

The Use of Hydrodissection in Nipple- and Skin-sparing Mastectomy: A Retrospective Cohort Study

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Background: Hydrodissection (HD) is a method to create a subcutaneous and prepectoral plane during mastectomy using a mixture of crystalloid solution with local anesthetic and epinephrine. The aim of this study was to evaluate postoperative complications and surgical outcomes of this technique compared with standard mastectomy.

Methods: This is a retrospective cohort study of patients who underwent bilateral risk-reducing, nipple-sparing mastectomy and immediate implant-based reconstruction through an inframammary crease incision either with standard electrocautery (control group) or HD (HD group) between January 2013 and January 2017. Patient demographics, procedural details, surgical outcomes, and complications were compared using nonparametric statistical tests and logistic regression analysis.

Results: Forty-one patients (82 nipple-sparing mastectomies) were analyzed (23 patients in the HD group and 18 in the control group). Patients' demographics were similar for both groups. Surgical time was shorter with HD compared with standard mastectomy (median 168 versus 207.5 minutes, $P = 0.016$) with shorter median hospital stay (2 versus 2.5 days, $P = 0.033$). Complication rates were similar in both groups, and fewer patients in the HD group required Coleman fat transfer to improve cosmesis (12 versus 3, $P = 0.003$).

Conclusions: HD mastectomy is a safe alternative to standard technique in selected patients. Further surgical research to explore the role of HD in a wider clinical setting is warranted. (*Plast Reconstr Surg Glob Open* 2019;7:e2495; doi: [10.1097/GOX.0000000000002495](https://doi.org/10.1097/GOX.0000000000002495); Published online 18 November 2019.)

INTRODUCTION

Hydrodissection (HD), also known as tumescent dissection, is a technique where an injection of a mixture of a crystalloid solution and local anesthetic with epinephrine is infused into subcutaneous and prepectoral tissue to facilitate the development of a bloodless plane for dissection. Worland first employed this technique to perform

a mastectomy in 1996,¹ and since then it has been increasingly used in the setting of breast oncologic²⁻⁶ and esthetic surgery.^{7,8}

During a mastectomy, injection of the tumescent solution is believed to facilitate the surgical procedure by distending and enlarging the space between the ligaments of Cooper. This may allow surgeons to better distinguish between the subcutaneous and glandular tissue and follow the oncoplastic plane of dissection achieving more even flaps and preserving the subdermal vascular plexus. Perioperative blood loss may be reduced by epinephrine-induced vasoconstriction together with the hydrostatic effect of the large volume infusion tamponading small blood vessels. These theoretical advantages together with reduced operating times and improvement in postoperative analgesia have been confirmed in a number of studies.⁹⁻¹³ However, apart from the potential benefits, the use of this technique especially in the setting of immediate implant-based breast reconstruction (IBR) may increase the risk of complications.^{3,4,14}

Despite the conflicting evidence, HD has a growing appeal in modern health-care systems as it may represent a quicker, low-risk alternative to standard mastectomy

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techniques. The better defined resection plane created by HD may be associated with improved quality flaps with less traction-related flap injury resulting in less frequent need for revision surgery. Therefore, the use of this technique could help address the increasing burden posed to already stretched health-care services. The aim of this study was to evaluate the effect of HD on surgical complications, operating times, and the need for revision surgery in the setting of risk-reducing, nipple-sparing mastectomy (NSM) with immediate IBR compared with the standard electrocautery operative technique.

METHODS

The Risk Reduction Dataset in our institution is a prospectively collected database of patients having surgery for gene mutations (eg, BRCA 1/2) or strong family history of breast cancer. This database was used to identify all patients who underwent bilateral risk-reducing, NSM and immediate IBR through an inframammary crease (IMC) incision between January 2013 and January 2017. All consecutive patients, aged 18 years or older, who underwent either mastectomy with HD (HD group) or conventional mastectomy (control group) before the adoption of HD as the standard technique in January 2015 were identified, and the data were retrospectively analyzed. The collected data included patient demographics, surgical indications, procedural details, surgical complications, and postoperative outcomes. Patients with history of previous radiotherapy were excluded. Smoking was not an absolute exclusion criterion but patients were advised to stop smoking at least 4 weeks before surgery. Data collection bias was limited by the use of all consecutive patients who underwent surgery with either technique within the predetermined timeframe and consented to have their data collected. All patients included in the study were under the care and had their surgery performed by the same senior surgeon (GG), in a single cancer centre.

