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Spiderplasty and Bow-tie Tension Relieving Suture Techniques for Large Skin Defects in Dogs

M. Gokulakrishnan[1], Noyingbeni Odyuo[2], K. Nagarajan[3], Mohamed Safiuzamma[1]

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ABSTRACT

Background: In veterinary practice, cutaneous injuries are a very common occurrence. Various methods have been employed to close large skin defects like skin graft or flap often associated with relatively more complex surgical procedures. Use of tension relieving suture techniques like spider plasty and bow tie technique allow the mobilization of adjacent local tissue to cover large cutaneous defects which was thus utilised in the study.

Methods: Twelve dogs brought to the Madras Veterinary College Teaching Hospital, Chennai, TANUVAS with large diameter open wounds were selected for the study. Irrespective of the stage of closure the two tension relieving suture techniques, *i.e.* Spiderplasty and Bow-tie, were performed for closure of the large wounds. The preoperative and postoperative wounds assessment were performed through subjective evaluation, planimetry, bacteriological examination and histopathological evaluation.

Result: The Spiderplasty technique was more time consuming, required more surgical expertise and had slightly lower cost efficiency ratio. It could however be better utilised to close wounds located in confined anatomical areas, as compared to the Bow-tie procedure which was limited by its requirement to resect 36% of adjacent normal tissue.

Key words: Bow tie technique, Canine, Chronic wounds, Outcome, Spiderplasty, Tension relieving suture technique.

INTRODUCTION

In veterinary practice, cutaneous injuries are common. The surgeon quite often encounters a challenge when the lesion is large or located in confined anatomical areas. Methods have been employed to close large skin defects, like skin graft or flap to cover the primary defect, whilst the secondary defect is allowed to heal in second intention. However, this approach is often associated with relatively more complex surgical procedures, significant morbidity and extended hospitalization and recovery periods. It has been seen that the use of tension relieving suture techniques allow the mobilization of adjacent local tissue to cover large cutaneous defects without raising a flap or harvesting a graft, allowing the correction of the primary wound without subjecting the patient to secondary trauma. The wounds selected for the present study were large acute or chronic cutaneous wounds, chronic contaminated or infected wounds that would initially be treated conventionally until wound bed contamination or infections were reduced and then closed by means of delayed primary or secondary closure. Irrespective of the stage of closure (*i.e.* primary, delayed primary or secondary) the two tension relieving suture techniques, *i.e.* Spiderplasty and Bow-tie were performed for closure of the large wounds in the study.

MATERIALS AND METHODS

Twelve dogs brought to Madras Veterinary College Teaching Hospital, Chennai, with large diameter open wounds were selected for the study during the period 2019 to 2021. In case of contaminated or infected wounds, conventional wound management therapies were initially followed to prepare the wound bed for a delayed primary or secondary closure followed by tension relieving suture techniques presented in the study. The twelve dogs were allotted to two groups of 6 each, based on the wound configuration, shape and size, which dictated the technique of closure to be used, *viz,* Spiderplasty and Bow-tie. All the twelve animals were evaluated subjectively on 0, 3rd, 7th day or until the day of delayed primary closure or secondary closure of the wound. Postoperative subjective evaluation of the same parameters was also performed on 3rd, 7th and 14th day after appropriate tension relieving suture technique. Wound planimetry, color flow ultrasound, histopathological evaluation were performed to evaluate the wound healing.

[1]Department of Clinics, Madras Veterinary College, Chennai-600 007, Tamil Nadu, India.
[2]Department of Veterinary Surgery and Radiology, Madras Veterinary College, Chennai-600 007, Tamil Nadu, India.
[3]Veterinary College and Research Institute, Theni-625 531, Tamil Nadu, India.

