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ABSTRACT • The operation described by Halsted, in 1894 and called radical mastectomy, represents a milestone in the treatment of breast cancer. It consisted of removal of the breast, muscles and axillary lymph nodes.

The pre-Halsted era saw attitudes ranging from the willful abstention to brutal treatments by cauterization or amputation. The introduction of anesthesia and asepsis enabled more advanced surgical attempts. The stratification of patients into operable and non-operable categories has improved surgical outcome. After attempts to extend Halsted procedure (by extended or super-radical mastectomies) proved to be of little benefit, a minimally-invasive trend emerged gradually.

It started with modified radical mastectomy that spares the muscles and was then followed by breast conservative surgery that leaves breast tissue behind. Then sentinel lymph node mapping was introduced with the hope of reducing the extent of axillary dissection. Finally, skin sparing mastectomy appeared in order to conserve skin and facilitate breast reconstruction.

INTRODUCTION

In the late 1890, William Halsted, the American surgeon who started the use of gloves in the operating room devised a new operation for breast cancer called radical mastectomy (RM). The operation was called "radical" because it involved, not only the removal of the breast, but also the lymph nodes and muscles. Despite the drawback of disfigurement, this operation was the standard procedure for almost 70 years, before it was challenged by less aggressive surgery.

PRE-HALSTED ERA

The pre-Halsted era witnessed various attitudes from the fatalistic nihilism to aggressive treatments such as red iron cauterization or guillotine amputations with instruments created for this purpose [1] (Fig. 1).

The Roman physician Galen (120-200 AD) attributed breast cancer to melancholy and "black bile" and recommended to the patient diet and purgation, followed possi-

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RÉSUMÉ • L'opération décrite par Halsted en 1894 et appelée mastectomie radicale, représente un jalon important dans le traitement du cancer du sein. Elle consistait en l'ablation du sein, des muscles et des ganglions lymphatiques axillaires.

L'époque préhalstedienne a vu des attitudes allant de l'abstention volontaire aux traitements brutaux par cautérisation ou amputation. L'introduction de l'anesthésie et de l'asepsie a permis plus d'avancées chirurgicales. La stratification des patients en opérables et non opérables a permis d'améliorer les résultats. Les tentatives d'élargir l'opération en pratiquant la mastectomie radicale étendue ou la mastectomie super-radical, se sont révélées peu avantageuses. Une tendance mini-invasive est progressivement apparue avec la mastectomie radicale modifiée respectant les muscles puis la chirurgie conservatrice gardant le sein après mastectomie partielle, suivie de curage axillaire et de radiothérapie. Récemment le *mapping* du ganglion sentinelle a permis d'éviter les curages surtout dans les cas précoces. Enfin, l'excision de la peau est de plus en plus limitée (*skin sparing mastectomy*) pour faciliter les reconstructions du sein.

bly by surgery if the tumor becomes "accessible". Diet and purgation were the "neoadjuvant" therapy of that time!

The Catholic Church denounced in the Council of Tours in 1162 any surgery on the breast but kept the belief

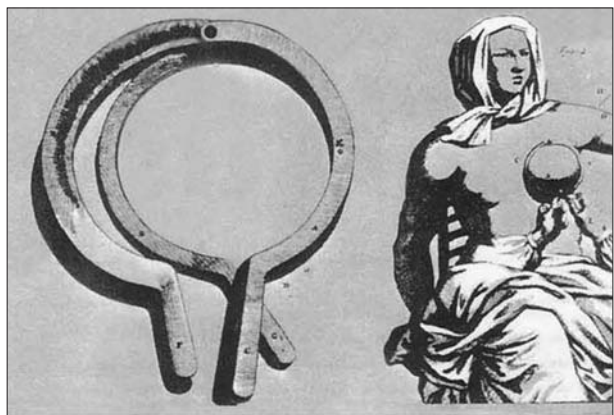


FIGURE 1. Instrument used for mastectomy in 1721.
(Illustration : Gerard Tabor)



FIGURE 2. Engraving of Saint Agatha (17th century).
Her breasts are carried on a plate by an angel.
Used tongs are represented.

in the miracle of Saint Agathe [2]. Agathe was a young and pious Christian who lived in Sicily around 250 AD. Because she refused the advances of Quinctianus, the Roman governor of the island, he ordered her breasts to be amputated. According to popular belief, Saint Pierre intervened to restore her breasts. This “First” in breast reconstruction is celebrated every year on February 5 in Catania (Sicily) where fervent believers carry a model of her breasts in the streets (Fig. 2). Since then, Saint Agathe is invoked as protector of the breasts.

