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(RESEARCH ARTICLE)

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Carbon marking failure in targeted axillary dissection post neoadjuvant treatment for breast cancer - single centre study and comparison with other published work

Monika Rezacova *

University Hospital Olomouc, CZE, Portsmouth Hospitals University NHS Trust, UK.

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Abstract

Background: Minimising surgery in the axilla for patients with breast cancer is becoming a very popular solution showing great advantages and minimising the risks of axillary clearance. Targeted axillary dissection is currently being investigated as a part of various trials and it is an important option in management for both patients and surgeons.

Methods: While collecting another study, we discovered an interesting secondary outcome of failure of marking specific node. We have focussed our attention specifically on carbon marking as it was a standard method in our institution at the time.

Results: A collection of 194 patients undergoing TAD in the period between 2021 and 2024 had been created. 42 have been excluded while the remaining 152 have been investigated fully, including pathology slides. Only 2.6% of cases have shown failure to identify nodes.

Discussion: Carbon marking is a valid method of marking although some higher level of evidence is missing. From the units that use carbon marking as routine, the results are comparable.

Keywords: breast cancer; targeted axillary dissection; sentinel node biopsy; axillary node marking

1. Introduction

Advances in cancer research have allowed us to perform limited axillary surgery for patients with positive axilla at diagnosis undergoing neoadjuvant therapy. This is called targeted axillary dissection (TAD) and allows the pathologist to assess the response in the nodes while minimising surgical intervention in the axilla.[1] It could be paired with "traditional" sentinel node biopsy. Depending on the pathology results, the recommendation might be for no further treatment, radiotherapy to the axilla or completion axillary clearance.

If TAD is considered as an option at diagnosis, it requires marking of the pathological node(s) by means that would survive neoadjuvant treatment. This could be done by carbon tattooing [2], seed (magnetic or radioactive) [3] or metal clip [4]. The latter normally requires further re-marking and can be used for any above-mentioned options or wire.

Our centre used carbon tattooing and has switched recently to seed. As a part of a different study, we have collected data that looked in detail into the carbon marking and the pathology picture to assess how well the carbon can guide the surgeon and what is the failure rate. We have compared these with other centres with available results.

* Corresponding author: Monika Rezacova

2. Methods

Retrospective data collection was performed between the years 2021-2024 in University Hospital Olomouc, Czech Republic. All patients undergoing TAD for breast cancer over the age of 18 have been included. As a further exclusion criterion, we have used other methods of marking or conversion to axillary clearance due to progression of the disease.

Where carbon tattooing took place, the operation notes and pathology slides have been reviewed. Particular attention was made to surgical localisation of the carbon and identification of the right node. Pathology slides have been reviewed to confirm that the node has carbon present and bears features of either residual disease or response to treatment.

The inclusion and exclusion criteria could be seen in the table below.

Table 1 Inclusion and exclusion criteria

Inclusion criteria	2021-2024, University Hospital Olomouc
	TAD for breast cancer
	Over the age of 18
	Carbon tattooing of pathological node
Exclusion criteria	Other mean of marking pathological node
	Conversion to axillary clearance
	Cancellation of surgery

3. Results

In total 194 patients have been included initially. 42 have been excluded as they had different methods of marking (seed, wire or clip) or progressed despite treatment and have been converted to axillary clearance pre-operatively. The rest of 152 patients underwent TAD with carbon marking +- sentinel node biopsy. We have reviewed all operation notes and pathology slides to see if the nodes have been easy to localize and if carbon has been present in the targeted node.

Out of the 152 cases we have assessed, carbon marking was successful for node localisation in 136 cases. This has been reflected in both the surgical op notes and the pathological finding, which was able to identify the “correct number” of nodes. This means that the number of nodes found at diagnoses and marked by carbon tattooing matched the number that has been found by the surgeon and identified by pathologist.

