

PREVENTION AND TREATMENT OF POSTOPERATIVE COMPLICATIONS IN THE PERINEAL WOUND AREA, INCLUDING DELAYED EPITHELIALIZATION AND SECONDARY WOUND HEALING

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Abstract

Postoperative complications involving the perineal wound remain a clinically important problem because of the anatomical characteristics of the region, its proximity to the gastrointestinal and genitourinary tracts, constant mechanical stress, moisture, and the high density of microorganisms. Delayed epithelialization, wound dehiscence, surgical-site infection, persistent inflammation, and secondary wound healing may substantially prolong recovery and negatively affect patients' quality of life. The development of perineal wound complications is influenced by both local and systemic factors, including tissue perfusion, contamination, surgical technique, obesity, diabetes mellitus, smoking, nutritional deficiency, immunosuppression, anemia, and the presence of infection. Prevention therefore requires an integrated perioperative strategy that includes appropriate patient preparation, meticulous surgical technique, effective hemostasis, infection prevention, adequate tissue perfusion, nutritional optimization, and individualized postoperative wound surveillance. When delayed healing or wound disruption develops, management should be based on careful assessment of the wound, control of infection, removal of devitalized tissue when indicated, maintenance of an appropriate moist wound environment, optimization of systemic conditions, and selection of appropriate local or advanced wound therapies. This article reviews contemporary principles for preventing and treating postoperative perineal wound complications, with particular attention to delayed epithelialization and secondary wound healing.

Keywords: perineal wound, postoperative complications, delayed epithelialization, secondary wound healing, surgical-site infection, wound dehiscence, wound management, tissue repair, postoperative care.

1. Introduction

Perineal wounds represent a distinctive category of postoperative wounds because healing takes place in an anatomically complex region exposed to multiple mechanical, microbial, and physiological influences. The perineum is located close to the anorectal and urogenital structures and is frequently exposed to moisture, friction, pressure, and bacterial contamination. These characteristics create conditions that can interfere with normal tissue repair and increase the likelihood of postoperative

complications.

Normal wound healing is a coordinated biological process involving hemostasis, inflammation, proliferation, epithelialization, extracellular matrix formation, angiogenesis, and tissue remodeling. Successful progression through these stages requires adequate blood supply, sufficient oxygenation, appropriate immune activity, effective cellular proliferation, and a favorable local wound environment. Disruption of any of these mechanisms may result in delayed healing.

Epithelialization is particularly important for restoration of the protective surface of the wound. During this stage, keratinocytes migrate across the wound bed and gradually reconstruct the epithelial barrier. If epithelial migration is impaired by infection, excessive inflammation, tissue ischemia, desiccation, mechanical trauma, or inadequate nutritional support, wound closure may be substantially delayed.

Secondary wound healing occurs when the wound is not completely closed by primary approximation of the tissue edges and must instead heal through granulation tissue formation, contraction, and progressive epithelialization. Although secondary healing is an effective physiological mechanism, it generally requires a longer period and may be associated with increased exudate, discomfort, scar formation, and prolonged need for wound care.

Perineal wound complications may include superficial or deep surgical-site infection, partial or complete wound dehiscence, hematoma, seroma, necrotic tissue, persistent drainage, delayed epithelialization, chronic inflammation, excessive granulation tissue, and persistent non-healing wounds. These complications may occur independently or in combination.

Surgical-site infection is among the most important causes of delayed postoperative healing. Microbial contamination can prolong the inflammatory phase, damage newly formed tissue, increase exudate production, and interfere with collagen deposition and epithelial migration. In severe cases, infection may result in wound separation, abscess formation, systemic inflammatory response, or the need for additional surgical intervention.

The anatomical location of a perineal wound contributes significantly to this risk. The wound is situated near areas with a high microbial burden, and postoperative contamination may occur despite appropriate surgical preparation. Fecal or urinary contamination, excessive moisture, and difficulty maintaining a clean and dry wound environment can further complicate postoperative management. Mechanical factors are also important. Sitting, walking, defecation, urination, coughing, and other routine activities may generate tension or friction around the perineal wound. Repeated mechanical stress can interfere with newly formed tissue and may contribute to wound-edge separation. Patient-related factors have a major influence on healing. Diabetes mellitus is associated with impaired immune function, microvascular dysfunction, altered collagen metabolism, and increased susceptibility to infection. Hyperglycemia may therefore contribute to both delayed epithelialization and postoperative infection.

Obesity may also negatively influence wound healing through impaired tissue perfusion, increased mechanical tension, chronic low-grade inflammation, and a higher risk of wound contamination. Similarly, smoking can reduce tissue oxygenation, impair angiogenesis, alter fibroblast function, and increase the likelihood of wound complications.