This kind of punishment was already practiced in Babylonian times. Hamurabi’s code prescribed it particularly for wet nurses committing a crime; so, the punishment also deprived the guilty nurse of her job. Another unusual indication for mastectomy is reported in the Greek mythology regarding the fabulous women warriors called Amazones (meaning possibly “breastless” in ancient Greek). They were known to cut off their right breast and their daughters’ right breast to prevent it from getting in the way of bowstring.

One of the earliest reports on surgery of the breast occurring at a later period is from the Greek historian, Herodotus. The patient was Atossa, the wife of Darius I, King of Persia. Democedes who was a Greek physician retained in the Court of Darius, cured Atossa from a “breast ulcer” and, as a reward, he was set free and allowed to return to Greece [2].

The famous Arab surgeon of the 10th century, Abou-El-Kassem Zahraoui (936?-1013), known in Europe under the name of Aboulcassis, practiced cauterization on the lumps of the breast, but considered it purely palliative. Ambroise Paré (1510-1590) and Andreas Vesalius (1514-1564) highlighted the role of axillary lymph nodes and the interest of tying the vessels instead of cauterization. Jean-Louis Petit (1654-1750) then President of the Academy of Surgery in Paris, suggested a resection of the tumor, lymph nodes and sometimes muscles. Lorentius Heister (1683-1758) in Germany adopted the technique of J.-L. Petit and added the eventual resection of the invaded part of the ribs. His book, entitled simply *Surgery*, considered a reference at that time, was translated into English in 1748 and profoundly influenced the English-speaking surgeons.

The end of the pre-Halsted era is marked by a disabused assertion of Theodor Billroth in his book of 664 pages entitled *Surgical Pathology and Therapeutic*. In that voluminous publication, he devoted only 12 pages on breast cancer. The surgery, he wrote, has no influence on the diathesis (meaning cancer). According to Billroth, if surgery is necessary, it should be for other reasons, i.e. in modern language, for palliation.

We have in Lebanon, no information on this pre-Halsted period. Probably cauterizations and ointments were used to reduce patients’ discomfort. Later, breast cancer surgery in Lebanon has closely followed the same pattern as elsewhere. Long before the Internet age, Lebanese surgeons remained informed of progress in this field by their frequent visits abroad and their familiarity with the medical literature.

THE RADICAL MASTECTOMY OF HALSTED

W.S. Halsted in 1894 brought his experience of 50 cases operated at John Hopkins between 1889 and 1894 [3] by an operation called radical mastectomy (RM). It involved the removal of the breast, pectoral muscles and axillary lymph nodes, after a vertical incision often closed with skin graft (Fig. 3). This operation remained the gold standard procedure for nearly three quarters of a century [4]. Halsted reported 6% of local recurrence with a 5-year survival of 40%. These figures were higher than those published at that time. These results, currently regarded as modest, are explained by the fact that many of Halsted patients had locally advanced tumors.

In 1943, C. Haagensen, a prominent surgeon dedicated to breast at Columbia University in New York, and A. Stout [5-6] brought an important contribution by publishing the criteria of operability, based on what was known as the Columbia Clinical Classification (CCC). This was the first clinical staging system widely used in the United States for decades, before the introduction of tumor-node-metastasis (TNM) staging. The following cancers were considered as inoperable: Cancers ulcerating the skin or fixed to the chest wall or with satellite nodules or with skin changes such as infiltration, edema or “*peau*



FIGURE 3. Radical mastectomy by vertical incision and skin graft, often used by Halsted.

d'orange", cases with positive axillary lymph nodes superior to 2 cm and fixed together or to the chest wall. In sum, all cases that are considered TNM stage III and corresponding to locally advanced cancers.

To improve patient selection for RM, Haagensen, proposed in some borderline cases, a pre-operative biopsy of the apex of the axilla and of the internal mammary lymph nodes. These recommendations were followed by some surgeons in Lebanon, and then discarded as elsewhere. In addition, Haagensen was insisting on obtaining fat free skin flaps, almost transparent, and stripping carefully all the adventia of the axillary vein.

Dr Sami Obeid at the American University Hospital in Beirut has remained faithful for a long time to the technical recommendations of Haagensen after a prolonged stay with him in Columbia. While in New York in 1966 I have personally watched a RM performed by a resident helped by Haagensen who was striving to show me the transparency of the flaps. His book [7] remained for many years a reference on the pathology of benign and malignant breast conditions and has been reprinted several times.

It is noteworthy that before Haagensen, RM was performed indiscriminately in all stages, and without radiation. These RM could lead to impressive recurrence (Fig. 4).

