigators have shown that thermal ablation of CRC liver metastases (CLM) is indicated as a local cure for relatively small tumors (ideally smaller than 3 cm) when located in relatively peripheral location where ablation can create margins all around the target tumor. Most papers indicate that a 5 mm minimal margin is the absolute minimal requirement for acceptable tumor control, whereas a 10 mm margin seems to offer optimal local control. A 10 mm margin practically eliminates the risk for local failure or local tumor progression (LTP) [3–7]. It has also been shown that margin assessments are challenging and that 3D software operates best for margin detection [8–9]. A dedicated paper describing the use of a 3D software in the assessment of the ablation zone (AZ) by Vasiniotis Kamarinos N et al. [10] discusses in detail all issues related to the AZ assessments by 3D software platforms. Paolucci et al. [11] provide further in-depth information with their paper on Volumetric Analyses of Ablation Dimensions in MWA for CLM.

Assessments of the AZ with biopsies, fluorescent stains and metabolic imaging have also been described [12–15]. Biopsy proven complete ablation with minimal margin of 5 mm can provide local control similar to optimal minimal margin over 10 mm [12–14]. Results of complete ablation with margins are similar to those reported by limited hepatic resection [3–7,9,12–15]. The role of thermal ablation as a local curative therapy for CLM with relevant literature is discussed in the paper by Odioso et al. [16].

Non-thermal ablation options including irreversible electroporation (IRE), Yttrium 90 radiation segmentectomy and image-guided radiotherapy are also presented, and their emerging role in the treatment of CLM is discussed [16,17]. Irreversible electroporation and its role in the treatment of CLM are discussed in detail in the paper of Narayanan R et al. [18] and Yttrium 90 radioembolization in the dedicated paper by Lewandowski et al. [19]. A detailed description of Stereotactic Body Radiation Therapy (SBRT) for CLM is authored by Hosni Abdalaty A et al. and provides a comprehensive review of the available evidence of SBRT in the setting of oligometastatic disease [20]. Recent developments with the use of metabolic imaging including real-time FDG-PET in the treatment of CLM are presented in a dedicated paper by Hunt S et al. [21].

**Thermal ablation in the management of CRC pulmonary metastases**

Ablation has been increasingly used as a local therapy in the treatment of small pulmonary metastases providing long-term disease control similar to resection and with minimal toxicity [22–25]. Outcomes of Thermal ablation (TA) have been reported after RFA [26], microwave ablation-MWA [22,23] and cryoablation [24,25]. Several publications indicate that smaller tumor size is associated with best local tumor control [22–24,26] and that ablation minimal margin of at least 5 mm is an important factor for local tumor control [23]. There is currently no definite maximum number of tumors that is a contraindication to local therapy. However, it is generally accepted that a small number (arguable 3–5 per lung) of relatively small metastases (arguably under 3 cm and ideally under 1.5 cm) are good indication for local therapy including TA [22–25]. Repeated ablation has been used to treat oligometastatic disease in the lung to provide long-term disease control with minimal risk and no long-term impact on pulmonary reserve. Ablation has been shown to be safe, even when repeated treatments are required as well as in patients with limited pulmonary reserve. Repeated TA presents a significant advantage of ablation over other local therapies especially in the metastatic setting, where subsequent metastases and repeated local therapy are likely [22–25,27,28]. The emerging role of repeated ablation provides disease control while extending the chemotherapy-free interval and better quality of life [23,28].

The role of ablation in the management of oligometastatic CRC in the liver and lung as well as in less common sites is discussed [29,30]. Concepts, expectations and outcomes of ablation in these different settings are described and discussed, summarizing available evidence [29,30]. deBaere et al. provide a comprehensive review on the role of ablation in the oligometastatic setting in patient with CRC and hepatic and pulmonary metastases [31], whereas Thompson et al. elaborate on the role of ablation for CRC oligometastatic disease in extrahepatic and extrapulmonary sites [32].
Antenna designs to improve safety and efficacy of thermal ablation

A final paper by Phannensteil et al. [33] focuses on performance and limitations of current microwave applicators currently used for thermal ablation. Emerging antenna designs with capability of controlling radial power deposition may enable better coverage of target volumes while protecting nearby normal tissues from thermal damage.

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