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Graft Failures in Lower Limb Reconstruction for Non-Melanoma Skin Cancers (NMSCs)

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ABSTRACT

Aims/ Objectives: To measure quality of service provided, to correlate between graft morbidity and age, sex of the patient, size of the lesion, site, type of skin cancer and underlying co-morbidities, to improve service, to raise awareness and educate on the failures of spilt-skin grafts on the lower limb, to compare outcomes from other studies

Standards and Methods: Local guidelines on the STSGs within the Trust exist and should be followed. No formal standards found in BAPRAS, NICE, ASPS. Retrospective data collection on password-protected Trust computers.

Results: The majority of the grafts fell into the uncomplicated (44%) and minor complications (43%) category (0 and 1 respectively), whereas only 6% of the total grafts failed. In the category 3, there are 5% females and 1% males. It is apparent that there is a pattern in which the majority of the failed grafts are located in the shin (67% in category 0, 72% in category 1, 69% in category 2 and 73% in category 3). This observation is in accordance with another study which supports that the distal the lesion, the greater the complication rates. This could also be attributed to the decreased blood supply in the peripheral system. Failed grafts were noticed in patients >80 years old (91%), whereas cardiovascular conditions, including peripheral vascular disease, atrial fibrillation and hypertension were 82% in category 3.

Discussion: Actions for change Documentation and categorisation of STSG morbidity according to the following: Category 0 Healed/ uncomplicated graft, Category 1 Minor, easily-treatable complications (inflammation, slough, seroma), Category 2 Partial graft loss, >3 weeks to heal (infection, haematoma). Category 3 Failed graft. Pre-operative assessment for co-morbidities.

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KEYWORDS: NMSC, Non melanoma skin cancer, graft failure, lower limb reconstruction, graft failure in lower limb reconstruction

INTRODUCTION

Definitions

Graft morbidity categories	
Category 0	Healed/ uncomplicated graft
Category 1	Minor, easily-treatable complications (inflammation, slough, seroma)
Category 2	Partial graft loss, >3 weeks to heal (infection, haematoma)
Category 3	Failed graft

Split-thickness skin grafts (STSG) currently represent the most rapid, effective method of reconstructing large skin defects, granulating tissue beds, tissue loss across joints in areas where contraction will cause deformity, and where epithelialization alone will produce an unstable wound cover. For both chronic and acute wounds, STSG offer a rapid and effective way to provide closure and healing. Ideal conditions for successful STSG include red granulation tissue dominating the wound bed, no visible tendon or bone, no discernible sloughing or exudate in wound, no residual necrotic tissue, no local signs of soft-tissue infection, no systemic signs of infection, and no severe peripheral arterial disease (ankle-brachial index 0.9 or distal pulses present)[1].

Skin grafts in diabetic foot[1]

Graft survival is predicated on several factors: historically, graft failure rates were high and primarily attributed to

infection, highlighting the importance of biofilm management and eradication; as well preventing shearing, seroma, and hematoma formation beneath the graft with immobilization to allow for the initial take or incorporation, which occurs by diffusion of nutrition from the recipient site, termed 'plasmatic imbibition'. STSGs must be placed on a well-vascularized bed with low bacterial counts to prevent infection. Revascularization generally occurs between days 3 and 5 by reconnection of blood vessels in the graft to recipient site vessels or by ingrowth of vessels from the recipient site into the graft. Skin grafts generally will not take on poorly vascularized wound beds, such as bare tendons, cortical bone without periosteum, heavily irradiated areas, or infected wounds. However, virtually any tissue type with a vascular granulating bed is acceptable for grafting. NPWT has been shown to provide many aspects of STSG success by promoting granulation tissue, lowering bacterial counts, and removing accumulated fluid, such as hematoma/seroma, both of which reduce the chronic inflammatory process that occurs in chronic wounds such as elevated MMPs.

Graft failure[2]

A meticulous surgical technique contributes greatly to the survival of a skin graft. Particular attention should be paid to ensuringatraumatic graft handling, a well-vascularized, scar-free bed, careful haemostasis and removal of accumulated blood before dressing the wound, postoperative immobilization of the graft recipient site, use of a tourniquet during graft harvest and transfer and no proximal constricting bandages.

Flowers reviews the usual complications associated with graft failure and recommends steps to avoid them. The graft bed should be as clean as possible, free of dead tissue, and have an appropriate substrate (eg, bone should have periosteum, tendon should have peritenon). A clean area with endothelium is all that is required in the bed of a successful skin graft.

The most common cause of autologous skin graft failure is hematoma. The clot isolates the undersurface of the graft from the endothelial buds of the recipient site so that revascularization cannot take place.

The second most common cause of graft loss is infection. Infection can be avoided by carefully preparing the wound bed, using quilting sutures, meshing or pie-crusting the graft surface to allow free egress of subjacent fluids, and applying wet saline dressings that are changed every 4 hours.

Fluid beneath the graft can also cause graft necrosis. Areas rich in lymphatics such as the supraclavicular, inguinal, and axillary regions are particularly prone to develop seromas. Atraumatic tissue handling, cauterization of lymphatic vessels, limited use of electrocautery in the graft bed, and a light pressure dressing or VAC technique minimizes the risk of fluid accumulation under the graft.

Excessive pressure on a fresh graft may also cause it to die. The applied pressure should never exceed 30 mmHg. Tie-over dressings immobilize the graft, reduce dead space, and prevent hematoma formation, but exert no significant pressure on the wound. Other causes of graft failure include gravitational dependency, movement of the area arterial insufficiency, venous congestion, lymphatic stasis, and surgeon error.

Teh studied21 patients with stasis ulcers in an attempt to pinpoint the causes of graft failure. Wound exudates were assayed for fibrin degradation products, fibrinogen, available plasminogen, and active plasmin. All wounds showed granulation tissue and were classified as clean or dirty. Clean wounds had low bacterial counts and showed no detectable plasmin activity. Dirty wounds had high bacterial counts and increased levels of active plasmin. High plasmin and proteolytic enzyme activity was generally seen in wounds contaminated with beta-hemolytic streptococci and various species of Pseudomonas. The presence of fibrin under autografts was associated with success in 17 of 21 ulcers, and the absence of fibrin was associated with graft failure. This finding suggested to the author that dissolution of fibrin by plasmin and proteolytic enzymes is the probable mechanism in graft failure secondary to microorganisms[3].

