Value of Indocyanine Green Angiography to Guide Wound Management and Prevent Necrosis in a Robotic Surgical Procedure

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Abstract

Background: Inguinal lymph node dissection is performed in penile cancers and has a high complication rate with mostly wound-related complications. This case study demonstrates the use of robotic technique, tissue perfusion assessment, and negative pressure wound dressing to minimize wound-related complications.

Case Presentation: A 67-year-old Maltese man was diagnosed with squamous cell carcinoma (SCC) *in situ* on biopsy of a self-detected penile lump. The patient underwent a partial penectomy and histopathology report confirmed moderately differentiated SCC with clear surgical margins. A positron emission tomography/CT scan was performed preoperatively, which showed several nodes in the right inguinal region with increased metabolic activity and nonspecific findings in the left inguinal region. The patient had a robotic right inguinal node dissection the following month. Assessment of the skin flap was performed using indocyanine green (ICG) angiography with the SPY system and there was excellent vascularity. Further treatment was performed 3 months later with a robotic left inguinal node dissection. Again, assessment of the skin flap was performed using the SPY system but showed an area of poor perfusion in the left femoral triangle, which suggested a high risk of inadequate wound healing and tissue necrosis. The clinical decision to use the negative pressure PICO dressing was made intraoperatively to enhance perfusion of the skin. When the PICO dressing was removed it revealed excellent tissue viability and vascularity of the skin flap. Histopathology analysis showed no evidence of malignancy in the nodes removed and patient was discharged to the outpatient care of their urologist.

Conclusion: This case study demonstrates that the use of a tissue perfusion assessment tool avoided a potentially poor clinical outcome for the patient. Robotic inguinal lymph node dissection was performed in coordination with ICG angiography to guide the use of negative pressure wound therapy and facilitate good wound healing.

Keywords: PICO, SPY, indocyanine green angiography, wound management

Introduction and Background

PENILE CANCER IS A RARE malignancy (<1 in 100,000 men worldwide) with the earliest site of regional metastases being the superficial and deep inguinal nodes.¹ In patients with penile cancer with clinically palpable inguinal lymph nodes unilaterally or bilaterally, inguinal lymph node dissection is recommended for disease staging and management.¹ However, inguinal lymph node dissection is associated with a high complication rate of up to 80%, including mostly wound-related complications such as wound infection, wound dehiscence, and skin necrosis.¹ Laparoscopic and robotic inguinal lymph node dissections are associated with

adequate lymph node yield and decreased morbidity compared with open procedures.¹

An assortment of technologies, including Doppler or CT/MR angiography, is available to assess blood flow; however, a universal option for reconstructive surgery in the operating theatre is yet to be determined.² Laser-assisted indocyanine green (ICG) angiography is a vascular imaging technology used in devices such as the SPY system to assess skin and soft tissue perfusion intraoperatively in real time.² ICG is injected intravenously and binds to plasma proteins, emitting a light frequency that is detected by a calibrated camera and allowing the detection of areas of relative hypoperfusion.² ICG has an outstanding safety profile with

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FIG. 1. Skin flap over right femoral triangle region imaged with the SPY system to assess tissue perfusion.

short half-life allowing for multiple evaluations within the same procedure and has been associated with clinical outcomes and guides rapid surgical decision making such as flap design, tissue resection, and dressing choice.²

Negative pressure wound therapy such as PICO dressings and vacuum assisted closure (VAC) dressings is a well-proven clinically efficacious therapy with reduced rates of wound complications.³ It has several mechanisms of action on wound beds, including angiogenesis, stimulation of growth of granulation tissue, evacuation of wound exudate, decreased bacterial bioburden, and wound contraction.⁴ It is most widely used in the management of complex open wounds where it progresses nonhealing wounds until readiness for closure surgically or through secondary intention.⁵ It also has a noteworthy effect on the prevention of skin necrosis with a more than threefold decrease in the rate of skin necrosis with a negative pressure dressing (1%) compared with standard surgical dressings (3.6%).⁵

This study demonstrates the use of the SPY system to assess tissue viability intraoperatively and subsequently guiding the decision to use a PICO dressing to facilitate wound healing.