Lymphedema of the arm was not rare after RM, particularly when followed by radiation. It is usually mild but can, exceptionally, be monstrous (Fig. 5). A very unusual complication observed in one case, is a late thrombophlebitis of the homolateral arm leading to venous gangrene and death despite anticoagulation and venous thrombectomy (Fig. 6).



FIGURE 4. Local recurrence after inadequate surgery for locally advanced breast cancer.



FIGURE 5. Unusual monstrous lymphedema after radical mastectomy and radiation.



FIGURE 6. Unusual late venous gangrene of the upper limb after radical mastectomy. Venous thrombectomy did not prevent from amputation and death.

EXTENDED AND SUPER-RADICAL MASTECTOMIES

The selection applied by CCC, then TNM classification made it possible to intervene only on so-called operable cases (stage I and II) and therefore to improve the outcome of surgery; but failures persisted in some cases. This prompted some surgeons to consider that the operation of Halsted was insufficient. In 1951, Jerome Urban [8] at Memorial Sloan-Kettering Cancer Center (MSKCC), in New York, added the removal of the internal mammary lymph nodes (Extended radical mastectomy) to the standard radical operation. In 1956, Waugensteen et al. of Minnesota [9] added dissection of supraclavicular, internal mammary and mediastinal lymph nodes (Super-radical mastectomy). These operations did not improve results and were abandoned [10].

THE MODIFIED RADICAL MASTECTOMY (MRM)

The MRM was an opposite trend. Advocated by Patey and Dyson in England in 1948 [11-12], it respects the pectoralis major but removes the pectoralis minor to facilitate the dissection of the level III axillary lymph nodes. It has been very successful in Europe before being adopted in the U.S. in its current form [13-15]. It now spares both pectoralis muscles (major and minor) and involves the dissection of only level I and II axillary nodes.

The easy transition from RM to MRM was probably due to more frequent stage I and II presentations, and to the increased recognition of the role of postoperative radiation in sterilizing residual cancer cells [16-17].

In Lebanon, most surgeons have adopted MRM since 1970. Very few have remained faithful to the RM of Halsted. Meanwhile, randomized clinical trials have shown no difference in survival between RM and MRM.



FIGURE 7. Modified radical mastectomy by a transverse incision.

The later has the advantage of being performed by a transverse incision (almost invisible) and of preserving the function of the pectoralis major (Fig. 7).

BREAST CONSERVATIVE THERAPY (BCT)

Conservative treatment was a logical desire to avoid the psychological trauma caused by mastectomy. But it seemed irrational to keep the breast in view of the reported high incidence of tumor multicentricity in mastectomy specimens (more than 44%) [18-20]. This negativism was nevertheless overcome for the following reasons: 1) These specimens came often from locally advanced cancers; 2) Operable stages I and II became more frequent; 3) Radiotherapy had seen its role confirmed after the publications of McWhirter [17] and Baclesse [16]. McWhirter [17] published in 1948 his famous report on 2000 patients deemed operable according to the criteria required for radical mastectomy and who were treated by simple mastectomy and radiation with 62% of survival at five years. Baclesse [16] presented in 1948, in a meeting of the French Association of Surgery (AFC), his report on "Roentgen-therapy alone in the treatment of operable and non-operable cancers of the breast" with results equal to those of radical operations.

Among the pioneers of the local excision, are Porrit in 1964 [21], Crile et al. in 1971 [22] at the Cleveland Clinic, Vera Peters in Toronto and many others in Europe, particularly, at the Institut Gustave Roussy and the Institut Curie. Their reports did not show significant difference between RM and BCT. The randomized clinical trials, already established in Europe for several decades had confirmed that the conservative treatment in its three components – partial mastectomy, axillary dissection and post-operative radiation – gave the same results on survival that the MRM. The treatment initially proposed for stages I and II has seen its indications extended to tumors measuring 5 cm after oncoplastic surgery [23] and even to some locally advanced cases after neoadjuvant treatment [24].

Veronesi et al. [25-26] and Fisher et al. [27] reported in 2002 in the *New England Journal of Medicine* (NEJM) their results after 20 years of follow-up showing long-term maintenance of the similarity between the results of MRM and BCT.



FIGURE 8. Breast conservative surgery (quadrantectomy and axillary dissection) one month after surgery.



FIGURE 9. Reconstruction of the left breast by muscular transfer.

The BCT is being increasingly applied in the USA where it reached in some States 70% to 80%. Its rate of applicability is not uniform. It depends in part on geographical factors (distance to radiotherapy centers) and in part on the personal choice of famous patients. The MRM chosen by Mrs. Nancy Reagan [28] has, for a year, reduced the rate of conservative treatment. Another new factor which also contributed to the change in the rate of conservative surgery is the use of breast MRI advocated by some surgeons before BCT to verify the absence of multicentricity. The high sensitivity of MRI led to unnecessary mastectomies, given the reduced specificity of this method with false positive results. Recent randomized trials have found no significant difference in local recurrence between cases operated with or without preoperative MRI [29].

