



Optimizing flap surgery: the need for standardized surgical delay techniques and patient-specific approaches

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Comment on: Rozen WM, Yogaraj V, Siddiqui M, *et al.* Surgical delay in abdominal based flap surgery: a scoping review. *Ann Transl Med* 2024;12:51.

Keywords: Abdominal-based flap surgery; surgical delay technique; standardization; patient outcomes

Submitted May 30, 2024. Accepted for publication Jun 26, 2024. Published online Jul 25, 2024.

doi: 10.21037/atm-24-108

View this article at: <https://dx.doi.org/10.21037/atm-24-108>

A recent scoping review by Rozen *et al.* provides valuable insights into the use of surgical delay techniques to improve outcomes in abdominal-based flap surgery (1). It emphasizes the importance of surgical delay in reducing complications and enhancing flap survivability, especially in high-risk patients. However, it also points out the lack of consensus regarding the optimal technique for performing surgical delay. Consequently, further exploration and standardization in this area are crucial. Existing literature offers a wide range of definitions, from intervention-based classification systems to criteria based on timing, depth, or area of tissue involved, resulting in widely varying reported rates of flap necrosis, ranging from 2% to upwards of 40% (2). We aim to further explore the findings presented in the manuscript regarding surgical delay techniques and their implications for clinical practice. While recognizing the positive impact of surgical delay in reducing complications, it is essential to address the following aspects to optimize patient outcomes.

Standardization of surgical delay techniques

The literature review by Rozen *et al.* emphasizes the variability in surgical delay techniques, such as differences in vessel ligation, flap elevation, and muscle harvesting (1). However, they and other research note an absence of a gold standard methodology for flap delay. Moreover, there is also

a dearth of literature comparing one technique to another in terms of efficiency and effectiveness (3). This further poses a barrier to standardizing a technique for this purpose. This highlights the need for more comparative studies to identify the most effective surgical delay techniques for improving outcomes in abdominal-based flap surgery. By defining key parameters such as the timing of delay, method of vascular occlusion, and extent of flap dissection, standardized protocols can ensure uniformity in practice and facilitate meaningful comparisons between studies. Standardizing these techniques can make surgical procedures more efficient, improve reproducibility, and enable comparative analysis across studies. Hence, collaborative efforts among clinicians and researchers are necessary to establish evidence-based guidelines for implementing surgical delay in abdominal-based flap surgery.

Patient factors requiring surgical delay

Each patient presents a unique set of variables, encompassing medical history, anatomical variations, and individual risk profiles. Therefore, determining which patients would benefit from surgical delay prior to tissue transfer is crucial for maximizing the benefits and minimizing the risks associated with the procedure.

The surgical delay technique is particularly advantageous

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for high-risk patients prone to flap necrosis and other complications. According to Rozen *et al.*, patients with certain risk factors, such as diabetes, a history of smoking, previous radiation therapy, and compromised vascularity in the recipient area are more likely to benefit from surgical delay techniques due to the enhancement of flap perfusion and viability (1). Similarly, studies have also shown significantly better outcomes in patients with peripheral vascular disease since vascular delay increases perfusion (4,5).

Previous studies have highlighted the significance of patient selection in optimizing surgical outcomes (6). Prior to surgery, a comprehensive evaluation of the patient's medical history and current health status is imperative. This assessment includes a thorough review of comorbidities such as diabetes, hypertension, and smoking status, all of which can significantly impact surgical outcomes (7). Additionally, consideration is given to factors such as previous abdominal surgeries, radiation therapy, and body mass index (BMI), all of which may influence flap viability and wound healing. Once patient-specific risk factors have been identified, a comprehensive risk stratification approach aids in determining the suitability for surgical delay. High-risk patients, such as those with significant comorbidities or a history of radiation therapy, may benefit most from the protective effects of surgical delay. Conversely, low-risk patients with favorable health status may not benefit from a delay procedure. Optimal patient selection often necessitates input from a multidisciplinary team of healthcare professionals, including plastic surgeons, oncologists, anesthesiologists, and primary care providers. Collaborative discussions regarding patient management help weigh the risks and benefits of surgical delay for each patient's unique circumstances. Moreover, involving patients in shared decision-making processes empowers them to actively participate in their care and align treatment goals with individual preferences (8).