Corresponding Author: M. Gokulakrishnan, Department of Clinics, Madras Veterinary College, Chennai-600 007, Tamil Nadu, India. Email: drgocool_vet@yahoo.co.in

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Spiderplasty technique

The Spiderplasty procedure involved converting the primary wound to an equilateral or an isosceles triangle. The triangle was created in such a manner that the base lay upward and the apex was facing downwards. Two lines 'Y' were drawn superolaterally from the two edges of the base of the triangle. The lengths of 'Y' lines were made approximately two-thirds of the length of the base of the triangle Lines 'Z' were then drawn from the edges of 'Y', directed downwards and parallel to the adjacent margins of the triangle. The lengths of the lines 'Z' were almost equal to two-thirds of the length of the neighbouring margins. The mid-point of the base was determined and two lines 'X' were drawn superolateral and parallel to the two margins of the triangle on both sides. Length of 'X' was equal to the length of 'Z'. The angle between the base of the triangle and 'Y' was 15°, between the base and 'X' was 60° and between 'Y' and 'Z' was 45°. These lines were then incised carefully with a Bard Parker (BP) blade of size 10 and then undermined using blunt dissection; subsequently 5 free flaps were created. The resulting flaps were transposed and closed in the following manner (Plate 1).

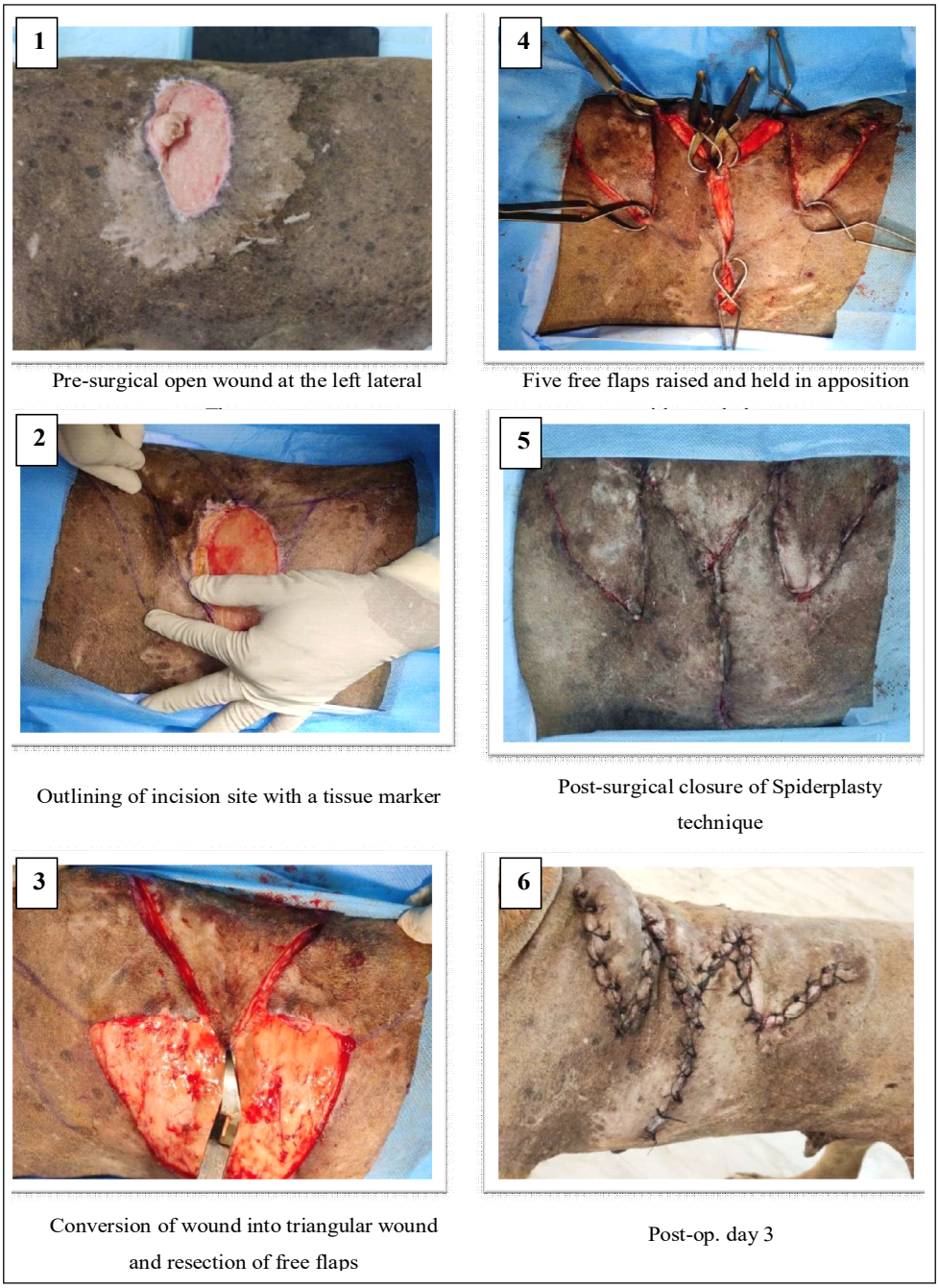


Plate 1: Step wise representation of Spiderplasty procedure.

Bow-tie technique

The bow-tie technique was practically more applicable to circular or semi-circular defects, in which such defects were apposed by converting it into a fusiform defect. This was achieved in the following manner- Two triangular sections of skin lying in opposite sides of the defect were outlined. The triangles were made equilateral and the lengths of the sides were roughly equal to the radius of the defect.Both the apices of the triangles were faced towards the primary defect and their central axis lay 30° from the long axis of the skin tension lines. After careful layout of the surgical outline, the triangles were incised using a sterile BP blade. These triangular sections of skin were undermined and removed.The immediate peri-wound area was also undermined with blind dissection to relieve any tension and enable easier apposition of the wound edges. Thus, the primary circular wound was closed by converting it into a fusiform defect (Plate 2).

Bacteriological examination was performed and the bacterial colonies were evaluated for specific antibiotic sensitivity tests which were performed on the 3rd day post operatively and changes in the treatment protocols, if any, were tailored according to the results of the tests.