In conclusion, a grafted wound is rendered sterile through the blocking action of fibrin in the interface between graft and bed. Fibrin plays a central role in graft survival and is responsible for the antibacterial character of adherent dressings and autografts. This bacteriostatic effect of grafts has proved invaluable in the management of large burns.

Skin graft classification, recipient and healing [4,5]

Podiatric surgeons commonly use skin grafting to help close cutaneous wounds secondary to trauma, following amputations and for chronic ulcerations. Surgeons also use skin grafts to cover the donor site following certain types of soft tissue flaps. Skin grafts provide rapid closure to full thickness wounds that might otherwise take a prolonged period of time to heal. The longer it takes a wound to close, the greater the cost and risk to the patient. In patients with diabetes, the risk of resistant strains of bacteria developing in chronic wounds is always a concern to the podiatric physician.

Skin grafts can be classified as autografts (from the same individual), allografts (from the same species) or xenografts (from different species). Surgeons have used cadaver skin when they needed to cover large areas, such as the case with burn victims, and this may initially show some degree of incorporation or "take." However, the host will eventually reject the graft, limiting its use to a temporary biological dressing. Xenografts never take and surgeons only use them as biological dressings. These types of grafts are rarely necessary in foot wounds due to the relatively small areas that one needs to cover. The most common types

of grafts used in foot wounds are autogenous skin grafts and are divided into two general types: full-thickness skin grafts (FTSGs) or split-thickness skin grafts (STSGs). Both types of grafts use the entire epidermis but vary as to the amount of dermis each uses. Distinct differences exist between these grafts. Accordingly, selecting one graft over the other is dependent on each specific case. Split-thickness skin grafts include the epidermis and a portion of the dermis. They are generally divided into thin (0.008 to 0.012 inch) grafts, intermediate (0.013 to 0.016 inch) grafts and thick (0.017 to 0.02) grafts, depending on the amount of dermis taken. The thinner the graft, the more likely a graft is to take. The higher initial success rate is the main advantage to using a thin graft over thicker grafts. The main disadvantage to using thin grafts is they are much less durable. One must consider this fact when using grafts in foot surgery. In addition, thin grafts contract much more than thicker grafts and are less cosmetically appealing. Skin grafting in the foot provides some unique challenges due to the stresses applied to the grafts by weight bearing forces and contact with shoe gear. As a general rule, one should avoid applying grafts to areas, such as underneath the metatarsal heads that directly bear weight. Grafts in these areas tend to break down over time and a soft tissue flap may be more appropriate.

Preparation of the recipient bed is the most critical component of skin grafting. It begins with the removal of all necrotic, fibrotic or avascular tissue. Do not use skin grafts to cover structures, such as tendon, cartilage and bone that are relatively avascular. Tendon covered by paratenon or bone covered by periosteum may support a graft. One may use grafts to cover small avascular regions by a process known as bridging. In these cases, the graft is supplied by the wound's periphery. If possible, practitioners should debride wounds and then allow them to granulate for several days prior to applying the graft. One should remove most of the granulation tissue since it has a tendency to harbor bacteria. A wound that is infected or contaminated will invariably cause the graft to fail. A quantitative bacterial culture of less than 1 x 106 is preferred prior to grafting.7 Researchers have shown that applying silver sulfadiazine to the wound for 10 days prior to grafting reduces the bacterial count greatly.8 Hemostasis of the recipient bed is critical. Excessive bleeding may result in a hematoma, which separates the graft from the bed and prevents it from taking. One may achieve hemostasis by using direct pressure, electrocautery, topical thrombin or epinephrine soaked gauze. Carefully assess patients on anticoagulation therapy or those with coagulopathies preoperatively since uncontrolled bleeding would be a contraindication to skin grafting.

Graft healing begins with the formation of a fibrin layer between the wound and the graft. This layer helps stabilize the graft and allows passive movement of fluid and nutrients from the bed to the graft.5 This phase of graft healing is called the plasmatic imbibition phase and occurs during the first 24 to 48 hours. During the end of this phase, capillary budding from the recipient bed begins but the graft remains ischemic and is white and dusky in appearance. At approximately 48 hours, the capillaries make contact with the graft and the phase of inosculation begins. Blood flow is usually reestablished by day four through a combination of new vessel growth and re-anastomosis of existing vessels. The graft will appear mottled at first and will then become erythematous. One should not confuse this vascular "blush" with infection. Strict elevation of the foot is still important at this point since the lymphatics do not start to function until about one week post-op. The final phase of healing is re-innervation and reorganization. This phase can continue for one to two years.

Lower limb skin grafts are thought to have higher failure rates than skin grafts in other sites of the body. Reddy et al attempted to determine the incidence of failure of lower limb skin grafts and to identify contributing factors in a series of 70 lower limb skin grafts in 50 patients with outcomes at 6 weeks. One-third of lower limb skin grafts went on to fail with increased BMI, peripheral vascular disease, and immunosuppressant medication use identified as significant risk factors.

METHODOLOGY

The objectives of the present study are:

- To analyse and measure the morbidity of the STSGs for there construction of NMSC defects in the lower limb in our department
- To measure quality of service provided
- To correlate between graftmorbidity and age, sex of the patient, size of the lesion, site, type of skin cancer and underlyingco-morbidities
- To improve service
- To raise awareness and educateon the failures of spilt-skin graftson the lower limb

In regards to standards, the local guidelines on the STSGs within the Trust exist and should be followed. These guidelines encompass a tool for assessing graft morbidity by a trained nurse, wound care safe practices, arranging appropriate follow-up appointments to monitor progress and healing of the graft and response to treatment[7].

