Wound healing in total joint replacement

Satisfactory primary wound healing following total joint replacement is essential. Wound healing problems can have devastating consequences for patients. Assessment of their healing capacity is useful in predicting complications. Local factors that influence wound healing include multiple previous incisions, extensive scarring, lymphoedema, and poor vascular perfusion. Systemic factors include diabetes mellitus, inflammatory arthropathy, renal or liver disease, immune compromise, corticosteroid therapy, smoking, and poor nutrition. Modifications in the surgical technique are necessary in selected cases to minimize potential wound complications. Prompt and systematic intervention is necessary to address any wound healing problems to reduce the risks of infection and other potential complications.

Achieving and maintaining primary wound healing in total joint replacement is essential for a satisfactory outcome. Wound healing problems can result in devastating consequences. This review will focus on the optimisation of patient factors in order to reduce wound healing complications, the diagnosis of wound healing complications, and the treatment options to recover the situation in these patients.

Peri-operative patient management

Risk factors for wound complications can be classified as those that are intrinsic to the patient or extrinsic within the environment. These factors can be further differentiated into modifiable or non-modifiable risks. It is critical to reduce medically associated risks for patients where possible prior to surgery, and during the peri-operative period.

Achieving optimum pre-operative nutrition of patients and controlling as much as possible any medical comorbidities, decreases post-operative wound complications. Low total lymphocyte counts, transferrin, albumin, and pre-albumin are associated with poor healing.1 Nutritional supplementation should aim to achieve a total lymphocyte count > 1500 cells/μl, albumin level > 3.5 g/dl, zinc level > 5 μl/dl, and transferrin > 200 mg/dl.2,3

Cierny, Mader and Pennick classified the patient healing response into three categories;4 type A: no healing compromise, type B: local, systemic, or combined compromising factors, and type C: significant compromising factors, high morbidity, and poor prognosis. Local factors particular to patients include extensive scarring, lymphoedema, poor vascular perfusion, and excessive adipose tissue. Systemic comorbidities include diabetes mellitus, rheumatoid diseases, renal or liver disease, corticosteroid medication, poor nutrition, immune compromise states such as human immunodeficiency virus (HIV) infection, and smoking. Smoking causes vascular constriction and makes the patient a type B healing risk.5 Since a history of smoking is associated with a statistically significant increased risk of periprosthetic joint infection, many centres use formal smoking cessation programs to assist patients in giving up, preferably before surgery.

Patel et al6 conducted a retrospective study to determine the risk factors associated with prolonged wound drainage after primary total hip (THR) and total knee replacements (TKR). Risk factors included: a BMI > 40 kg/m², the use of low molecular weight heparin (LMWH) prophylaxis, and a high drain output after THRs. High drain output was the only risk factor associated with prolonged wound drainage after TKRs.6 HIV infection is also a risk for post-operative wound complications and infection. These patients should have a CD4 count > 400 cells/μm³ prior to surgery.7 Obesity is a risk factor associated with prolonged operation times, and a higher rate of early post-operative complications including excessive wound drainage and infection.8
Mellitus has been identified as an independent risk factor. However, optimal peri-operative glucose control is an important factor in decreasing wound complications for all patients, including those without diabetes. Mravic et al demonstrated that non-diabetic patients were three times more likely to develop periprosthetic joint infection if the fasting blood glucose was > 140 mg/dl on the first post-operative day. Although haemoglobin A1C levels have not been consistently associated with an increased risk of periprosthetic joint infection, many centres delay surgery until levels are < 7%.

Proper selection, dosing, and timing of prophylactic antibiotics are critical. This is a quality measure used by the Centres for Medicare and Medicaid Services (CMS). Most commonly, a first-generation cephalosporin is administered within one hour prior to the skin incision. In patients with allergies to penicillin or cephalosporins, clindamycin is an acceptable alternative. For patients with methicillin-resistant Staphylococcus aureus (MRSA) or coagulase-negative Staphylococcus colonisation, vancomycin is used. Timing of vancomycin infusion requires additional attention to meet the compliance requirement (up to 120 minutes prior to skin incision).

