ORIGINAL ARTICLE

The pulley suture: A reliable option for closure of selected soft tissue defects under tension- three years experience of a tertiary care hospital

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Abstract

Objective: To assess the outcome of closure of soft tissue defects through pulley suture in different clinical situations.

Methods: The descriptive chart review was conducted at The Indus Hospital, Karachi, and comprised data from May 2008 to November 2011. A detailed questionnaire was developed to address variables of interest. All patients with less than three months of follow-up or inadequate information were excluded. The data was collected through Health Management Information System. Data was entered and analysed by SPSS 16.

Results: There were 259 patients with 289 wounds in the study. The mean age was 29.2±11.9 years. At follow-up of two weeks, there was wound dehiscence in 2.07%, infection in 0.69% and partial flap necrosis in 1.03% patients. At 12 weeks, hypertrophic scar was reported in 2.07% and stretched scar in 0.3% patients. Acute pain was not reported in the first week of surgery. Type of wound was found to have significant association with complications (p value<0.005). Age and gender were not found have any significant association with complications (p value 0.372 and 0.238 respectively). None of the patients reported scar tenderness at 12-week follow-up. Cosmetic outcome was acceptable to all patients.

Conclusions: Judicious use of pulley suture can lead to primary closure of selected soft tissue defects under moderate tension. The technique, however, needs to be utilised by surgeons experienced in soft tissue reconstruction.

Keywords: Pulley suture, Tension sutures, Wound closure. (JPMA 65: S-35 (Suppl. 3); 2015)

Introduction

The medial aspect of tibia has a rich extraosseous blood supply by anastomosis between anterior and posterior tibial arteries as described by Borelli et al. in cadaver dissection studies.[1] Dynamic compression plating of closed tibial shaft fractures using medial approach poses significant danger of disruption of this vascular axis, leading to wound necrosis and breakdown, especially if tight closures are performed on wounds under tension by surgeons inexperienced in soft tissue reconstruction.[2] There is a trend towards injudicious use of lateral release incision to decrease tension on the medial wound and facilitate closure, which may further compromise the blood supply due to close proximity of incisions. This is not supported by literature. It also potentially destroys the vascular axis of three very important lower limb flaps, including sural, lateral supramalleolar and peroneal island flaps. Furthermore, skin grafting of the lateral release incision adds to the morbidity in terms of prolonged hospital stay, added visits to the operating room requiring anaesthesia and financial burden. The second unique scenario is the harvest of full thickness skin graft (FTSG) for larger soft tissue defects and the end result may well be the need of split thickness skin graft (STSG) for the donor defect, adding to the morbidity of the patient.

Based on the above observations, we started at our institution the use of pulley sutures for closure of selected soft tissue defects in various clinical situations. The current study was planned to assess the outcome of closure of soft tissue defects through pulley suture.

Materials and Methods

The descriptive chart review was conducted at The Indus Hospital, Karachi, and comprised data of all patients who underwent wound closures by pulley sutures between May 2008 and November 2011. All patients had a minimum follow-up of 3 months.

Patients in whom closure was achieved by any other method, or who had less than the required 3-month follow-up were excluded and so were those with missing data.

Since all medical records at the hospital are computerised, a list of patients who underwent the procedure during the years of interest were generated through the Health Management Information System (HMIS). Once identified,

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the programme assessed each medical record to determine if the patient met the selection criteria. A data extraction sheet was used to extract pertinent data.

The sheet included date and year of surgery, age (years), follow-up (months), gender, medical problem, site of injury/surgery, follow-up (months), pain (first week of surgery), infection, dehiscence, skin flap necrosis (at two weeks of surgery), scar hypertrophy, stretched scar and scar tenderness (at 12 weeks of surgery).

Patient satisfaction was assessed through documantation at follow-up. Additionally, photographs were also obtained where available. Patient's identity was not revealed in any of the photographs, and the study was approved by the institutional ethics committee.