In Lebanon, the conservative treatment introduced in the 1980's is increasingly applied (Fig. 8). It had as a precondition and as a consequence, the integration of imaging techniques, small biopsy procedures, pathology, diagnostic and therapeutic radiology. The misuse of MRI, here as elsewhere, is in the process of disrupting the indications of conservative treatment, while striving to solve the problem of its specificity.

Contraindications of BCT

The conservative treatment has its limits specified in consensus meetings [24, 30].

Absolute contraindications are:

1. Pregnancy, except for the third quarter, because radiation can be given after childbirth
2. Multicentricity, except for foci in the same quadrant
3. History of prior irradiation on the breast
4. Persistence of positive margins after reasonable effort of reexcision.

Relative contraindications are:

1. Collagen disease
2. Small breasts
3. Very large breasts.

These relative contraindications are linked to cosmetic problems or difficulty arising in radiation.



FIGURE 10. Immediate reconstruction by double implants for bilateral synchronous cancer.

For all these contraindications, MRM followed by reconstruction, especially after "skin sparing", offers a valuable alternative, and it is done by tissue transfers or prosthetic devices (Fig. 9-10).

THE MAPPING OF THE SENTINEL NODE

Introduced more than a decade ago, this mapping [31-34] is supposed to locate and remove the first relay lymph node. This node is sent for frozen section and if positive leads to axillary dissection. In case the frozen section shows a benign lymph node, axillary dissection is avoided pending paraffin sections analysis. The lymph node is localized by a blue dye, a radioactive agent, or both. This technique reduces the morbidity of the axillary dissection. Its effect on survival is the subject of controlled trials [24]

In Lebanon, sentinel node mapping is done in several centers by different agents including "patent blue" (Fig. 11). Some also have the probe for radioactive localization.



FIGURE 11. Mapping of sentinel node (arrow) by patent blue.

HISTORY OF THE FROZEN SECTION

One cannot talk about the history of breast cancer surgery without recalling the first frozen section (FS), as related by Rosai [35] in his book *The History of American Surgical Pathology*. In 1891, after removing a breast lump, Halsted cut the tumor and was somewhat worried about its nature. He sent it for FS to the pathologist William Welch, whose laboratory was not close to the operating room. When he returned after half an hour with the confirmation of benignity, Halsted had already completed the operation and was starting another one. Disappointed, Halsted did not request any FS for 25 years. This case was not reported. But according to Rosai [35], it is Cullen, who in 1895 published a report on the FS after being familiar with its technique during autopsies. His report was still greeted with skepticism by surgeons who claimed the accuracy of their macroscopic assessment during surgery without the risk of error in FS. FS was finally adopted after several decades.

In Lebanon, around 1950, one of the authors (AG) attended the first FS done at Hôtel-Dieu Hospital in Beirut by a visiting pathologist from Marseille, called Yves Poursines. The biopsied lump proved to be a phyllode tumor and the mastectomy scheduled by the surgeon, Pr Denis Ciaudo, was avoided.

THE FUTURISTIC ULTRA CONSERVATIVE TRENDS

Recent ultra conservative trends are under investigation in some specialized centers. They are reported under the headline "In situ destruction of the primary breast cancer" [24]. They use various sources of energy (laser, ultrasound or microwave). They are supposed to solve the local problem without scar but of course cannot solve the problem of lymph nodes or metastases. They are tried for small tumors and followed actually, by surgical excision to control efficiency.

These methods are confined to certain centers in the world and have no practical application in Lebanon.

CONCLUSION

This review illustrates the trend toward conservative surgery for breast cancer. It, also, shows the unavoidable need to cooperate with other disciplines to complete the treatment and implement the recommendations issued from consensus conferences [36]. The anatomical theory of Halsted [3-4] that inspired the various methods of local control had to cope with the assumption of Fisher [27] on the possibility of metastases early in the natural history of breast cancer with, as a consequence, the usefulness of adjuvant or neoadjuvant treatment alongside the local control. On the surgical side, Halsted's mastectomy, which was the "gold standard" and has saved millions of patients at the price of mutilation, has finally been stripped of most of its components. The removal of the entire breast, muscles, lymph nodes and a substantial

portion of the skin was gradually challenged and we can now deliver a requiem for this operation.

We can now tell the breast cancer patient that it is possible to come out of the operating room with a retained breast or with a reconstituted new breast (Fig. 9-10).

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