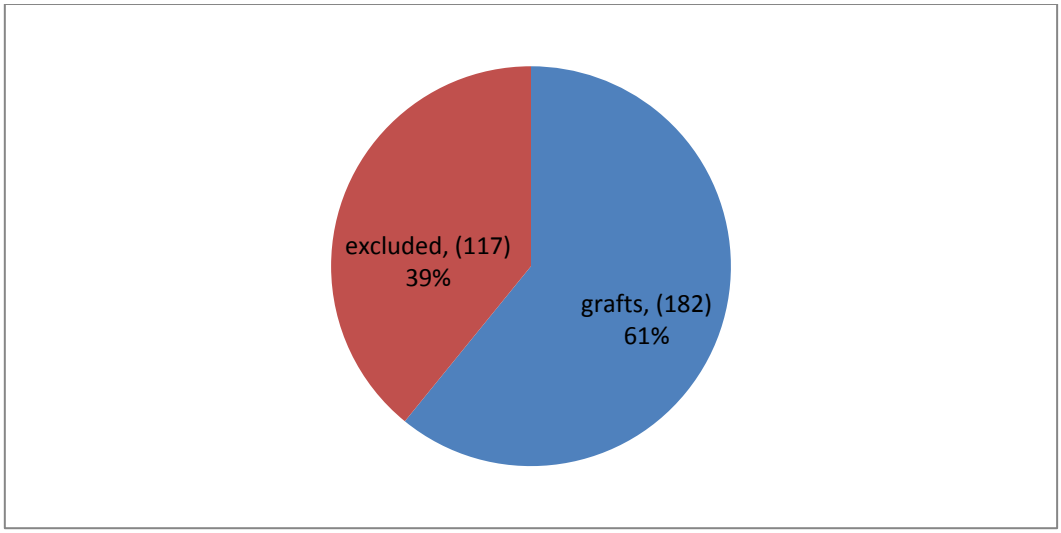
No formal standards found in BAPRAS, NICE, ASPS.

RESULTS

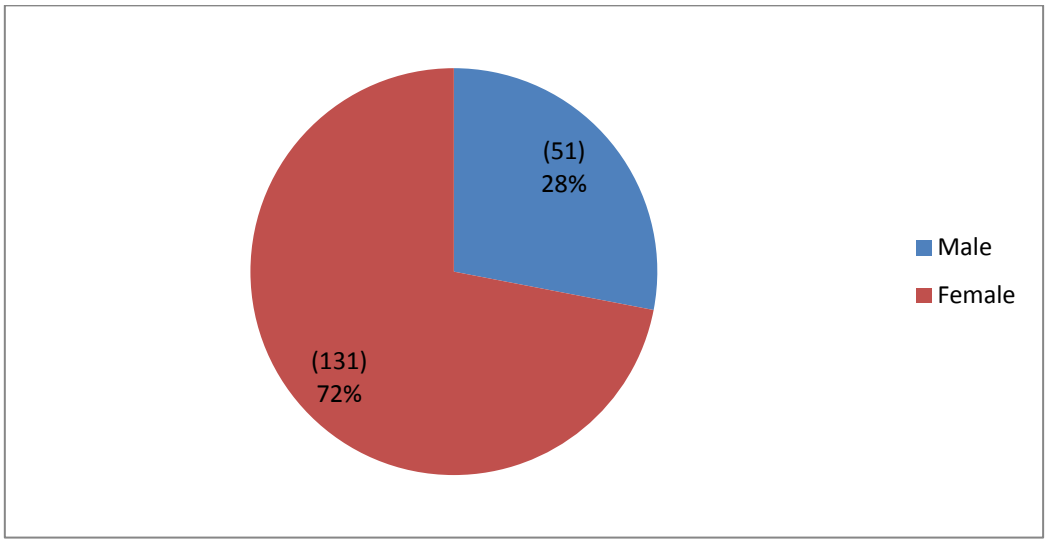
- Out of 299 patients, 182 (61%) underwent reconstruction with split-thickness skin graft and 117 (39%) were excluded for various reasons (reconstruction of defect with local flap, melanoma cancer, inadequate documentation on the graft morbidity and follow-up of the patient) **(Graph 1)**.
- The majority of the patients in our study were females (72%) and 28% were males **(Graph 2)**.

- The majority of the patients were above 80 years old (54%), whereas 33% were between 70-79, 10% between 60-69, 2% 50-59 and only 1% younger than 49 **(Graph 3)**.
- The majority of the lesions in category 0 and 1 measured more than 20 mm in diameter (43% and 43% respectively). Similarly, 4% of the lesions >20 mm resulted in failed grafts (category 3) **(Graph 4)**.
- The majority of the lesions were
    - well-differentiated SCCs (36%) within the uncomplicated grafts category **(graph 5)**,
    - high risk BCCs (poorly defined, 32%) within the category 1 **(graph 6)**
    - well-differentiated SCCs (38%) in category 2 **(graph 7)**
    - poorly-differentiated SCCs (high risk, 37%) in the failed grafts category 3 **(graph 8)**
- The majority of the grafts fell into the uncomplicated (44%) and minor complications (43%) category (0 and 1 respectively), whereas only 6% of the total grafts failed. The **graph 9** summarises the above results and it is a useful tool for assessing the efficacy in our department.
- In **graph 10**, in the category 3, there are 5% females and 1% males.
- In **graphs 11-14**, it is apparent that there is a pattern in which the majority of the failed grafts are located in the shin (67% in category 0, 72% in category 1, 69% in category 2 and 73% in category 3). This observation is in accordance with another study which supports that the distal the lesion, the greater the complicationrates[8]. This could also be attributed to the decreased blood supply in the peripheral system.
- Failed grafts were noticed in patients >80 years old (91%) **(graph 15)**, whereas cardiovascular conditions, including peripheral vascular disease, atrial fibrillation and hypertension were 82% in category 3 **(graph 16)**.