Histopathological evaluation of wound was performed after obtaining a punch biopsy tissue and then stained with



Plate 2: Step wise representation of Bow-tie procedure.

masson trichrome stain. Using Abramov's histological scoring system, the histological parameters were graded on post operative days 3, 7 and 14 for both groups of animals.

A pre-operative evaluation of the vascularity of skin in the peri-wound area was performed by Colour flow Doppler Ultrasonography with a 10- to 12-MHz linear transducer that had harmonic ultrasound capabilities (up to 14 MHz) was used. After appropriate surgical reconstruction of the wound through either of the tension relieving suture techniques, the same vascular evaluation was done post-operatively on the 3rd, 7th and 14th, days respectively to determine healthy flap uptake via presence of blood vessels.

Using the glasgow CMPS-SF pain scoring system developed by Reid *et al.* (2007) the post operative pain scores were assessed according to six behavioural signs, *viz*. vocalisation, attention to wound, mobility, response to touch, demeanour and posture/activity.

RESULTS AND DISCUSSION

The initial wound dimensions for groups I and II animals are represented in Table 1. A base dimension of ≥10 cm^2 was determined to be the appropriate size of wound to be reconstructed by the two tension relieving suture procedures, as any wound with dimensions ≥10 cm^2 created tension on closure. This value was determined by the attending surgeon as tension on the wound edges could not be measured quantitively (Johnston, 1990). Wounds with irregular configuration were closed with Spiderplasty technique, as prior documentations had mandated the conversion of the primary wounds to an equilateral or isosceles triangle. This secondary wound was then closed by raising five free flaps. (Mutaf *et al.,* 2012) (Plate 1). Whereas, wounds with a roughly circular or semi-circular configuration were selected for the Bow-tie group (Plate 2). This technique had been documented for closure of circular wounds by converting them into smaller fusiform defects (Swaim, 2006).

The subjective evaluation of the wounds pre operatively was done. With the appearance of granulation tissue and reduction in wound exudation, the frequency of wound irrigation and debridement were reduced (Knighton *et al.,* 1986). Initial wound dressings were done with 'wet-to-dry' bandaging, this helped to absorb wound exudates and also remove outer necrotic tissue debris on removal of the bandages (Swaim and Henderson 1997).

All cases were similarly treated conventionally to prepare the wound bed for adequate tissue granulation which enabled a secondary closure on the 7th day after initial wound presentation.