Nutritional status is another fundamental determinant of successful tissue repair. Protein deficiency, inadequate caloric intake, and deficiencies of micronutrients involved in collagen synthesis and immune function may interfere with wound healing. Patients undergoing major surgery or experiencing prolonged illness may be particularly vulnerable to nutritional deficiencies.

Anemia can reduce oxygen delivery to healing tissues. Oxygen is required for several critical processes, including oxidative killing by immune cells, fibroblast activity, collagen maturation, and angiogenesis. Therefore, clinically significant anemia should be identified and appropriately managed as part of perioperative optimization.

The surgical technique itself can influence postoperative wound outcomes. Excessive tissue manipulation, inadequate hemostasis, excessive tension at the wound edges, devascularization, retained foreign material, and poor tissue approximation may increase the risk of delayed healing. Gentle handling of tissues and preservation of viable blood supply are therefore essential principles of wound surgery.

Preoperative planning should include identification of patients at increased risk of postoperative wound complications. A detailed medical history should assess diabetes, vascular disease, smoking, obesity, immunosuppressive therapy, previous wound-healing problems, nutritional status, and other

relevant comorbidities.

Perioperative infection prevention is equally important. Appropriate antimicrobial prophylaxis should be selected according to the type of surgical procedure and local microbiological considerations when prophylaxis is indicated. Maintaining appropriate operating-room practices, skin preparation, sterile technique, and postoperative hygiene can reduce the risk of surgical-site infection.

Once a perineal wound complication occurs, management should begin with systematic assessment. The clinician should determine whether the wound is intact, partially separated, or completely dehiscent and should evaluate tissue viability, exudate, odor, erythema, pain, necrosis, and evidence of infection. Systemic signs such as fever, tachycardia, hypotension, or altered mental status require immediate clinical attention.

Treatment should be individualized according to the underlying cause. A wound that is delayed because of mild superficial inflammation requires a different strategy from a wound complicated by deep infection, extensive necrosis, or significant dehiscence. Treating the visible wound without correcting systemic or local causes may result in persistent non-healing.

Modern wound management emphasizes preservation of viable tissue, appropriate moisture balance, protection from contamination, reduction of mechanical stress, and stimulation of physiological tissue repair. Excessive dryness may impair cellular migration, whereas uncontrolled moisture can cause maceration and compromise surrounding skin.

Debridement may be necessary when necrotic or devitalized tissue prevents progression toward healing. The choice and extent of debridement should depend on the depth and characteristics of the wound and should be performed with attention to preserving viable structures.

Negative-pressure wound therapy has become an important option for selected complex postoperative wounds. By applying controlled subatmospheric pressure through an appropriate dressing system, this technique can assist with exudate management, reduce edema, promote granulation tissue formation, and support wound contraction. Its use should be individualized according to wound characteristics and patient condition.

Other advanced approaches, including specialized dressings, tissue-engineered materials, biologically active products, and selected regenerative techniques, may have a role in difficult wounds. However, these approaches should complement rather than replace fundamental principles such as infection control, adequate perfusion, nutritional optimization, and appropriate wound assessment.

The increasing emphasis on individualized wound management reflects the understanding that postoperative healing is determined by a complex interaction between local tissue conditions and systemic physiology. Effective prevention therefore begins before surgery and continues through the entire postoperative period.

The aim of this study is to evaluate the principal risk factors associated with postoperative perineal wound complications and to assess contemporary preventive and therapeutic approaches for delayed epithelialization, wound dehiscence, infection, and secondary wound healing.

2. Materials and Methods

A prospective observational study was designed to evaluate factors associated with postoperative perineal wound complications and to assess the effectiveness of an integrated wound-management strategy. The study included adult patients who underwent surgical procedures involving the perineal region and required postoperative wound observation.

Patients were evaluated during the perioperative period and followed throughout the postoperative healing process. Demographic characteristics, medical history, type of surgical procedure, duration of surgery, wound characteristics, perioperative antimicrobial therapy, comorbidities, nutritional status, and postoperative complications were documented.

Patients with diabetes mellitus, obesity, anemia, smoking history, cardiovascular disease, chronic inflammatory conditions, immunosuppression, or previous wound-healing problems were specifically identified because these factors may influence postoperative tissue repair.

Preoperative assessment included evaluation of general nutritional status, blood glucose, hemoglobin concentration, renal function, and other clinically relevant laboratory parameters. When indicated, nutritional or metabolic abnormalities were addressed before surgery.