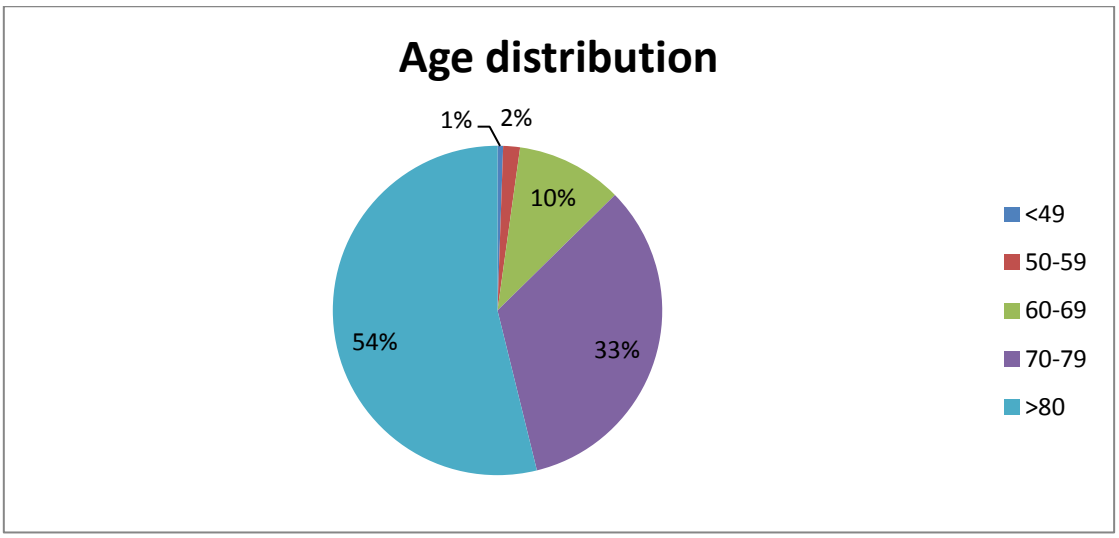
GRAPHS



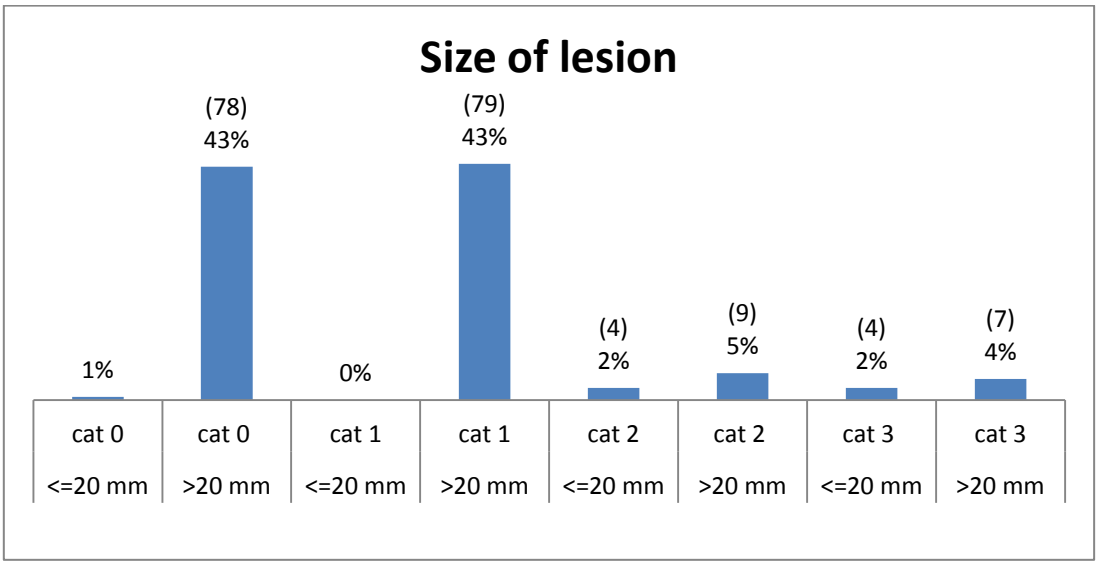
Graph 1.A number of cases were excluded (117) and 182 cases with STSG were assessed for morbidity in our study.



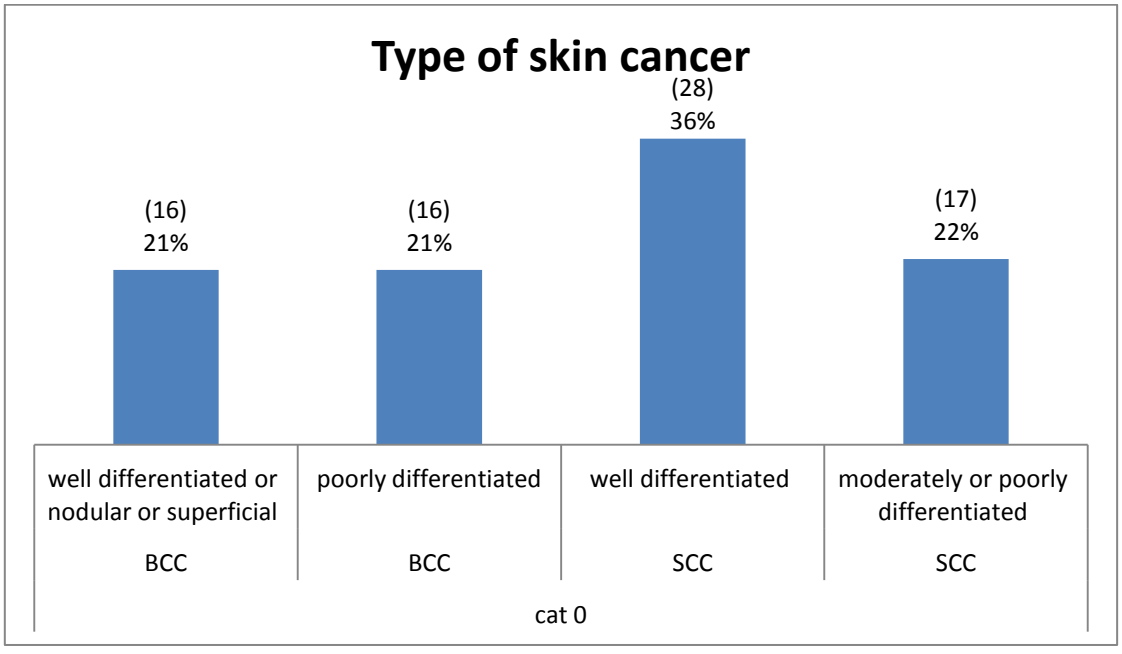
Graph 2. Percentage of male and female patients in our study.