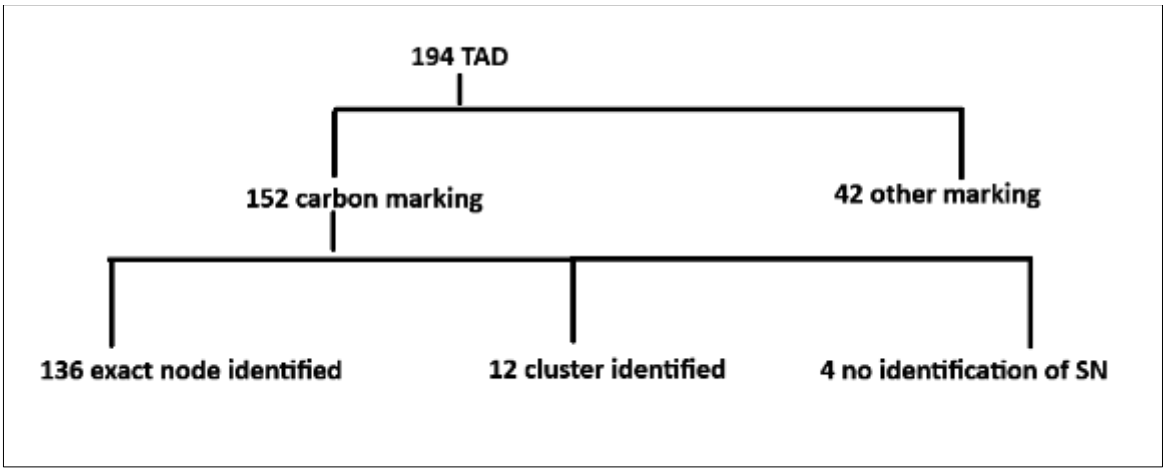

Figure 1 Patient stratification in the study

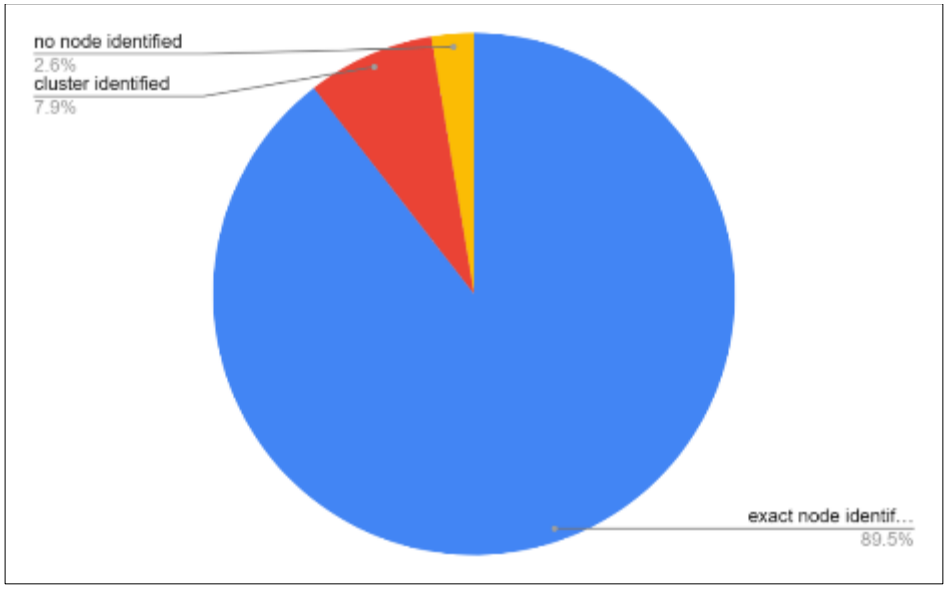

Figure 2 Representation of node identification

There were 12 cases where the marking has been marking a cluster of nodes, rather than a specific one. In 6 of these cases, it has been noted by a surgeon as uncertainty of which node has been marked as the carbon was seen within a cluster of nodes and this has been removed intra-operatively. In the other 6 cases, the surgeon believed that they had identified a single carbon tattooed node and it was only discovered by the pathologist that the sample contained more than a single node and the carbon had been spread through the cluster.

In 4 cases the carbon has not been identified in the axilla at all and the surgeon proceeded to axillary sampling (in 3 cases) or axillary node clearance (in 1 case). The proceeding to axillary clearance has been justified by clinical appearance of the axillary nodes.

If we consider the failure rate purely for nodes that have not been identified by surgical means or pathology, the rate would be 2% only.