Wound planimetry were calculated until closure of the wounds and tabulated according to the respective groups. (Table 1) The wounds were subjectively ascertained by the surgeon to be 'large' in size by determining the tension perceived as the wound edges were pulled closer (Johnston,1990). Along with this subjective evaluation, the minimal wound area measurement of 4.5×3 cm^2 as described by Katzengold *et al.* (2016) in their study on large wounds, was also taken into consideration to determine a base value of 10 cm^2 to denote a wound as being 'large' in size.

Spiderplasty technique

Spiderplasty was performed on large wounds presented with irregular conformations. The five free flaps that were raised for closure of the primary defect had 100% survivability rate and the resultant closures were successful. This technique was first documented in human medicine by Mutaf *et al.* (2012) for tension free closure of chronic wounds of varying sizes (1.5 cm to 17 cm). The non-obliteration of dead space may have been prevented by application of adequate quilting sutures and the use of an appropriate drainage tube (Aho *et al.,* 2016). Absence of visible tension on the suture lines, lack of dog-ear formation and 100% survivability rate in the five free flaps that were elevated was observed in all six cases in the study group (Plate 1).

Bow-tie Technique was performed for wound conformations that were mostly semi circular or circular. Surgical dimensions were followed as stated by Swaim *et al.* (1984), where the radius of the circular defect was considered as the length of the sides of the triangles. This would have been considerably difficult to perform, if the wounds were located in confined anatomical locations where as much as 36% of adjacent tissue would have to be expendable (Alvardo 2016) (Plate 2).

The subjective evaluations were performed on postoperative days 3, 7 and 14. (Table 2) (Fig 1 and 2). The surgical margins initially showed a pinkish tinge which denoted progressive angiogenesis, re-epithelialisation and neovascularisation (James and Bayat, 2003). This gradually turned pale pink and ensued resemblance to adjacent tissues.

Bacteriological examination for antibiotic sensitivity test (abst) was found to be sensitive against the antimicrobials-Amoxycillin, Azithromycin, Cefotaxime, Enrofloxacin, Amikacin and Tetracycline were tested. ABST performed for all the cases helped to formulate treatment protocols (Khan *et al*., 2019).

The posto-perative wound on 3rd, 7th and 14th days was evaluated for histopathological changes as represented in

Table 1: Preoperative wound sizes of groups I and II.

Group	Case no.	Wound size (cm^2)		
		Day 0	Day 3	Day 7
Group I	1	28.4	27.8	27.2
	2	23.8	23.2	21.8
	3	34.6	33.6	33.0
	4	23.6	22.6	22.1
	5	33.5	33.1	32.8
	6	29.6	28.5	28.0
Group II	1	25.0	24.7	24.5
	2	16.6	16.0	15.2
	3	21.4	21.2	20.9
	4	19	18.6	18.2
	5	21.2	20.8	20.5
	6	18	17.9	17.5

Plates 3 and 4 for groups I and II, respectively. The resultant stained sections of tissue were graded on the stage of their inflammation, density and maturation of granulation tissue collagen density, re-epithelisation and neovas cularisation (Table 3; Plate 3 and 4). The statistical inference for all histological parameters between groups I and II in all the three (3, 7 and 14) days of evaluation were found to be non significant ($p>0.05$). However, on comparison within the

Table 2: Subjective evaluation of postoperative wound of groups I and II.

Parameter	Days	Group I						Group II					
		1	2	3	4	5	6	1	2	3	4	5	6
Colour	3	P	P	P	Y	P	P	P	P	P	P	P	P
P= Pink Y= Yellow	7	P	P	P	P	P	P	P	P	P	P	P	P
B= Black N= Nad	14	N	N	N	P	P	N	P	N	N	N	N	P
Odour	3	N	N	N	P	N	N	N	N	N	N	N	N
M= Mal odour	7	N	N	N	M	N	N	N	N	N	N	N	N
O= Offensive	14	N	N	N	N	N	N	N	N	N	N	N	N
P= Putrid													
N= Nil													
Exudate	3	N	N	S	P	N	N	N	S	N	N	S	N
S= Serous	7	N	N	N	S	N	N	N	N	N	N	N	N
Sa= Sanguineous	14	N	N	N	N	N	N	N	N	N	N	N	N
SS= Serosanguineous													
P= Purulent													
N= Nil													