Patient demographics included age, body mass index, smoking status, presence of diabetes mellitus, and bra cup size. Indication for surgery was identification of gene mutation or strong family history of breast cancer according to national guidelines. Data regarding weight of the excised breast, volume and type of implant, use of acellular dermal matrix (ADM), and duration of surgery were collected. Postoperative outcomes included length of hospital stay, the duration the surgical drain remained in situ and 30-day unplanned hospital readmissions. Complications, defined as occurring within 30 days, were recorded, including bleeding requiring intervention, superficial and full-thickness nipple areola complex (NAC) and skin flap necrosis, superficial infection requiring management with antibiotics, deep infection requiring surgical intervention, and wound dehiscence. The complication rate was expressed as a proportion of mastectomy procedures. Data on the need for further surgery to improve cosmesis (Coleman fat transfer or other type of revision surgery) were also collected. The minimum planned follow-up for the patients was 6 months at which

point the need for revision surgery was assessed. All data were collected using electronic patient records.

The primary objective of the study was to evaluate the effect of HD on surgical outcomes and complication rates compared with the standard mastectomy technique. The secondary objectives were to assess the impact of HD on operating time, the need for revision surgery for cosmetic purposes and to estimate the potential cost-saving effect of the technique.

The study was reviewed and approved by the Trust's Clinical Audit Committee. Following written informed consent, data were collected and kept in accordance with the Data Protection Act (UK), the International Conference on Harmonization Guideline for Good Clinical Practice, the Trust's Standard Operating Procedures and adhered to the Declaration of Helsinki. The guidance from the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement was applied.¹⁵

Surgical Technique

The surgical approach used in both groups was through an IMC incision. In the control group, electrocautery was used to raise the mastectomy flap as standard technique. Following the removal of the breast gland, separate nipple cores were obtained from the area behind the NAC. Reconstruction was performed by raising pectoralis major muscle and releasing it from its inferior chest wall attachment. A fixed volume, highly cohesive, anatomically shaped silicone-filled implant was inserted in the developed subpectoral pocket. The inferior pole of the implant was covered using an ADM. Local anesthetic (0.5% chirocaine) was administered at the end of the procedure for additional pain control. One vacuum drain was routinely inserted and left in situ until output was less than 30 ml/24 h. In the HD group, the HD solution was prepared by admixing 1,000 ml of a crystalloid solution (normal saline, NaCl 0.9%) with 0.5 ml of 1:1,000 adrenaline and 30 ml of 0.5% chirocaine. The solution was then administered through stab incisions in the IMC incision, using fat transfer blunt tip needles (1.5 mm, 12 cm long; Blink Medical Ltd, Solihull, UK), to infiltrate 500 ml of fluid in the subcutaneous and prepectoral plane of each breast. The surgical procedure commenced as soon as instillation of the HD fluid was completed. The rest of the procedure was performed as described above for the control group with the exception that the dissection was carried out bluntly with scissors and no additional local anesthetic was used. In all cases, the used implant was of the Natrelle 410 series, Allergan plc (NYSE: AGN), Dublin, Ireland, and the used ADM was SurgiMend PRS (Integra LifeSciences, Plainsboro, NJ, USA). All patients had prophylactic antibiotics for as long as the drains remained in situ or for a maximum of 7 days.