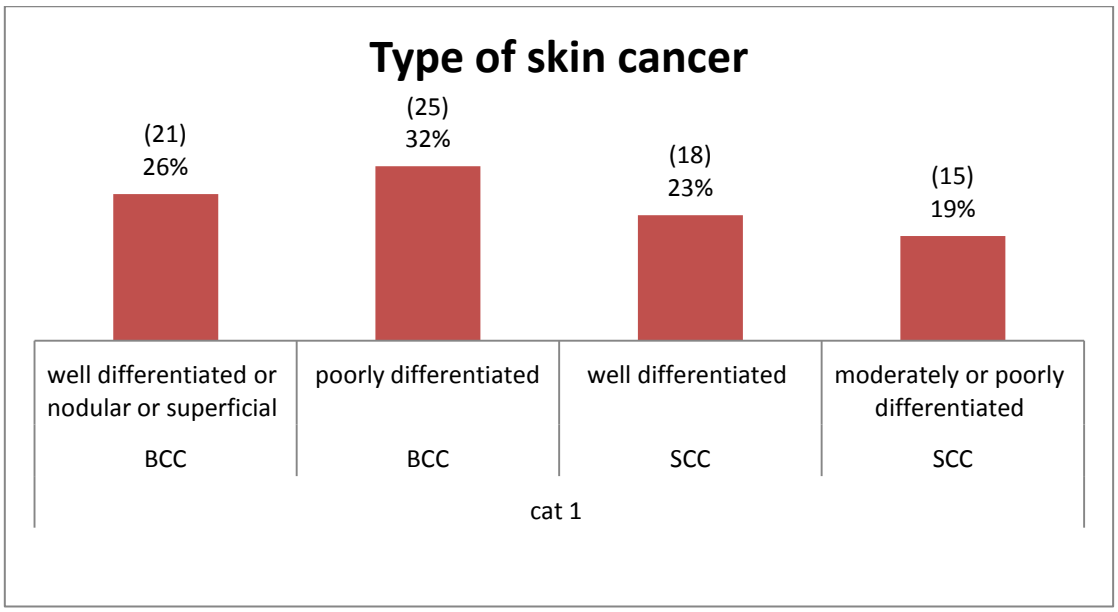
Graph 3. The majority of the patients in our study were above eighty years old.



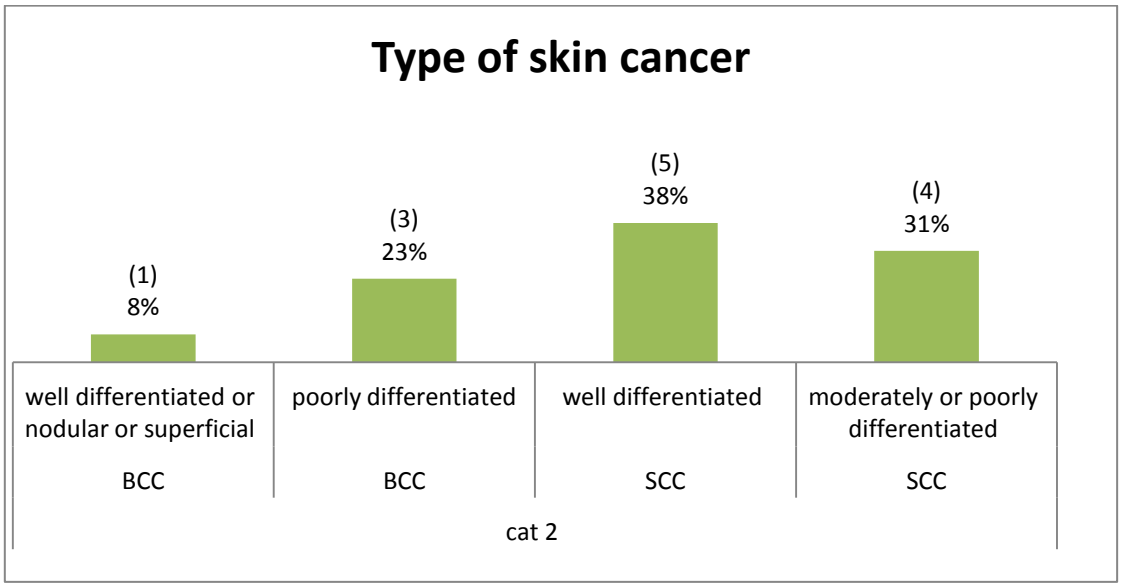
Graph 4. Results relevant to the size of the lesion (low risk <20 mm, high risk >20 mm) per category.



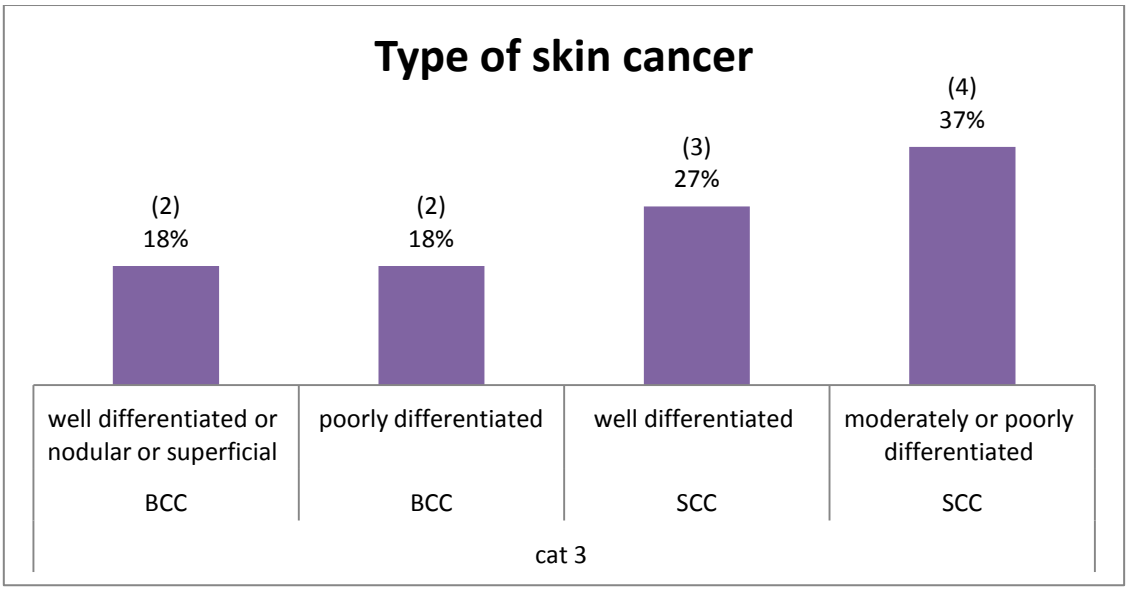
Graph 5. Percentage of BCCs and SCCs in category 0.