During surgery, attention was given to preservation of tissue perfusion, atraumatic handling of tissues, adequate hemostasis, removal of clearly nonviable tissue, and appropriate wound-edge approximation. The surgical approach and closure technique were selected according to the

underlying disease, wound contamination risk, tissue condition, and expected mechanical stress. Postoperative wound assessment was performed at regular intervals. The wound was evaluated for epithelialization, edema, erythema, pain, exudate, odor, tissue viability, wound-edge separation, granulation tissue, and evidence of infection.

Delayed epithelialization was defined as failure of expected progression of epithelial coverage during the normal postoperative healing period. Secondary healing was documented when the wound required progressive granulation, contraction, and epithelialization rather than uncomplicated primary closure.

When wound complications developed, treatment was selected according to clinical findings.

Management options included local wound cleansing, appropriate dressings, infection control, removal of devitalized tissue, management of wound exudate, optimization of glucose and nutritional status, reduction of mechanical stress, and advanced wound therapies in selected cases.

Microbiological samples were obtained when infection was clinically suspected, particularly in the presence of purulent discharge, progressive erythema, systemic inflammatory signs, unexpected wound deterioration, or persistent non-healing. Antimicrobial treatment was selected according to the clinical presentation and, when available, microbiological susceptibility results.

Patients were monitored until satisfactory epithelialization or clinically stable wound closure was achieved. The primary outcomes were incidence of delayed epithelialization, wound dehiscence, surgical-site infection, and prolonged secondary healing.

Secondary outcomes included duration of wound care, need for additional procedures, length of hospitalization, recurrence of wound complications, and overall healing time.

Statistical analysis was performed using appropriate statistical software. Continuous variables were expressed as mean values with standard deviations, while categorical variables were reported as frequencies and percentages.

3. Results

The postoperative assessment demonstrated that perineal wound healing was influenced by a combination of local wound characteristics, patient-related factors, and perioperative management. Most patients demonstrated progressive reduction in wound exudate, development of healthy granulation tissue, and gradual epithelial coverage during follow-up. However, a clinically important subgroup experienced delayed healing or other postoperative wound complications.

Delayed epithelialization was one of the most frequently observed healing abnormalities. Patients with delayed epithelialization generally demonstrated prolonged inflammatory activity, persistent exudate, fragile granulation tissue, or incomplete epithelial coverage at the expected stage of recovery. In several cases, delayed epithelialization was associated with superficial wound infection or repeated mechanical irritation.

Wound dehiscence was observed more frequently among patients with increased wound tension, postoperative infection, impaired tissue perfusion, obesity, diabetes mellitus, and prolonged coughing or physical strain. Partial wound separation was more common than complete disruption. Patients with limited superficial separation generally responded to conservative wound management, whereas deeper or infected dehiscence required more intensive intervention.

Surgical-site infection was associated with delayed wound progression and increased duration of wound care. Patients with clinical evidence of infection demonstrated greater wound exudation, local erythema, tenderness, and delayed development of a stable epithelial surface. Microbiological assessment identified a range of bacterial organisms, with the specific pattern varying according to the underlying procedure and individual patient characteristics.

Patients with diabetes mellitus demonstrated slower wound progression than patients without diabetes. Poor perioperative glycemic control was particularly associated with prolonged inflammation and increased susceptibility to infection. Patients with better metabolic control demonstrated more favorable epithelialization and fewer wound-related complications.

Obesity was also associated with an increased incidence of delayed wound healing. Increased tissue thickness, mechanical tension, local moisture, and impaired microcirculation may have contributed to this association. Patients with obesity required more frequent wound assessment and, in some cases, longer periods of local wound care.

Smoking was associated with a higher frequency of delayed epithelialization. The observed relationship may be explained by reduced tissue oxygenation, impaired endothelial function,

decreased fibroblast activity, and inhibition of angiogenesis.

Nutritional status demonstrated a clinically relevant relationship with healing outcomes. Patients with inadequate protein intake or evidence of nutritional depletion were more likely to experience prolonged wound healing. Nutritional optimization was associated with improved granulation tissue development and progressive epithelial migration.

Anemia was another factor associated with delayed recovery. Patients with reduced hemoglobin concentrations demonstrated slower wound progression, particularly when anemia occurred together with infection or nutritional deficiency. Correction of clinically significant anemia was accompanied by improvement in the overall healing trajectory in appropriately selected patients.

The integrated postoperative wound-management strategy was associated with progressive improvement in wound condition. Regular assessment, appropriate wound cleansing, moisture-balanced dressings, control of infection, protection from mechanical trauma, and correction of systemic risk factors contributed to favorable healing.