All wounds had been closed in single layer using either absorbable or non-absorbable suture. A vertical mattress suture was applied and before knot-tying the needle was looped back from the suture loop on the opposite side. After application of the pulley sutures, rest of the wound was closed with running vertical or horizontal mattress sutures. No skin undermining was done in any case (Figure-1). The sutures were removed at two to three weeks depending on the state of the wound.

Data was entered and analysed using SPSS 16. Mean ± standard deviation were computed for quantitative variable (age). Frequency and percentage were computed for all the qualitative variables. Chi-square test or Likelihood ratio test or Fisher exact test, as appropriate, were applied to check significant association between various qualitative variables. Effect modifiers were controlled through stratification of age and gender. $P \leq 0.05$ was considered significant.

Results

There were 289 wound closures in 259 patients in the study (Table-1). Elective wound closures (26%) included 50 after dynamic compression plating (DCP) of tibia and 20 after DCP forearm bones. Thirteen miscellaneous wounds (4.5%) included thenar H flaps, thenar paired flap, wound closures after transversus rectus abdominis muscle (TRAM) flap and wound necrosis after total knee replacement.

Wound type was found to be significant for complications (p=0.005) (Table-2).

In terms of complications, hypertrophic scar (at 12-week follow-up) was observed in 6 (2.07%) wound closures. The scars responded very well to oil massage and settled in few months. No additional procedures were required. All of these scars occurred in the FTSG donor site closure group which had 143 wounds. In the FTSG group, 60 were harvested from the thigh, 50 from the groin, 20 from the forearm, 10 from the abdomen and 03 from the hypothenar eminence. Three out of 60 (5%) FTSG closure were thigh hypertrophied, whereas 3 out of 50 (6%) closures were groin hypertrophied. There was no scar problem on any other site. Stretched scar (at 12-week follow-up) was seen in 1(0.9%) patient in the abdominal

Table-1: Descriptive analysis.

Variables	
Age; Mean±SD	29.2±11.9
(min, max)	(4, 60)
Gender	
Male; N (%)	197 (68.2)
Female; N (%)	92 (31.8)
Types of Wound; N (%)	
FTSG donor site	143 (49.5)
Abdominal flap donor site	11 (3.8)
Elective wound closure	75 (26)
Infected wounds	20 (6.9)
Tumour excision	9 (3.1)
Abdominoplasty wounds	10 (3.5)
Donor site of rotational flap in lower limbs	8 (2.8)
Miscellaneous wounds	13 (4.5)
Complications; n (%)	
Wound dehiscence	6 (2.1)
Partial skin flap necrosis	3 (1)
Infection	2 (0.7)
Hypertrophic scar	6 (2.1)
Stretched scar	1 (0.3)

FTSG: Full-thickness skin graft.

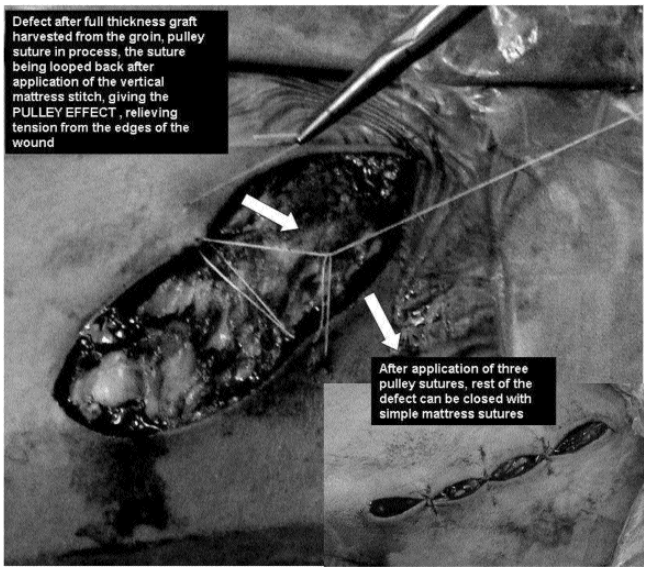

Figure-1: Pulley suture technique diagram.