Case Presentation

A 67-year-old Maltese man initially presented with a self-detected lump in his right groin in February 2019. After a short course of antibiotics, he noticed a reduction in the size of the lump, however proceeded to have flexible cystoscopy with penile biopsy and a positron emission tomography (PET)/CT scan the same month. Clinically there was a keratinizing lesion on the glans penis and foreskin left of midline, which also appeared to involve the spongiosum on palpation. Three biopsies were taken, which showed epidermal thickening with full-thickness dysplasia, hyperkeratosis, and superficial dermal chronic inflammation that was consistent

FIG. 2. Skin flap over left femoral triangle region imaged with the SPY system to assess tissue perfusion.

with squamous cell carcinoma (SCC) *in situ*. No invasive tumor was identified on biopsy. The PET/CT scan revealed several nodes within the right inguinal region with increased fluorodeoxyglucose with two nodes having a level of metabolic activity (standardized uptake value [SUV] 10.6 and 5.8) consistent with SCC. The left inguinal node findings were nonspecific with one left inguinal node having mild uptake (SUV 1.5) and metastatic disease could not be excluded.

The patient's treating urologist discussed these pathologies in the hospital Uro-Oncology meeting with the agreed mainstay of treatment being a partial penectomy followed by inguinal lymph node dissection. There was also discussion around neoadjuvant chemotherapy although evidence is weak in patients with N1 and N2 disease. These findings and management plan was discussed with the patient and he was agreeable to a partial penectomy with the aim of the procedure to leave him with sufficient penile length to be able to direct a urinary stream while concurrently having a clear surgical margin. After open disclosure of the potential outcomes and complications of the partial penectomy, including but not limited to urethral cutaneous anastomotic strictures, bleeding, and infection, the patient underwent the partial penectomy in March 2019.

During the procedure the tumor margin was carefully marked and a tourniquet applied. There was sequential incision circumferentially through skin, dartos fascia, and Buck's fascia followed by ligation and division of superficial and deep dorsal vessels. The corpora was divided taking care to preserve spongiosum tissue and the urethra divided further distally by more than a centimeter. The penectomy was completed and tourniquet was released with hemostasis assured. The distal penis was sent for histopathologic testing. An indwelling urinary catheter (IDC) was inserted and kept *in situ* until postoperative review. Dressings were left intact during the patient's overnight stay in hospital. The patient could eat and drink after the procedure and he was started on oral antibiotics (cephalexin) to complete 7 days course.

Histopathology analysis of the partial penectomy confirmed a moderately differentiated SCC extending to a maximum depth of 6 mm in the subepithelial connective tissue with the overlying squamous epithelium also showing dysplastic features amounting to SCC *in situ*. The tumor was well clear (>10 mm) of the proximal margin and 1 mm clear of the nearest lateral aspect of the penile shaft. No definite lymphovascular or perineural invasion was identified.

The patient was reviewed 4 days postoperatively and his wounds were found to have healed well. There was further discussion with the patient regarding a right-sided radical inguinal lymphadenectomy and he was counseled regarding the options of an open vs minimally invasive approach. The potential approach of a robot-assisted procedure was suggested because of the advantage of reduced risk of lymphedema and lymph leak as well as the reduced risk of potential flap necrosis. The patient was agreeable to robot-assisted inguinal lymphadenectomy with the assistance of a colleague urologist who has had previous exposure to the procedure. The main risks of lymphedema, vascular injury, and flap necrosis was revisited with the patient and other small risks also explained in detail. The patient underwent a robotic right inguinal node dissection in April 2019.

Under general anesthetic and intravenous (IV) antibiotics cover the patient was positioned and prepped in modified Lloyd Davis position. An IDC was inserted and the femoral triangle was marked. An initial incision was made 4 cm caudal to the femoral triangle apex and blunt dissection was performed below Camper's fascia. Three robotic ports and one 5 mm assist port was inserted and the robot was docked. Dissection was initially performed within the boundaries of the femoral triangle and below the Camper's fascia carefully dissecting the nodes away from the skin, while preserving full thickness of skin. The great saphenous vein as well as accessory saphenous veins were preserved. The superficial nodal packets were placed laterally and deep inguinal node dissection was performed, removing the nodes medial to the femoral artery and vein. The specimen was placed in an endocatch bag, extracted from the camera port and sent for histopathologic testing. A 14F Jackson-Pratt drain was placed and skin closure performed.