Selected patients with complex wounds received negative-pressure wound therapy. These patients generally demonstrated improved exudate control, reduction in local edema, development of healthy granulation tissue, and progressive reduction in wound dimensions. Negative-pressure therapy was particularly useful for selected wounds with substantial exudate or difficult-to-manage wound beds. Patients with superficial complications generally achieved healing through conservative treatment and secondary epithelialization. In contrast, deep infection, extensive necrosis, or significant wound disruption required more intensive treatment, including surgical revision or debridement when clinically indicated.

The duration of wound healing varied substantially according to the severity of the complication. Patients without significant postoperative complications demonstrated the shortest healing periods, while patients with infection, extensive dehiscence, metabolic disorders, or nutritional deficiency required prolonged wound care.

A combination of early postoperative surveillance and rapid correction of local and systemic risk factors was associated with better outcomes than delayed recognition of wound deterioration.

4. Discussion

The findings demonstrate that postoperative perineal wound healing is a multifactorial process requiring simultaneous control of local tissue conditions and systemic patient factors. Delayed epithelialization and secondary wound healing should not be considered isolated complications because they frequently arise from a combination of infection, impaired perfusion, mechanical stress, metabolic dysfunction, and nutritional limitations.

The perineal region presents unique challenges for postoperative wound management. Its anatomical proximity to the gastrointestinal and genitourinary systems creates a relatively high risk of microbial contamination. In addition, moisture, friction, pressure, and frequent movement may repeatedly disturb the wound environment.

The results emphasize the importance of preventing infection. Once a postoperative wound becomes infected, inflammatory activity may persist beyond the normal phase of tissue repair. Excessive inflammation can damage newly formed extracellular matrix, increase tissue breakdown, and delay migration of keratinocytes across the wound surface.

For this reason, clinical surveillance should begin immediately after surgery. Early recognition of increasing pain, erythema, abnormal exudate, wound-edge separation, fever, or unexpected deterioration allows intervention before a superficial complication progresses to a deeper infection or extensive dehiscence.

The management of postoperative infection should be based on clinical severity. Local wound care may be sufficient for minor superficial abnormalities, whereas deeper infection may require drainage, debridement, microbiological investigation, and systemic antimicrobial therapy. Antimicrobial treatment should be appropriately targeted whenever microbiological information is available.

The association between diabetes and delayed wound healing observed in this study is biologically plausible. Persistent hyperglycemia can impair leukocyte function, alter microvascular circulation, increase oxidative stress, and interfere with collagen synthesis. Effective perioperative glycemic management is therefore an important component of wound prevention.

Obesity represents another important modifiable risk factor. Excess adipose tissue may have reduced vascularity and may increase mechanical stress on the wound. Skin folds and local moisture can

additionally facilitate microbial growth and maceration. Weight management and appropriate postoperative positioning can therefore contribute to improved outcomes.

Smoking cessation should be encouraged before elective surgery whenever possible. Nicotine and other components of tobacco smoke can compromise tissue oxygenation and vascular function, while carbon monoxide reduces oxygen delivery. These effects can interfere with angiogenesis and collagen maturation and may increase the risk of wound complications.

Nutritional optimization is equally important. Tissue repair requires adequate protein, energy, amino acids, vitamins, minerals, and other micronutrients. In patients with prolonged illness or major surgery, early identification of nutritional deficiency allows appropriate dietary intervention and may support recovery.

The findings also support careful consideration of tissue perfusion during surgery. Excessive tissue tension or aggressive dissection can compromise local blood flow. Atraumatic surgical technique and preservation of viable tissue are therefore fundamental components of prevention.

Secondary healing should not automatically be considered a treatment failure. In appropriately selected wounds, allowing controlled secondary healing can be safer than immediate closure, particularly when contamination or infection is present. The formation of healthy granulation tissue followed by contraction and epithelialization can ultimately produce stable wound closure.

However, secondary healing requires prolonged monitoring. The wound must be protected from excessive moisture, contamination, mechanical trauma, and further tissue breakdown. Regular reassessment is necessary to determine whether the wound is progressing normally or whether additional intervention is required.

Negative-pressure wound therapy may be valuable in selected complex postoperative wounds. Its potential benefits include management of excessive exudate, reduction of tissue edema, mechanical stimulation of granulation tissue, and assistance with wound contraction. Nevertheless, it should be considered an adjunct to comprehensive wound management rather than a substitute for infection control, adequate perfusion, or correction of systemic risk factors.