Table-2: Association of age, gender and wound type with complications.

	Complications				P-value
	NO		YES		
	Mean	SD	Mean	SD	
Age	29.05	11.792	32.08	14.648	0.372**
Gender	N	%	N	%	
Male	186	67.4	11	84.6	0.238§
Female	90	32.6	2	15.4	
Type of wound	N	%	N	%	
FTSG donor site	137	49.60	6	46.20	0.005*†
Abdominal flap donor site	10	3.60	1	7.70	
Elective wound closure	75	27.20	0	0.00	
Infected wounds	18	6.50	2	15.40	
Tumour excision	9	3.30	0	0.00	
Abdominoplasty wounds	10	3.60	0	0.00	
Donor site of rotational flap in lower limbs	8	2.90	0	0.00	
Miscellaneous wounds	9	3.30	4	30.80	

*P-value< 0.05, **Independent sample t-test, §Fisher exact test, †Likelihood ratio test-
Complication: Presence of any one of the following complications wound dehiscence, partial skin flap necrosis, infection, hypertrophic scar and stretched scar
SD: Standard deviation
FTSG: Full-thickness skin graft.

Figure-2: Closure of full thickness skin graft donor site from the thigh. a) Large defect after harvesting full thickness skin graft. b) Pulley sutures in place approximating the wound in one layer without any undermining of the skin. c) Final closure of the defect completed with running vertical mattress suture. d) Appearance of the donor site at thigh at three months.

Figure-3: Skin closure after wound excision for skin necrosis post-bilateral total knee replacement in a rheumatoid patient. a & d) Right and left knee, necrosis of wound margins 2 weeks from surgery. b & e) Right and left knee, wound excision and closure with pulley sutures. c & f) Right and left knee, appearance of wounds at six weeks from closure.

flap donor site closure group that had 11 patients. Wound dehiscence (at 2-week follow-up) occurred in 6(2.07%) patients. There was one patient in the abdominal flap donor site closure group, where partial wound dehiscence occurred as a result of early suture removal at two weeks. This required re-suturing and resulted in uneventful recovery. Two patients had infected wounds and dehiscence occurred as a result of infection despite wound excision. One patient settled with wound debridement and closure and the other patient required debridement and flap reconstruction. One patient developed partial wound dehiscence after closure of the wound over the shin post-removal of malignant melanoma. The last two cases occurred in two chronic non-healing wounds in diabetic patients.

Infection (at 2-week follow-up) occurred in 2(0.69%) cases. One patient with chronic osteomyelitis tibia had wound dehiscence due to persistence of bone and soft tissue infection and required segment exision of tibia and internal bone transport. The other case was of malignant melanoma of the distal medial shin where dehiscence and infection occurred. Although it settled with dressings, it added to the morbidity as wound healing was delayed and took a month.

Superficial skin flap necrosis (at 2-week follow-up) occurred in 3 (0.1%) patients with chronic non-healing wounds in diabetic patients, who were not found suitable for any other major procedure due to health issues. All settled with dressings.

No significant tenderness was reported at 12-week follow-up.