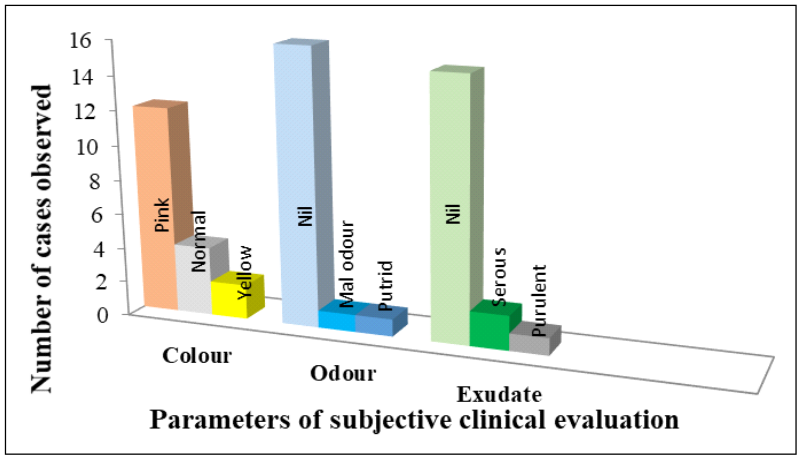


Fig 1: Postoperative subjective evaluation of group I.

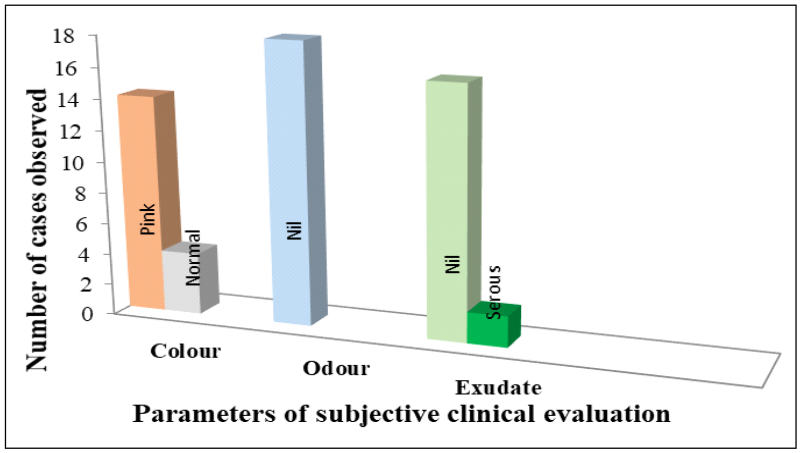


Fig 2: Postoperative subjective evaluation of group II.

groups, high significance (p<0.01) were noted within both the groups.

This inference suggested that on comparison between the two groups, the rates of acute inflammation, chronic inflammation, granulation tissue density, granulation tissue maturation, collagen density, re-epithelialisation and neovascularisation proceeded parallelly between both groups. However, within the groups there were high variations in the histological parameters (Schultz *et al.*, 2003). The statistical analysis conducted was hence in agreement with the clinical observations of a healing wound.

Colour flow doppler ultrasonography was performed on postoperative days 3, 7 and 14 for the groups I and II and the images from representative groups have been