Statistical Analysis

Patient demographic variables are presented using simple descriptive statistics. For the comparison of continuous variables between the control and HD groups, Mann-Whitney *U* test was performed, whereas Fisher's exact test was used for comparisons of categorical variables between

Table 1. Patient Demographics

| | Control Group, n = 18 | HD Group, n = 23 | P |
|--------------------------|--------------------------|---------------------|-------|
| | Median (Range) | | |
| Age (y) | 36.5 (19–52) | 38 (25–63) | 0.378 |
| BMI (kg/m ²) | 22.5 (19.2–27.9) | 22 (19.2–24.5) | 0.935 |
| Bra cup size | B (A–F) | C (B–DD) | 0.321 |
| Left breast weight (g) | 231 (137–468) | 280 (93–430) | 0.636 |
| Right breast weight (g) | 203.5 (143–440) | 239 (99–420) | 0.386 |
| | No. patients (%) | | |
| Genetic mutation | 16* (88.9) | 22† (95.6) | 0.572 |
| Strong family history | 2 (11.1) | 1 (4.4) | 0.572 |
| Smoking | 1 (5.6) | 0 (0) | 0.439 |
| Diabetes mellitus | 0 (0) | 0 (0) | na |

n reflects no. cases. $P < 0.05$ was considered statistically significant.

*In the control group, 10 patients had a BRCA1 and 6 had a BRCA2 gene mutation.

†In the HD group, 10 patients had a BRCA1 and 12 patients had a BRCA2 gene mutation.

BMI, body mass index; na, not applicable.

groups. To further assess whether the use of HD could predict the need for Coleman fat transfer, a logistic regression model was used. P values < 0.05 were considered statistically significant. All statistical analyses were performed with the use of SPSS v23.0 (IBM SPSS Statistics for Windows; IBM Corp, Armonk, NY, USA).

RESULTS

A total of 41 eligible patients were identified and included in the analysis: 18 in the control group and 23 in the HD group. Patient demographics are presented in Table 1; no differences were identified between the 2 groups in terms of age, bra cup size, breast size, and comorbidities. Despite similarity in breast weight and size of implants used between groups, HD was associated with a significantly shorter surgical time and shown to be a faster procedure compared with the standard mastectomy (Table 2). The length of hospital stay was also shorter in the HD group but no difference was identified between the 2 groups regarding the duration drains remained in situ or the 30-day unplanned readmission rate (Table 2). Patients in the control group had a median follow-up of 24.5 months whereas the median follow-up for those in the HD group was 9 months ($P < 0.001$).

Table 2. Procedural Details and Surgical Outcomes Based on Per-Case Analysis

| | Control Group, n = 18 | HD Group, n = 23 | P |
|------------------------------|--------------------------|---------------------|------------------|
| | Median (range) | | |
| Implant size (cc) | 392.5 (245–470) | 420 (245–520) | 0.332 |
| Duration of procedure (min) | 207.5 (90–305) | 168 (45–215) | 0.016 |
| Length of inpatient stay (d) | 2.5 (1–5) | 2 (1–3) | 0.033 |
| Drains in situ (d) | 8 (5–13) | 7 (3–14) | 0.503 |
| Follow-up (mo) | 24.5 (15–57) | 9 (3–35) | <0.001 |
| | No. patients (%) | | |
| Use of ADM | 18 (100) | 23 (100) | na |
| 30-d unplanned readmission | 1 (5.6) | 3 ¹³ | 0.618 |

n reflects no. cases. $P < 0.05$ was considered statistically significant.

Analysis of complication rates per procedure performed (number of mastectomies) showed that HD is safe with associated complication rates similar to those observed with the standard technique (Table 3). There was a trend toward higher surgical site infection rates but this did not reach statistical significance. Numerically, more patients in the HD group developed NAC necrosis (not significant difference between groups), but this was superficial and managed conservatively in all cases. There were no implant losses in either group. In terms of postoperative outcomes, patients in the HD group exhibited lower rates of revision surgery to improve cosmesis and significantly fewer patients underwent Coleman fat transfer procedures (Table 3).

A logistic regression model including mastectomy technique and patient and surgical variables showed that only standard mastectomy technique was significantly associated with Coleman fat transfer with an odds ratio of 22.57 (95% confidence interval 1.497–23.822, $P = 0.011$) (Table 4).

DISCUSSION

HD may represent a safe alternative to standard electrocautery dissection. The results of the present study show that this technique is faster, may result in reduced length of hospital stay, and is associated with fewer reoperations to improve cosmesis and a favorable complication profile compared with the control group.