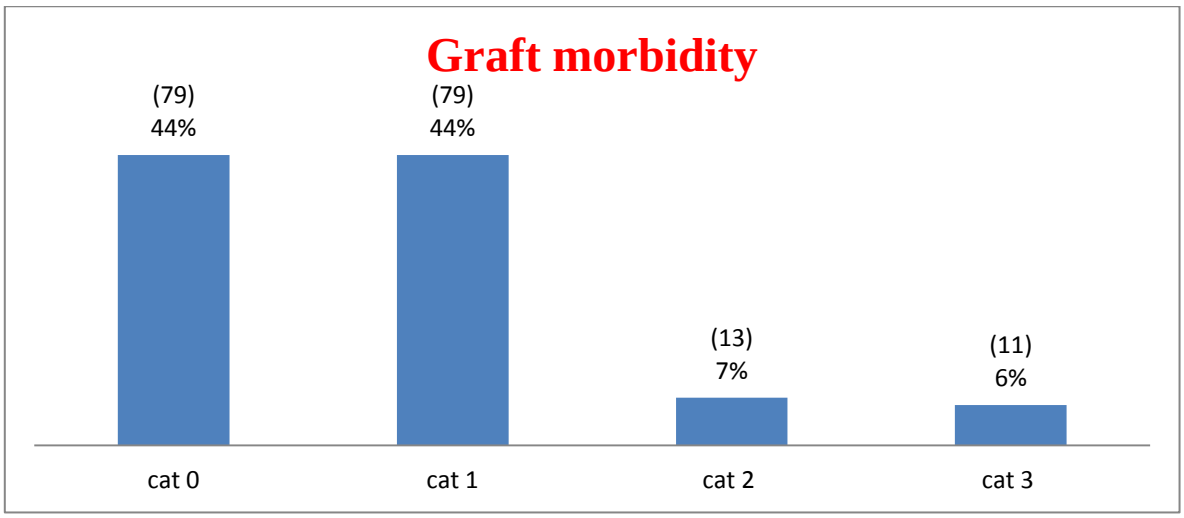
Graph 6. Percentage of BCCs and SCCs in category 1.



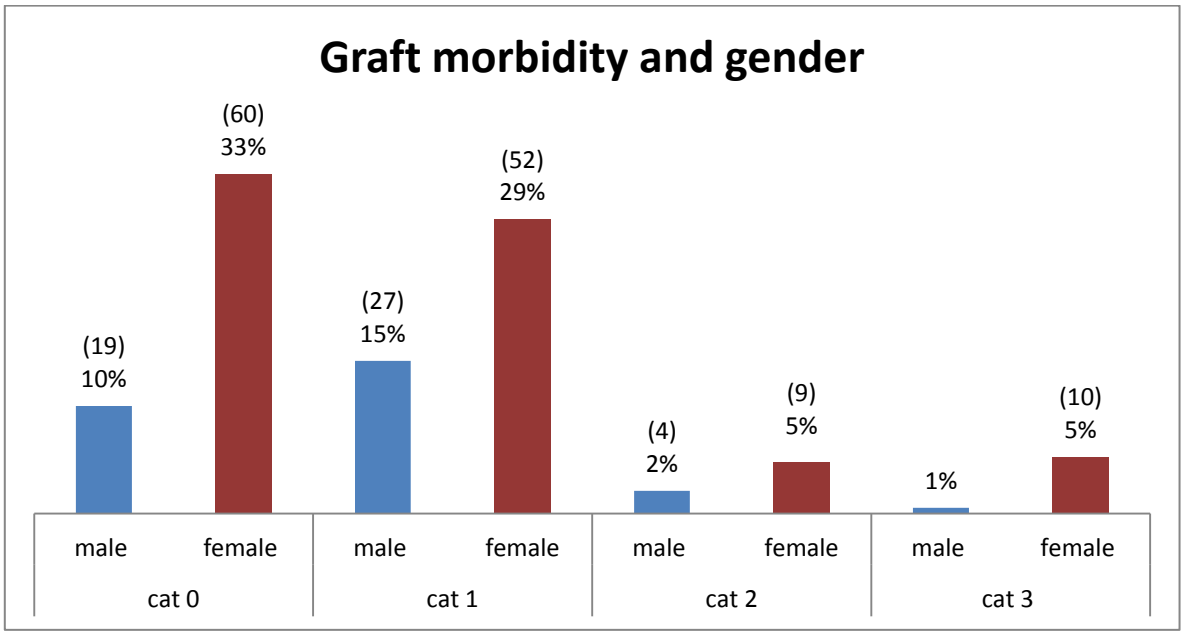
Graph 7. Percentage of BCCs and SCCs in category 2.



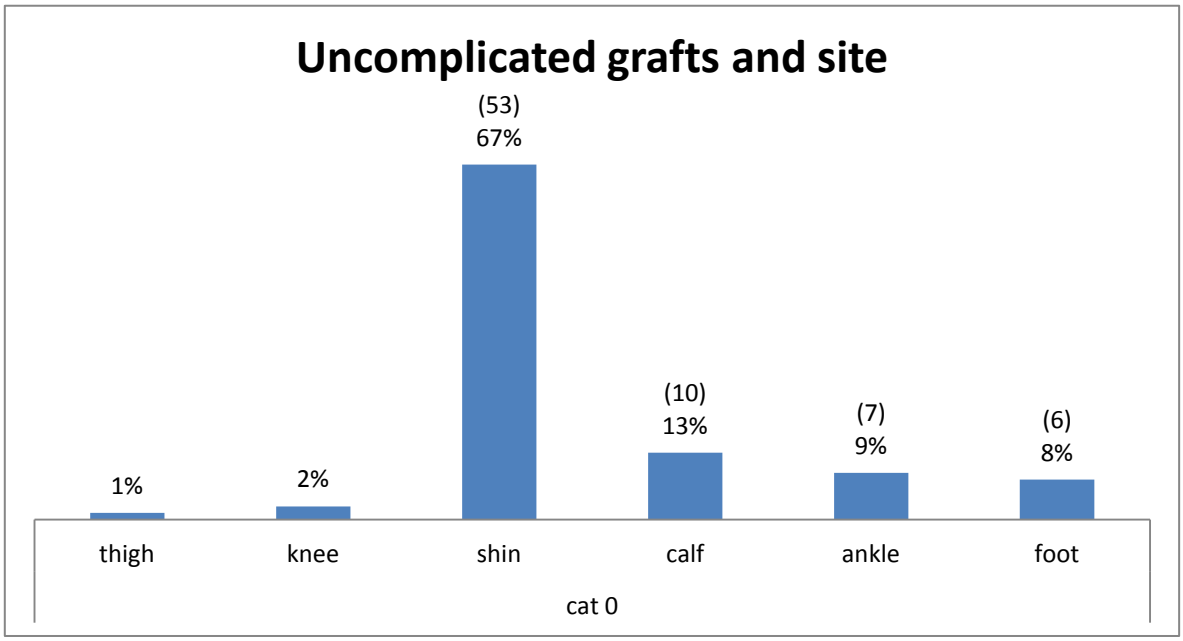
Graph 8. Percentage of BCCs and SCCs in category 3.