Transparent communication is paramount in ensuring patients fully understand the rationale behind surgical delay and its potential impact on their outcomes. Providing detailed information about the procedure, its risks, and expected benefits enables patients to make informed decisions about their treatment. Additionally, discussing alternative treatment options and their respective advantages and limitations fosters a collaborative approach to care. Following surgery, close monitoring of patients is essential to identify and address any postoperative complications

promptly. Regular follow-up appointments allow clinicians to assess flap viability, monitor wound healing, and provide ongoing support to patients as they recover. Furthermore, the ability to adapt treatment strategies based on individual patient responses ensures that care remains tailored to their evolving needs.

Designing studies to evaluate the necessity of delay technique

To evaluate whether the surgical delay technique is necessary, it is crucial to design rigorous studies that can provide clear evidence of its efficacy and impact on patient outcomes. Given that surgical delay involves an additional operation, evidence to justify this intervention is required. The prospective studies should focus on clearly defined patient populations, standardized surgical protocols, and robust outcome measures. Randomized controlled trials (RCTs) remain the gold standard for evaluating surgical interventions. To assess the surgical delay technique, RCTs should compare delayed flaps with non-delayed flaps in similar patient cohorts. This will help in determining the relative benefits and identifying any specific patient subgroups that gain the most from the delay technique. Studying surgical delay in this manner may help enable the indications for abdominally-based autologous breast reconstruction to be expanded to patients who otherwise would not be indicated for this type of reconstruction. Moreover, standardizing the surgical delay technique across studies is critical. This includes uniform definitions of delay intervals, methods of vascular occlusion, and flap types. Consistent reporting of outcomes such as flap survival rates, complication rates, and patient satisfaction will facilitate meta-analyses and systematic reviews. Long-term follow-up is necessary to assess the durability of outcomes. Studies should include follow-up periods of at least 1 year to capture late complications and the long-term benefits of the delay technique. Lastly, incorporating patient-reported outcome measures (PROMs) is essential for capturing the patient's perspective on the success of the surgery. PROMs can provide insights into the functional and aesthetic outcomes from the patient's viewpoint, complementing objective clinical measures. By addressing these key design elements, future studies can provide robust evidence on the necessity and efficacy of the surgical delay technique, ultimately leading to better patient outcomes and more standardized clinical practices.

Advancing techniques through innovation

Integrating advanced imaging modalities, including laser doppler imaging (LDI), indocyanine green angiography (ICGA), and near-infrared spectroscopy (NIRS), offers real-time assessment of flap perfusion, aiding surgeons in informed decision-making during surgery (9,10). By incorporating these modalities into preoperative planning and intraoperative assessment, surgeons can optimize flap design and minimize ischemic complications. Moreover, the exploration of tissue engineering and regenerative medicine holds potential in enhancing flap survival and promoting tissue regeneration. Further investigation, however, is required before clinical application (11,12). Advancements in microsurgical techniques, such as supermicrosurgery and robotic-assisted microsurgery, facilitate precise vascular connections and enhance surgical precision (13). These techniques minimize surgical trauma and morbidity, leading to superior outcomes in abdominal-based flap surgery (14). Furthermore, ongoing research into pharmacological interventions, including vasodilators and anti-inflammatory agents, demonstrate potential to improve flap perfusion and reduce ischemic complications (15,16). Clinical trials evaluating the efficacy of these agents in enhancing flap survival are underway, with promising preliminary results.

Conclusions

The integration of surgical delay techniques in flap surgery holds significant promise for enhancing patient outcomes, particularly in high-risk individuals. Standardizing these techniques through rigorous comparative studies is crucial for establishing evidence-based guidelines. Identifying optimal patient profiles for surgical delay and involving multidisciplinary teams in patient selection can maximize benefits and minimize risks. Additionally, designing robust studies with standardized protocols, long-term follow-up intervals, and patient-reported outcomes will provide clear evidence of the necessity and efficacy of surgical delay. Continued innovation in imaging, tissue engineering, and microsurgical techniques will further advance the field, improving the quality of care and patient satisfaction.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Annals of Translational Medicine*. The article did not undergo external peer review.

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at <https://atm.amegroups.com/article/view/10.21037/atm-24-108/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Cite this article as: Hirani R, Boyd CJ. Optimizing flap surgery: the need for standardized surgical delay techniques and patient-specific approaches. *Ann Transl Med* 2024;12(6):110. doi: 10.21037/atm-24-108