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Wound healing complications after autologous breast reconstruction: A model to predict risk

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Summary *Introduction:* Delayed wound healing is costly to the breast reconstruction patient and the health care infrastructure. The purpose of this study is to identify potentially modifiable risk factors and to create a model to assess patient risk of these complications.
Methods: We performed a retrospective study of all free autologous reconstructions at a single institution (2005—2011). Patients with delayed wound healing (operative wounds requiring dressing changes for longer than 3 weeks) were compared to patients with normal healing with respect to history and case characteristics. A risk model was developed to stratify patients based on the multivariate logistic regression results.
Results: Delayed wound healing impacted 297 (44%) of 682 patients. These patients were older ($p = 0.02$), with higher BMI($p < 0.0001$), and higher rates of medical comorbidities ($p < 0.001$), active smoking ($p = 0.02$) and bilateral reconstruction ($p = 0.02$). They received a lower rate/kg of fluid resuscitation intraoperatively ($p = 0.001$) and more commonly received vasopressors ($p = 0.004$), with a greater total reconstructive cost ($p = 0.003$). A regression demonstrated that progressive obesity, smoking, bilateral reconstruction, and utilization of vasopressors were associated with delayed healing ($p < 0.05$). The final model, with three risk groups (low, intermediate and high) demonstrated that high risk patients have an 86% risk of wound healing complications, compared to a 33% risk in patients with few risk factors.
Conclusions: While patient disease remains a major predictor of wound complications, potentially modifiable variables including smoking and vasopressor administration impacted this

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complication. Utilizing the simple model to preoperatively assess patient risk, targeted measures can be undertaken with the goal of ultimately reducing wound healing complications and cost.

Introduction

Wound healing complications are the most common complication following autologous breast reconstruction, impacting upwards of one third of patients.[1–5] Such complications are costly to the patient as well as the healthcare infrastructure.

The principles of wound healing are fundamental to plastics surgery. Covered in the first chapter of many texts, numerous general studies have labeled age, hormones, stress, diabetes, obesity, alcoholism, and smoking, among other factors, as affecting the general wound healing process.[6] The predictive power of these general risk factors in autologous reconstruction, however, may be limited. Autologous reconstruction presents a unique patient population, whose comorbidities and demographics often differ considerably from other surgical patient populations. Yet the basic principles of optimizing wound healing potential still hold true.

The purpose of this study is to identify potentially modifiable risk factors which, if altered, could lead to improvements in patient outcomes and decreased wound healing complication following autologous reconstruction. Secondarily, we sought to create a model to more accurately assess patient risk of wound healing complications in an effort to improve preoperative risk counseling and patient selection.

Methods

Study design

This cohort study identified all patients undergoing free tissue transfer for breast reconstruction from 2005 to 2011 at the Hospital of the University of Pennsylvania. These patients were specifically examined retrospectively with respect to postoperative wound healing complications. This complication was defined as a surgical wound of any size requiring dressing changes for greater than three weeks.

Data collection

A detailed review of hospital and office records included the following: preoperative history and physical, operative reports, anesthesia records, postoperative nursing records, discharge summaries, outpatient clinic notes, and laboratory data. Additionally, the institutional hospital database was queried for medical complications associated with each patient's initial reconstructive hospitalization. Patients were excluded from the analysis if full records were not available in health system electronic medical records. Variables examined included: baseline patient characteristics, oncologic history, reconstructive details (timing, laterality, flap type), intraoperative complications (thrombotic events), and postoperative surgical complications including flap loss (partial and total), delayed breast or donor site wound complications, early infection (during hospitalization), delayed infection (outpatient infection), seroma, and blood transfusion.

Anesthesia related variables included hemoglobin (hgb), heart rate, case length (min), total fluid volume (ml) and rate (ml/kg/hr), total urine output (UOP,ml) and rate (ml/kg/min), estimated blood loss (EBL), number of hypotensive episodes (MAP$<$60 mm Hg), use of vasopressor agents (type, number of doses), timing of vasopressor administration (at induction, in first $^1/_2$ of case, in second $^1/_2$ of case) and postoperative hgb. Fluid resuscitation and administration of vasopressors was performed at the discretion of the anesthesia team. Operative technique and positioning was consistent for all patients. Intravascular volume and resuscitation was assessed by UOP, with normal output defined as 0.5–1.0 ml/kg/h.[7,8] Non-invasive blood pressure monitoring and standard electrocardiogram with pulse oximetry were utilized.

Statistical analysis

Any Delayed wound healing was used as the primary dependent variable. Patients experiencing any delayed wound healing were compared to those who did not utilizing Pearson χ^2 or Fisher's exact test were used to analyze categorical variables; Wilcoxon rank sum was used for continuous variables. Variables with a $p \leq 0.1$ in univariate analysis were used as covariates in a logistic regression analysis with delayed wound healing as the dependent variable. Subgroup analysis was performed examining breast incision delayed wound healing and donor site delayed wound healing specifically.

Variables with a $p < 0.10$ in this initial multivariate analysis were entered into a backward stepwise bootstrap regression model (STATA IC 12.0 Command: swboot).[9,10] In this procedure, 1000 random samples patients (patients were excluded if data is incomplete) were generated with replacement. Frequencies of occurrence of each covariate in the final model were noted; if predictors occurred in 50% or more of the bootstrap models, they were retained in the final multivariate logistic regression model. Numerous simulation studies have shown that this approach reduces the inherent bias (or optimism) in overestimating performance in the derivation dataset.[10]