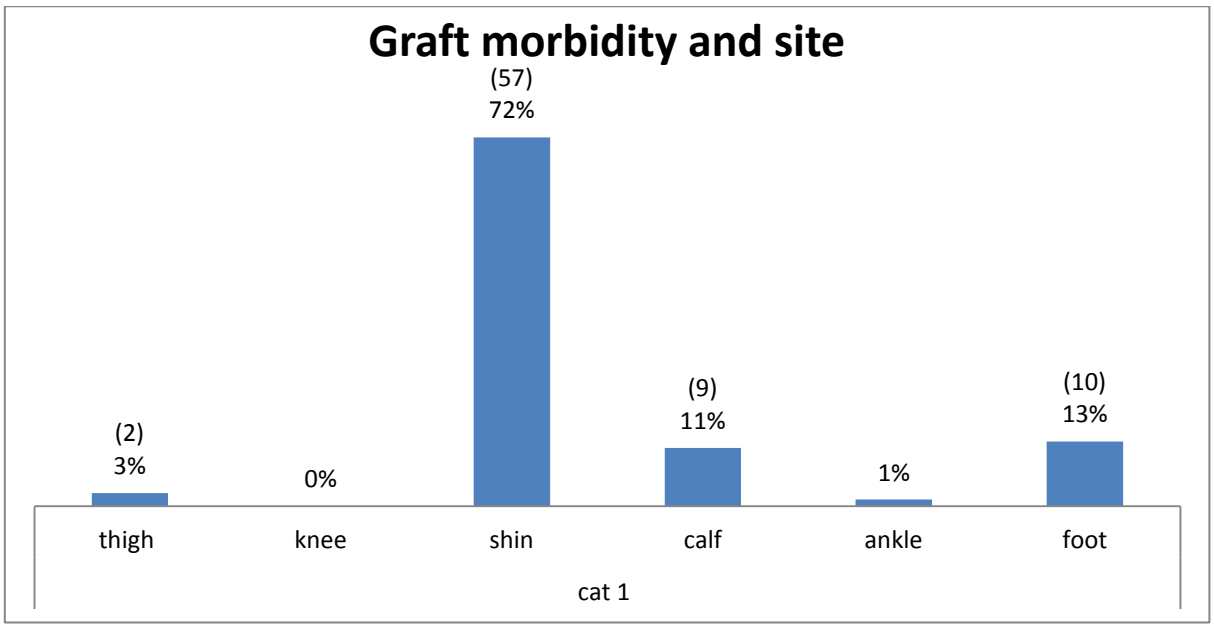
Graph 9. Graft morbidity per category.



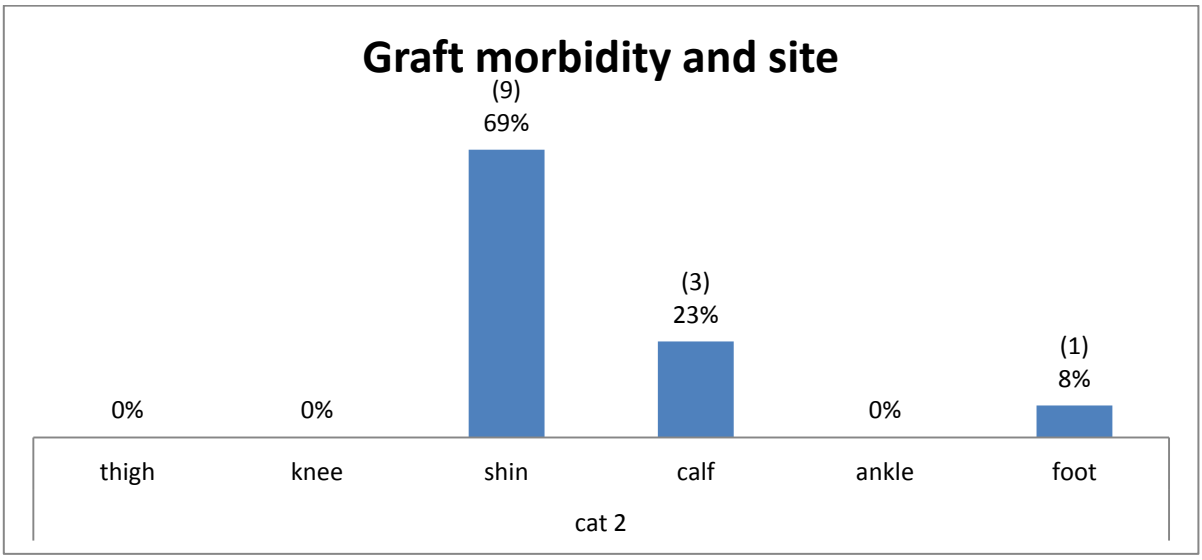
Graph 10. Graft morbidity in relation to the sex of the patient.



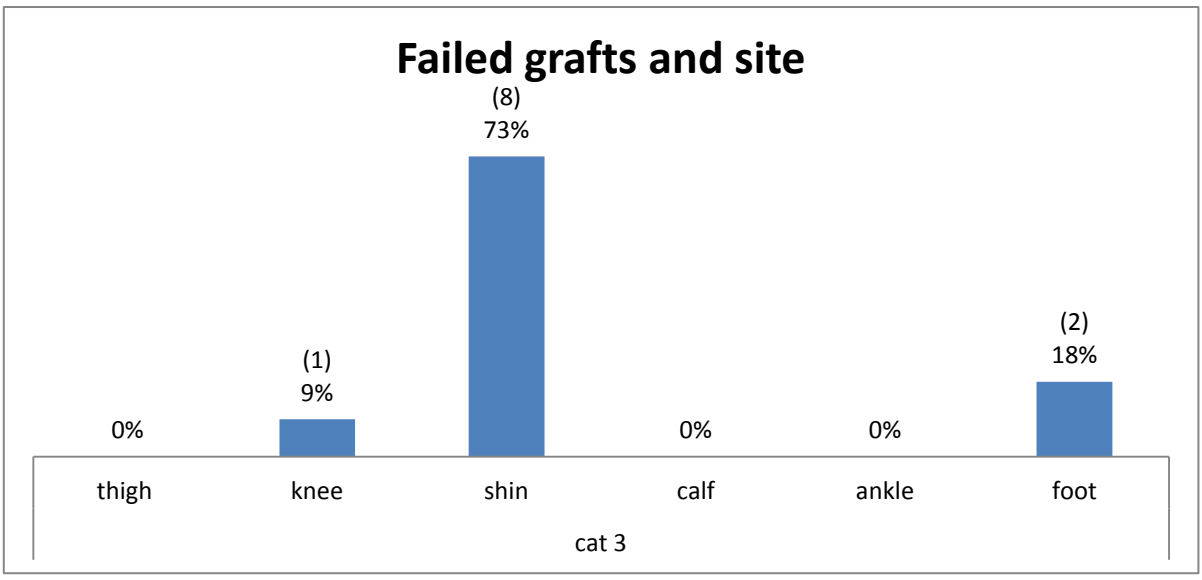
Graph 11. Graft morbidity and site of the lesion in category 0.



