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Matsumoto, DRM; Facina, G.

Corresponding author:
Danielle Matsumoto

danielle_rmartin@hotmail.com

Author Affiliation:
Hospital Israelita Albert Einstein.

ADMINISTRATIVE INFORMATION

Support - None.

Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 10 October 2024 and was last updated on 10 October 2024.

INTRODUCTION

Review question / Objective We aim to assess the studies published to date and identify appropriate methodological and patient selection parameters to optimize results with laser ablation in stage I breast cancer. Additionally, we aimed to analyze whether this method is a viable alternative to current surgical treatments.

Rationale Breast cancer is the most prevalent form of malignant cancer among women globally. An estimated 2.3 million new cases were reported worldwide in 2023 .Advancements in screening technologies and improved accessibility have facilitated the detection of breast cancer at earlier stages. In the United States, approximately 63% of diagnosed patients had tumors smaller than 2 cm . Numerous studies are exploring treatments that increase cure rates, reduce toxicity, and are less invasive while maintaining equivalent efficacy. As such, percutaneous ablative procedures have

garnered significant interest. Among the primary methods under investigation, ranked by the number of publications, are radiofrequency ablation (RFA), cryoablation, percutaneous interstitial laser ablation (PLA), high-intensity focused ultrasound, and microwave ablation. Previous studies on the ablation of early-stage breast cancer have shown promising results, especially with the use of RFA, PLA, and cryoablation. Since these methods can be applied to other types of tumors, equipment with these technologies is available in specialized hospitals around the world. Therefore, refining techniques for using these ablative methods could broaden their indications and allow treatment for a greater number of patients. This review primarily focuses on PLA, as this method has shown promising results in isolated studies, albeit with significant discrepancies and a lack of standardization. Laser interstitial photocoagulation for solid organ tumors, including hepatic nodules, was initially reported in 1983 by Bown S.G. as a minimally invasive technique providing localized destruction.

Since the first reports of this method for the treatment of breast cancer in 1989, nearly 310 women have undergone laser ablation. However, the results obtained from these procedures exhibit significant diversity.

Condition being studied Percutaneous Laser Ablation in Stage I breast cancer.

METHODS

Search strategy The 2020 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) method was employed (13). The terms laser ablation AND breast cancer were employed to select all articles published up to January 2024 on the PubMed and Embase platforms.

The inclusion criteria comprised original articles utilizing laser as an ablation method for local breast cancer treatment, irrespective of its association with other methods or whether subsequent surgery was conducted. Review articles, editorials, letters, and non-human studies (e.g., in vitro or animal studies) were excluded. Articles focusing on laser ablation for metastatic lesions were also omitted from consideration.

All articles were selected by a single author (DRMM), and the selections were subsequently validated by the second author (GF). Data were collected and tabulated based on several topics of interest, including year of publication, number of patients included, type of device used, and technical parameters such as power and energy. Additionally, the imaging method used to guide ablation and evaluate the area of necrosis and any residual lesions, ablation rates, and the necessity for surgery following ablation were recorded.

The data were compiled and described in terms of proportions or intervals. Whenever feasible, averages were calculated based on descriptions provided in the texts or tables within the articles.

Participant or population Patients with breast cancer treated with percutaneous laser ablation.

Intervention Percutaneous Laser Ablation.

Comparator No comparative intervention.

Study designs to be included Clinical studies.

Eligibility criteria Original articles utilizing laser as an ablation method for local breast cancer treatment, irrespective of its association with other methods or whether subsequent surgery was conducted.

Information sources All articles published up to January 2024 on the PubMed and Embase platforms with the terms "laser ablation" AND "breast cancer".

Main outcome(s) The search yielded 1,778 and 739 articles in the Pubmed and Embase platforms, respectively. During the review of the selected articles, 10 studies not previously identified by the search platforms were actively found through references and included for analysis. Among the 2,527 total articles, 2,510 were excluded due to duplication or because they did not meet the inclusion criteria. Therefore, a total of 17 articles were included in the review. PLA was employed in the treatment of around 310 patients in previous studies, demonstrates promising results as a method for locally treating early-stage breast cancer. However, the lack of standardized protocols hinders its reproducibility and challenges its immediate application in clinical practice. The average tumor ablation rates found in this review ranged from 33% to 87%, and the studies that describe a complete tumor ablation reported an average rate of 64.7%. As with other conservative treatments, the accurate selection of patients for ablative procedures is paramount for their success. Utilizing MRI to more accurately estimate tumor dimensions, along with excluding histological subtypes such as ductal carcinoma in situ (DCIS), and invasive lobular carcinoma (ILC), are correlated with increased success rates of the procedure.

Additional outcome(s) Among the 4 studies that documented the rate of complete ablation followed by surgery, 3 used diode laser and observed, on average, 65% complete ablation, compared to 50% in the study that used Nd:YAG laser. Therefore, a diode laser coupled to a thermistor and aiming for a temperature above 60°C at all points of the sensor seems to have the highest possibility of ablative success. Concerning the best power to be calibrated, the studies with higher ablation rates reported power between 5 and 10 W. Developing an improved method to guide the procedure, with real-time monitoring of residual lesions, would also be indispensable in improving results.

Quality assessment / Risk of bias analysis As we only describe the previous findings (meta analysis was not performed), the risk of bias analysis was not performed to.

Strategy of data synthesis Data were collected and tabulated based on several topics of interest, including year of publication, number of patients included, type of device used, and technical

parameters such as power and energy. Additionally, the imaging method used to guide ablation and evaluate the area of necrosis and any residual lesions, ablation rates, and the necessity for surgery following ablation were recorded. The data were compiled and described in terms of proportions or intervals. Whenever feasible, averages were calculated based on descriptions provided in the texts or tables within the articles.

Subgroup analysis Not done.

Sensitivity analysis Not done.

Country(ies) involved Brazil.

Keywords Breast cancer; Thermotherapy Laser; Minimally-invasive treatment; Thermal ablation; Percutaneous ablation; Systematic review.

Contributions of each author

Author 1 - Danielle Matsumoto - Selection of all articles, data analysis and draft of the manuscript.

Email: danielle_rmartin@hotmail.com

Author 2 - Gil Facina - The author Validated the selected articles, and revised the manuscript.

Email: facina@unifesp.br