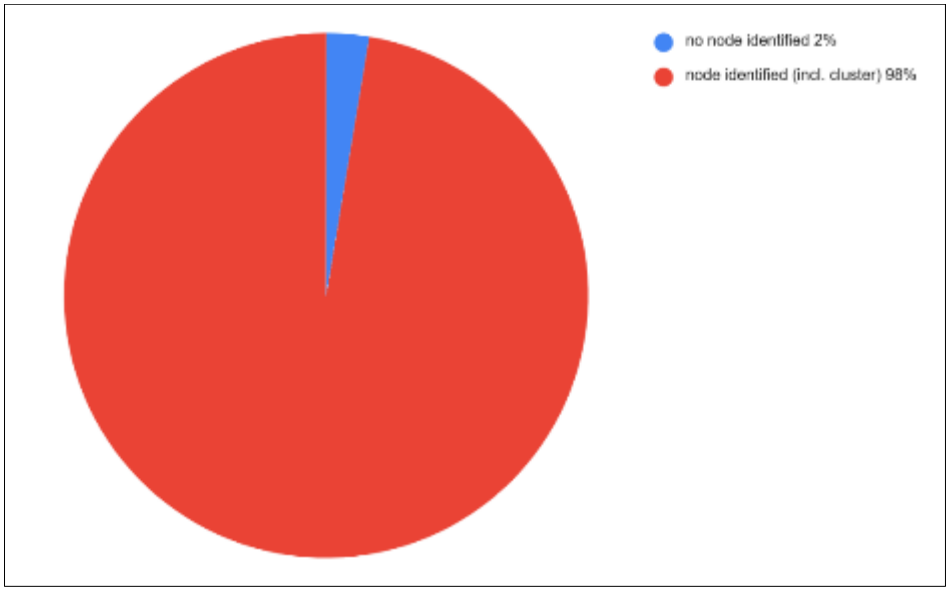

Figure 3 Representation of node identification failure (identification includes cluster)

This is a very good result for a single use technique., If we have taken into account the cluster that have been marked and found surgically or on pathology, it would raise the failure rate up to 10%.

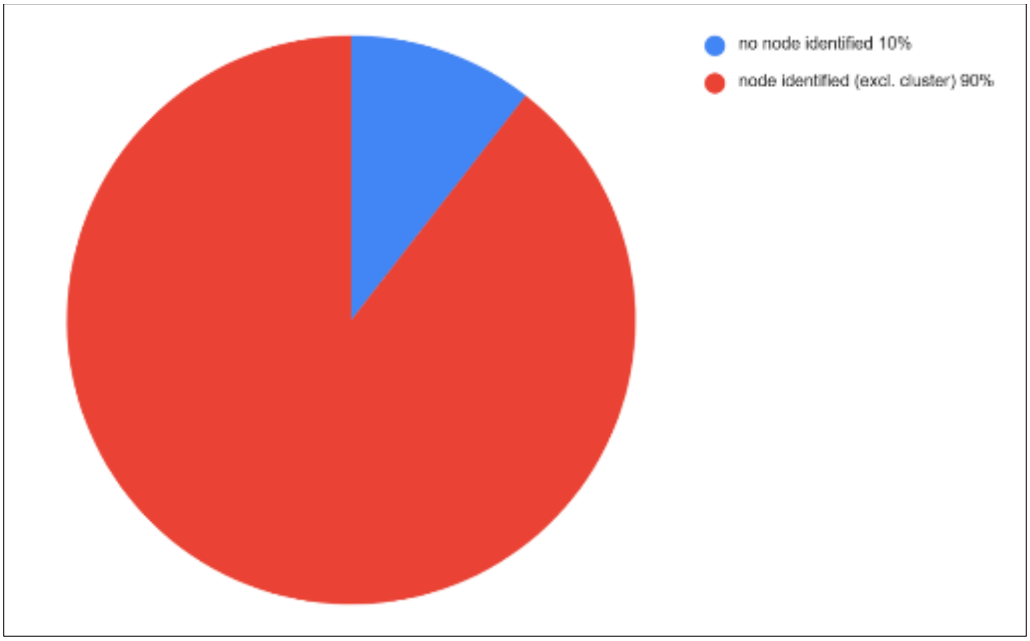

Figure 4 Representation of node identification failure (identification excludes cluster)

4. Discussion

The failure rate for carbon tattooing in breast cancer axillary staging is not definitively established, but studies indicate a high variability in success rates, with detection rates ranging from around 78% to over 94%,[5] depending on the technique and whether a second procedure like intraoperative ultrasound or surgical specimen radiography is used. While carbon is a common marker, it can be difficult to visualize, leading to technical challenges and a significant risk of not finding the marked node, thus requiring further action like a complete axillary lymph node dissection.

In our cases when talking about the ability to identify the nodes, even as a part of the cluster, the rates were very favourable. This is very good results and it is comparable with other means of marking.

There is no question that the carbon tattooing is very dependent on the radiologist skills and the individual anatomy of the patient. Although we have now started to use seed for localisation and it has proven to be a slightly easier identification, it could affect other imaging that a patient would need while receiving neoadjuvant treatment.

It is definitely a valid method that in good hands can provide very good results. The seeds are reporting failure rates of about 2.5% however there is no report of cluster marking as it would be not physically possible. [6]

5. Conclusion

Carbon marking of axillary nodes is a valid method and in the hands of a skilled radiologist provides excellent guidance for the surgeon. Although it brings some elements of marking clusters or not working at all, our small study has shown that the results are comparable with other methods of marking. This would benefit from a bigger scale trial with multicentre involvement to be able to provide accurate data.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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