There are conflicting results in the existing literature about the effect of HD on postoperative complications. In a retrospective review, Chun et al found a significantly increased risk of flap necrosis when HD was employed.⁴ However, this result may be limited by the large amount of surgical variation with 22 oncologic surgeons carrying out the mastectomies. Similar results were reported in another retrospective study that showed increased rates of major flap necrosis but no difference in terms of other complications.¹⁴ However, in this study, more than 75% of the complications observed in the HD group were influenced by at least 1 additional, more significant, risk factor. Interestingly, the same group, in a subsequent publication, did not identify a negative impact of HD on postoperative complications.² The authors attributed the discordant findings to the substantial variation in surgeon experience and technique in the initial study. It is therefore likely that surgical experience plays an important role in the safe performance of the technique. In the present study, all procedures were performed by the same senior surgeon and the analysis showed that HD was not associated with more complications, of any type, compared with the control group. Similarly, additional studies have reported comparable complication rates in both the HD and standard electrocautery groups.^{3,9,12} More recently, Siotos et al published a systematic review and meta-analysis showing that the use of tumescent technique is associated with significantly higher risk of skin flap necrosis.¹⁶ These results should be interpreted with caution though, as the authors included only a small number of moderately heterogeneous retrospective studies in their analysis.

Table 3. Surgical Complications and Outcomes Based on Per-Procedure Analysis

| | Control Group, n = 36 | HD Group, n = 46 | P |
|--|-----------------------|------------------|--------------|
| | No. patients (%) | | |
| Bleeding requiring intervention | 2 (5.6) | 0 (0) | 0.19 |
| Superficial infection treated with antibiotics | 1 (2.8) | 7 (15.2) | 0.073 |
| Deep infection requiring surgical intervention | 0 (0) | 0 (0) | na |
| Wound dehiscence | 0 (0) | 4 (8.7) | 0.127 |
| Superficial NAC necrosis | 3 (8.3) | 10 (21.7) | 0.132 |
| Full-thickness NAC necrosis | 0 (0) | 0 (0) | na |
| Flap necrosis | 0 (0) | 0 (0) | na |
| Revision surgery | 13 (36.1) | 7 (15.2) | 0.039 |
| Coleman fat transfer | 12 (33.3) | 3 (6.5) | 0.003 |
| Other revision* | 1 (2.8) | 4 (8.7) | 0.379 |

n reflects no. mastectomies performed. *P* < 0.05 was considered statistically significant.

*Pocket revision and implant exchange.

na, not applicable.

Table 4. Logistic Regression Model to Evaluate the Association between Patient, Surgery, and Complication Data and Need for Coleman Fat Transfer

| Variable | OR | 95% CI | P |
|---|--------|---------------|-------|
| Age (y) | 1.083 | 0.992–1.181 | 0.074 |
| BMI (kg/m ²) | 0.925 | 0.638–1.341 | 0.681 |
| Standard mastectomy technique versus HD | 22.569 | 2.033–250.587 | 0.011 |
| Implant size | 1.005 | 0.990–1.020 | 0.512 |
| NAC necrosis | 5.609 | 0.48–65.612 | 0.169 |
| Infection | 1.391 | 0.091–21.157 | 0.812 |
| Dehiscence | 8.808 | 0.336–231.159 | 0.192 |

P < 0.05 was considered statistically significant.

BMI, body mass index; CI, confidence interval; OR, odds ratio

Moreover, 2 of the included studies come from the same group that demonstrated improvement in their outcomes as expertise in the technique was acquired. The authors of the meta-analysis conclude that HD could be used in patients with no additional risk factors for complications. This supports the results of the present study showing that this technique is safe in selected patient populations when performed in units with relevant experience.