Discussion

Healing of wounds is a multifactorial phenomenon. The general status of protein energy malnutrition and lean body mass are frequently overlooked during patient assessment, leading to healing problems in chronic wounds.[3] A combination of local and systemic factors contribute to the effective delivery of oxygen to the injured tissues, leading to adequate cellular function required for wound healing.[4] Various methods are available for the measurement of wound healing potential, including transcutaneous pressure of oxygen and skin perfusion pressure.[5] The lack of availability of these sophisticated measurement tools in our setups demand careful clinical judgement, which still holds the greatest value as the most important outcome determinant. Wounds under tension due to large soft tissue defects merit expert handling. It is a matter of debate whether the string force in closure of wounds affects the microcirculatory pattern of skin flaps.[6] It is therefore wise to decrease the incidence of flap ischemia by decreasing the tension of wound edges. As a result of fear of wound necrosis or due to lack of expertise and experience, many wounds which could otherwise be primarily closed are left to alternative treatments. This also includes the routine injudicious use of lateral release incision and skin grafts in dynamic compression plating of the tibia. Although many chronic wounds merit alternative treatment modalities like the use of vaccum-assisted closure or matrix-based therapy,[7-9] but a large number of defects can benefit from either primary closure by pulley sutures or flap reconstruction leading to a decrease in long-term functional morbidity. The use of rubber elastic bands[10] for chronic wounds under tension has remained a popular and effective treatment over the years. The abdominal wound dehiscence has been shown to decrease by reinforced tension line sutures in midline laparotomies.[11] Similarly, defect closure by tension sutures has shown to decrease dead space, thereby improving wound outcome in large defects.[12] Various modifications of mattress sutures have been described to handle this complex issue of defects under tension.[13,14] The use of locked vertical mattress suture was described as early as 1968.[15] There are many studies in literature on the far near near far and horizontal mattress sutures for such situations.[16-18] The techniques of vertical and horizontal mattress "pulley" sutures have been elaborately explained in various studies and texts.[19-22] Ahmed et al. have pointed out the clinical relevance of vertical mattress pulley suture in donor site defects of paired abdominal flap closures.[23] This situation would otherwise demand the use of STSG, leading to additional morbidity. The wound dehiscence in one such case occurred as a result of suture removal at two weeks. We recommend that the sutures over the abdomen be removed at three weeks. Stretched scar in one patient after paired abdominal flap donor site defect closure was a patient-related complication as the patient started squatting in the first week after surgery which caused superficial flap necrosis, delayed healing and a stretched scar.

The results of our study have clearly established the extreme usefulness of this technique in the primary closure of moderately large donor defects of FTSGs, especially from the thigh, again preventing the use of STSGs (Figure-2).

We were able to salvage two cases of bilateral total knee replacements where wound necrosis occurred in the first two weeks of surgery. Both the patients were rheumatoid and were successfully healed by the excision of the wound and closure (Figure-3). The technique was found beneficial in elective wound closures after dynamic compression plating of tibia where oedema makes wound closure difficult in acute fracture surgery. The need for lateral release to aid skin closure was avoided. There is a word of caution. Chronic non-healing wounds, especially neuropathic heel ulcers, implant exposure after skin necrosis post-DCP tibia, post-traumatic big soft tissue defects especially over the tibia exposing bone and transversely oriented wounds over the shin are not suitable for this form of closure. This is a technique for a surgeon who already has mature judgment of the soft tissue reconstruction techniques. No wound should be closed under tension. The blanching and capillary refill of skin flaps should be assessed and if not found appropriate alternative strategies should be used. Careful patient selection and timing of closure is required to prevent infection and wound dehiscence.

We found no significant acute pain in our study as

opposed to some reports in literature.[24] There has been interest in dermal pulley sutures and their modifications,[25] but it needs significant undermining of the skin edges, is technically demanding, not suitable for thin skin flaps and may not achieve desired result in all cases.

The main limitation of our study is its retrospective nature. As there was no randomisation and control group in the study, firm recommendations cannot be made. The bias decreased as there was proper documentation in the data extracted from electronic medical records and there were only two experienced surgeons performing these procedures. However, we recommend randomised controlled trials to evaluate the comparative efficacy and pitfalls of various wound closure techniques for wounds under tension.

Conclusions

The vertical mattress pulley suture is an effective method of closure for selected soft tissue defects under tension. The most important determinant of adequate string tension in such situations is the experience and clinical judgement of the surgeon. It is an excellent technique for surgeons already performing soft tissue reconstruction.

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