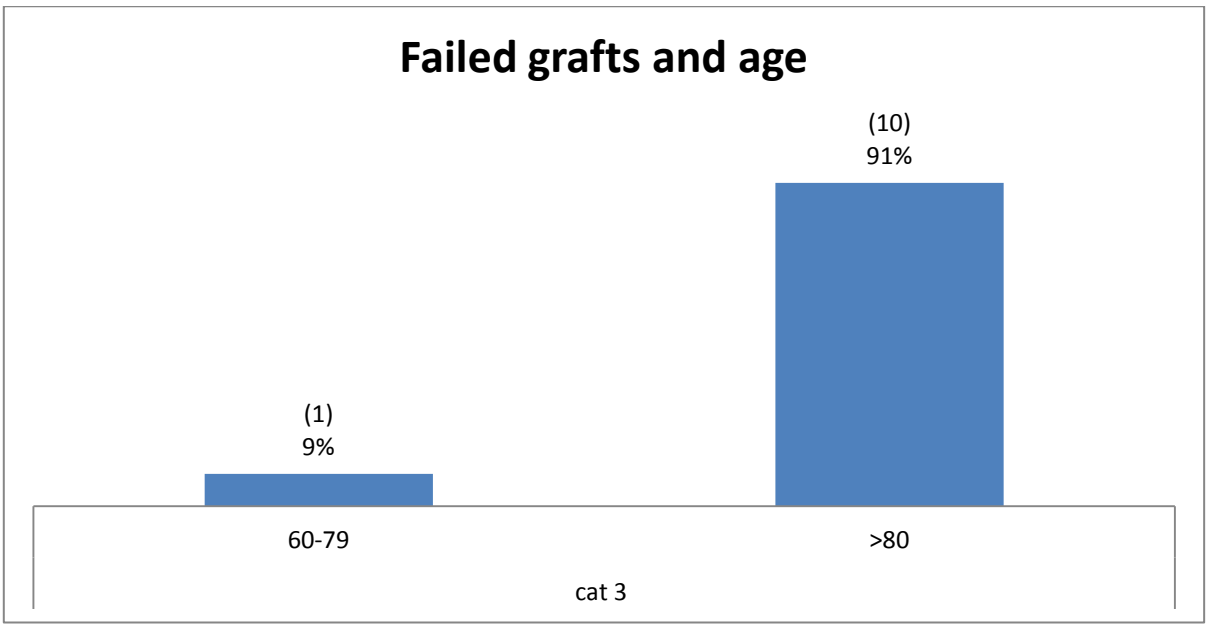
Graph 12. Graft morbidity and site of the lesion in category 1.



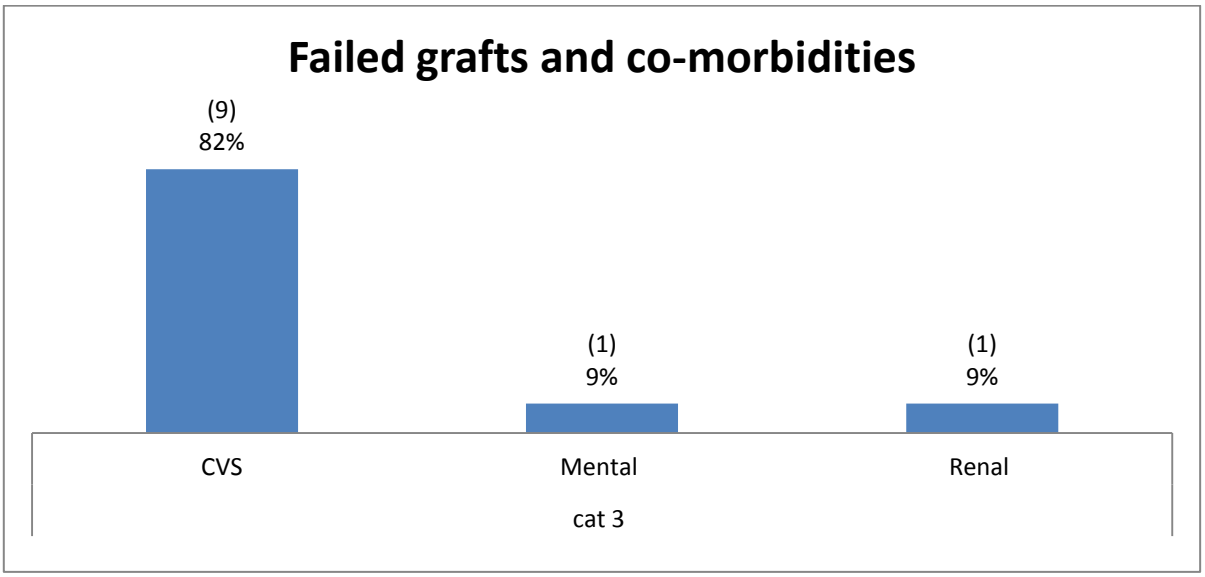
Graph 13. Graft morbidity and site of the lesion in category 2.



Graph 14. Graft morbidity and site of the lesion in category 3.



Graph 15. Failed grafts in relation to the age of the patients.



Graph 16. Failed grafts in relation to the co-morbidities of the patients.

Recommendations

All patients with PVD to receive a workup by vascular surgery prior to application of STSG in order to be deemed to have sufficient blood supply for healing[9].

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