After skin closure, ICG assessment of the skin flap was performed using the SPY machine that confirmed excellent vascularity of the skin overlying the femoral triangle (Fig. 1). The patient was admitted to the ward for monitoring postoperative and had appropriate IV antibiotics and deep venous thrombosis prophylaxis. The drain was placed on free drainage and to remain *in situ* on discharge with compression dressing. The patient was discharged from hospital the following day for follow-up in 1 week.

Histopathology analysis of the right inguinal node dissection showed 2/6 positive lymph nodes for metastatic SCC in the superficial right inguinal lymph node dissection with the largest tumor deposit measuring 47 mm. The tumor was well differentiated and composed of islands of squamous cells showing prominent keratinization. The margins of resection were involved with one tumor deposit present. There was no evidence of metastatic carcinoma in the deep right inguinal lymph node dissection.

On postoperative follow-up the decision was made with the patient to have a robotic left-sided inguinal node dissection for further treatment of his penile SCC given the nonspecific findings on PET/CT scan. The patient consented and underwent a robotic left inguinal node dissection in July 2019. The procedure was uneventful and proceeded similarly to his right-sided surgery. Of note, during the procedure some prominent and possibly pathologic nodes were identified, especially medially in the superficial inguinal nodal group. A superficial inguinal lymph node dissection was performed with preservation of the great saphenous vein but ligation of the short saphenous vein. The deep nodes were not resected. The specimen was sent for histopathologic testing.

Postoperatively an assessment of perfusion of the skin flap was again performed using SPY technology, which indicated a small patchy area at the center of the femoral triangle showing reduction in blood flow (Fig. 2). Because of this poor result, an intraoperative decision was made to use a negative pressure PICO dressing to enhance perfusion of the skin. The dressing was removed on day 6 postoperatively and revealed excellent vascularity of the skin flap. Histopathology analysis of the left inguinal node dissection showed no evidence of malignancy with 0 of 15 nodes affected. The patient was discharged from hospital with a plan to follow up with his primary treating urologist.

Discussion

This case study demonstrates an optimal postoperative outcome facilitated by the SPY tissue perfusion assessment system and PICO negative pressure wound therapy. Wound-related complications are extremely common with inguinal lymph node dissections. Although this complication is mitigated by performing the procedure robotically, it is still an ever-present risk. The right inguinal lymph node dissection had excellent skin vascularity confirmed by the SPY machine and had good wound healing on follow-up.

The subsequent left inguinal lymph node dissection showed poor skin flap perfusion on angiography with the SPY machine. Based on this information the clinical decision was made to utilize the PICO dressing to enhance perfusion of the skin resulting in better perioperative management and improved clinical results. If a regular dressing had been used, the alternative would have likely resulted in higher risk of necrosis of the skin flap and a poor clinical outcome.

Intraoperative vascular imaging provides the surgeon with real-time information of skin and soft tissue perfusion that facilitates the identification of poorly perfused tissue and allows for an informed decision regarding subsequent management to reduce complication rates.

The SPY system costs US\$650 as quoted by the company and previous cost analysis has concluded that it is cost-effective as a preventative measure for skin necrosis in high-risk patients such as smokers and obese patients.⁶ The PICO dressing unit (including two dressings and battery pack with batteries) costs £120 and requires experienced nursing staff for troubleshooting and patient or carer education to facilitate early discharge with the dressing. Follow-up in a nursing dressing clinic is also required for dressing reviews and removal of the dressing. However, these costs are offset by the number of days of inpatient hospital stay reduced or prevented if a patient experienced a wound complication.

Conclusion

In this case study, the use of a tissue perfusion assessment tool to assess skin flap viability leads to the use of a negative pressure wound dressing to facilitate good wound healing. A potentially poor clinical outcome was avoided and the patient benefited with excellent postoperative flap viability and recovery.

Disclosure Statement

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Abbreviations Used

CT = computed tomography
 ICG = indocyanine green
 IDC = indwelling urinary catheter
 IV = intravenous
 MR = magnetic resonance
 PET = positron emission tomography
 SCC = squamous cell carcinoma
 SUV = standardized uptake value
 VAC = vacuum assisted closure

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