**Intra-operative patient management**

Selection of the most appropriate incision can diminish the risk associated with multiple prior incisions at the surgical site. The blood supply to the skin over the knee joint is fasciocutaneous and is more robust on the medial side. When there are multiple previous incisions, select the most lateral one to approach the knee joint. This may require a tubercle osteotomy to best expose the joint. Meticulous handling of the soft tissues is essential. Undermining of the skin flaps should be minimised, especially in the lateral flap. Full thickness fasciocutaneous flaps best preserve the blood supply. In patients with extensive scarring or adherence to the underlying tissue, pre-operative use of tissue expanders or muscle flaps during surgery may provide a more satisfactory healing environment.

In the authors’ experience, personal isolation suits for many and laminar flow operating rooms for most are routinely used for THRs and TKRs. However, Hooper et al analysed over 51 000 primary THRs and over 36 000 primary TKRs. The data failed to demonstrate any decrease in the rate of infection using these methods.

**Post-operative patient management**

Post-operatively, the method of thromboembolism prophylaxis has an effect on wound complications. Potent chemoprophylaxis has been associated with higher rates of wound drainage and complications. Parvizi et al demonstrated a clear association with anticoagulants to periprosthetic joint infection after THR and TKR. Patients with infections had a higher mean international normalised ratios (INR) > 1.5 compared with those patients that did not develop an infection. Others have recommended using a combination of mechanical prophylaxis and less potent chemoprophylaxis in those patients at high risk of wound complications.

**Diagnosis and management of wound complications**

Wound healing problems can range from superficial incisional, to deep incisional (outside the joint space), to involving the joint space (Fig. 1). Gaine et al reported a 10% incidence of superficial wound problems in primary TKRs. Patel et al found that each day of prolonged wound drainage increased the risk of deep wound infection by 29% following TKRs.

Drainage from the incision one to three days after surgery should be managed by immobilisation in extension, and application of a foam or rolled gauze compressive
bandage over the incision. Use of immobilization and observation should not exceed three days. Wound drainage that persists greater than three days is considered abnormal and should be treated surgically to decrease the chance of subsequent periprosthetic joint infection.\(^6,16,19,20\)

Aspiration of the joint is necessary if there is a high level of suspicion. The synovial fluid should be analysed for white blood cell (WBC) count and differential. Cultures should also be obtained. There is some consensus with regard to the cell count. In patients with TKRs, a synovial WBC count $> 1700$ cells/$\mu l$ or a polymorphonuclear neutrophil (PMN) percentage $> 65\%$ is the recommended threshold for the diagnosis of infection.\(^21-23\) In THRs, the recommended thresholds are a synovial WBC count of $> 4200$ cells/$\mu l$ or PMN percentage $> 80\%$.\(^24\) During the acute post-operative period, within six weeks of surgery, the thresholds are higher, with a synovial WBC count $> 10000$ cells/$\mu l$, and PMN $> 89\%$.\(^25\)

A single punctate site of persistent drainage may occasionally present a diagnostic challenge. We have found that intra-articular injection of a mixture of 10 ml hydrogen peroxide plus 0.5 ml of methylene blue will produce a ‘blue fountain’ at the punctate site if there is communication with the joint space.\(^26\) This should be carried out in the operating room since a positive finding requires operative intervention.

When surgery is undertaken, necrotic skin edges should always be excised and the wound haematoma evacuated. Proper debridement with total synovectomy and removal of all the contaminated tissues should be the goal. This is likely to produce a viable wound and facilitates further management.\(^27\) In cases with inadequate soft-tissue coverage a negative pressure wound dressing may help prevent further tissue necrosis and promote healing through reduction of oedema and elimination of shear. Soft-tissue coverage may also be achieved through the use of muscle flaps (Fig. 2).
Conclusion
Wound healing is essential in achieving a satisfactory outcome after joint replacement surgery. Wound healing problems can be minimised using a proactive approach to enhance the patient’s healing capacity. Once a problematic wound is recognised, prompt management of the wound including evacuating haematomas, debriding necrotic tissue, eliminating dead space, and obtaining adequate soft tissue coverage all contribute to satisfactory wound healing.

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References