The role of modern dressings is also increasingly important. Different wound stages require different dressing characteristics. Highly exudative wounds may require products capable of absorbing excess fluid, whereas relatively clean wounds with active epithelialization may benefit from dressings that maintain a controlled moist environment and protect newly formed tissue.

An important principle of modern wound care is avoiding unnecessary trauma during dressing changes. Repeated mechanical disruption of fragile granulation tissue can prolong inflammation and delay epithelial migration. Dressing selection should therefore consider the condition of the wound bed and the frequency of required changes.

The management of perineal wounds should also include attention to patient comfort and quality of life. Pain can reduce mobility and interfere with sleep, nutrition, and participation in rehabilitation. Appropriate analgesia and patient education can facilitate recovery and improve adherence to wound-care recommendations.

Multidisciplinary management may be particularly valuable for complicated cases. Surgeons, wound-care specialists, nurses, nutrition professionals, endocrinologists, infectious disease specialists, and rehabilitation professionals may all contribute to successful management depending on the patient's needs.

The results further emphasize the importance of individualized treatment. A standardized wound-care protocol can provide a useful framework, but the specific intervention should be adapted according to wound depth, tissue viability, infection status, exudate level, patient comorbidities, nutritional status, and ability to maintain postoperative care.

Preventive strategies are generally more effective and less resource-intensive than treatment of established wound complications. Appropriate preoperative optimization, meticulous surgical technique, infection prevention, adequate nutritional support, glycemic control, and early postoperative surveillance should therefore be considered integral components of surgical care.

Future approaches may increasingly incorporate digital wound monitoring, three-dimensional wound measurement, artificial intelligence-assisted assessment, advanced biomaterials, tissue-engineered products, and personalized wound-healing algorithms. These technologies may improve objective monitoring and allow earlier identification of patients at risk for prolonged healing.

5. Conclusion

Postoperative perineal wound complications, particularly delayed epithelialization, infection, wound dehiscence, and prolonged secondary healing, represent significant clinical challenges. Their development is influenced by both local factors and systemic patient characteristics.

The most effective prevention strategy begins before surgery and continues throughout the postoperative period. Optimization of diabetes control, nutritional status, anemia, smoking status, and other modifiable risk factors should be combined with atraumatic surgical technique, preservation of tissue perfusion, appropriate infection prevention, and careful wound closure.

Early postoperative assessment is essential for identifying infection, tissue ischemia, excessive exudate, wound separation, or impaired epithelialization. Prompt treatment of the underlying cause can prevent progression to more severe complications.

When delayed healing occurs, management should focus on maintaining a physiologically favorable wound environment, controlling infection, removing devitalized tissue when necessary, managing exudate, minimizing mechanical trauma, and correcting systemic factors that interfere with tissue repair.

Secondary wound healing remains an important and effective option for appropriately selected perineal wounds, particularly when primary closure is unsafe because of contamination or infection. Advanced techniques such as negative-pressure wound therapy may provide additional benefits in selected complex wounds.

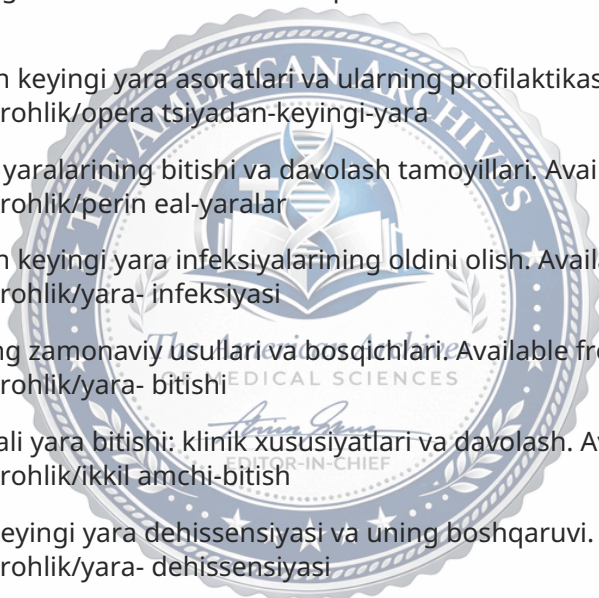
A multidisciplinary and individualized approach offers the greatest potential for reducing postoperative complications, shortening healing time, minimizing the need for repeated surgical intervention, and improving patients' quality of life.

Ultimately, successful perineal wound management depends not on a single treatment method but on coordinated control of infection, tissue perfusion, mechanical stress, metabolic status, nutrition, and wound environment. Continued development of evidence-based protocols and modern wound technologies may further improve outcomes for patients at high risk of delayed epithelialization and secondary wound healing.

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