IBR is associated with a number of potential caveats, including implant displacement, capsular contracture, and irregularities due to variable flap thickness that may compromise the esthetic outcomes necessitating further revision surgery. This could result in increased psychological burden for the patients, exposing them to the risks associated with an additional surgical procedure, including further general anesthetics, and also has a significant impact on health economics because of the ensuing additional cost. In the present study, patients in the HD group required significantly fewer Coleman fat transfer procedures to improve the quality of the mastectomy flaps and subsequent cosmesis. Although the reconstructive esthetic outcome can be affected by a number of factors including body habitus, body mass index, and type of reconstruction, these factors were similar in both groups in the present study. It is therefore likely that this observation might be explained by the achievement of more even skin flaps after HD by following the oncologic plane and preserving the subcutaneous fat tissue. Moreover, the improved quality of the flaps in the HD group may be the result of less traction-related flap injury. The regression model showed that

the mastectomy technique used was the only variable that could independently predict the need for subsequent fat transfer. Patients in the control group had a more than 22 times higher likelihood to require Coleman fat transfer. In our hospital, the average cost of Coleman fat transfer as a day-case procedure is £2,852.78; this could translate into a significant clinical expenditure and represent a substantial cost-saving achievable with HD.

One of the advantages of HD is that it has been shown to be faster compared with standard electrocautery technique.^{2,9,17} The present analysis confirms these results. In this study, the median operating time in the HD group was shorter by 39.5 minutes. The average theatre cost per minute in our hospital is calculated to be £15.7. Therefore, the use of HD could translate to an average saving of £620.15 per case. Moreover, patients in the HD group had a significantly shorter hospital stay (2.5 versus 2 days). This could be attributed to the lower duration of the surgical operation, leading to reduced time under general anesthetic and possibly faster recovery compared with patients in the control group. In addition, the use of the tumescent solution including local anesthetic could result in less postoperative pain^{18,19} and hence earlier discharge. With an average cost of £522.06/d for inpatient stay, the shorter median length of hospital stay in the HD group could represent an additional substantial cost-saving. These findings however should be interpreted with caution due to the small number of patients included in the study. Moreover, the observed median length of stay for both groups is longer than the currently considered standard of 1-day stay. This could be explained by the fact that patients in the study underwent surgery between January 2013–January 2015 (control group) and January 2015–January 2017 (HD group) when the <23-hour stay pathway was not routine policy. An additional reason might be improvements in anesthetic and recovery protocols.

In an ever-challenging health-care environment because of the increasing financial pressures, it is important to adopt our practices to maximize cost-efficiency of service provision to ensure economic sustainability. HD represents an alternative to the standard electrocautery dissection technique with shorter operating times, shorter length of hospital stay, and reduced need for revision surgery, yet with similar complication rates. HD could thus be

considered as a cost-efficient method of performing NSMs and IBR in selected patients.

The present study has a number of limitations. First of all, it is a retrospective analysis of a prospectively collected database including a relatively small number of patients. The eligibility criteria for this study were restricted to patients who underwent risk-reducing, NSM with IBR through an IMC incision. Although inclusion of all mastectomy types would increase the size of the cohort and would make the findings more broadly applicable, this population was chosen as it would represent healthy individuals and would allow us to assess the effect of HD in the absence of significant confounding factors including oncologic adjuvant treatments. In addition, patients in the HD group had a significantly shorter follow-up compared with those in the control group. However, the need for revision surgery is generally evident at the 3-month post-operative clinical appointment with activation of the plan for secondary procedures at the 6-month clinical visit. It is therefore unlikely that differences in follow-up duration between the 2 groups would influence our results.

The present study has included a carefully selected group of consecutive patients who underwent risk-reducing mastectomy and IBR. This limits the selection bias and allows assessment of the technique in 2 similar groups of relatively healthy women without significant comorbidities or factors that could affect the outcomes. To our knowledge, this is the only study that has looked into the need for revision surgery to improve cosmesis following IBR in the setting of risk-reducing mastectomy using either standard electrocautery or HD technique. In addition, this is the first attempt to provide a financial analysis and explore the potential for cost-savings using HD. This might have significant implications in the current health-care environments striving to maximize cost-efficiency.

In conclusion, HD could be considered as a safe alternative to standard electrocautery mastectomy in a selected cohort of relatively healthy individuals without significant comorbidities. The associated advantages of this technique including shorter operating time and less need for revision surgery, leading to potential significant cost-savings, warrant further surgical and health economic research to explore the role of HD in a wider clinical setting.

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