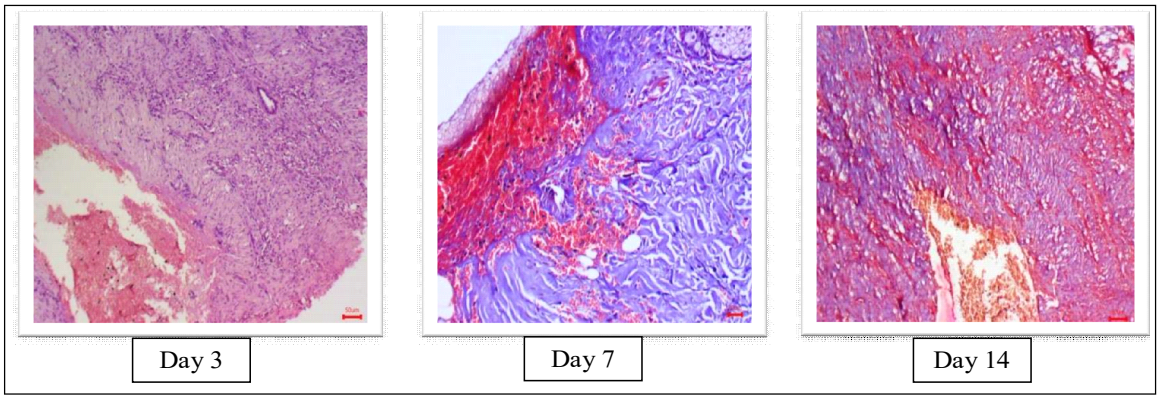


Plate 3: Masson's Trichrome staining of tissues - Group I collected on post operative days 3, 7 and 14.

Table 3: Histological scoring of groups I and II.

Parameter	Groups / Test value (Between groups)	Days			Test value (Within groups)	
		3	7	14	P-value	K-W value
Acute inflammation	I	1.33±0.21	1.33±0.21	0±0.00	.001**	13.114
	II	1.5±0.22	1.32±0.21	0±0.00	.002**	12.958
	P-value	0.699^{NS}	1.000^{NS}	1.000^{NS}		
	M-W value	21.0	18.0	18.0		
Chronic inflammation	I	0.33±0.21	2.5±0.22	2.16±0.30	.003**	11.884
	II	0.16±0.16	2.5±0.22	2.33±0.33	.002**	12.035
	P-value	0.699^{NS}	0.240^{NS}	0.699^{NS}		
	M-W value	15.0	10.5	20.5		
Granulation tissue density	I	0±0.00	2.33±0.21	3±0.00	.001**	15.057
	II	0±0.00	2.5±0.22	3±0.00	.001**	14.733
	P-value	1.000^{NS}	0.699^{NS}	1.000^{NS}		
	M-W value	18.0	21.0	18.0		
Granulationtissue maturation	I	0±0.00	1.83±0.16	3±0.00	.000**	16.710
	II	0±0.00	1.66±0.33	3±0.00	.000**	15.540
	P-value	1.000^{NS}	0.589^{NS}	1.000^{NS}		
	M-W value	18.0	14.5	18.0		
Collagen density	I	0.33±0.21	2±0.00	2.83±0.16	.000**	15.381
	II	0.33±0.21	2.33±0.21	2.83±0.16	.001**	13.531
	P-value	1.000^{NS}	0.394^{NS}	1.000^{NS}		
	M-W value	18.0	24.0	18.0		
Reepithelialisation	I	0±0.00	2.33±0.21	3±0.00	.001**	15.057
	II	0±0.00	2.5±0.22	3±0.00	.001**	14.733
	P-value	1.000^{NS}	0.699^{NS}	1.000^{NS}		
	M-W value	18.0	21.0	18.0		
Neovascularisation	I	0.16±0.16	1.83±0.16	3±0.00	.000**	16.223
	II	0±0.00	1.33±0.21	2±0.25	.001**	13.822
	P-value	0.699^{NS}	0.699^{NS}	0.699^{NS}		
	M-W value	15.0	21.0	20.5		

depicted in Plate 5 and 6, respectively. Grading of colour flow Doppler USG was done based on the subjective grading as determined by Reetz *et al.* (2006). The inference from the statistical analysis revealed significant difference within group I across the days, suggesting that the degree of vessel detection differed significantly across the days of evaluation. But no such significant difference was revealed within group II, *i.e*. the rate of detection of vessels was similar on all three days of examination for group II animals.

The postoperative pain scores on days 3, 7 and 14 for groups I and II were assessed using the glasgow CMPS-SF scoring system (Table 4). Inferences from the statistical analysis revealed no significant difference between the groups and within the groups. This suggested that the animals in both the groups I and II evinced similar levels of pain across all the days of evaluation.

Post-operative complications

Two cases in group I showed complications which involved wound dehiscence at the ventral-most surgical site (Case 4) and a seroma pocket formation ventral to the primary surgical site (Case 5). This led to an infection at the site of dehiscence with presence of mild pus discharge. Claeys (2016). This wound complication was treated in a timely

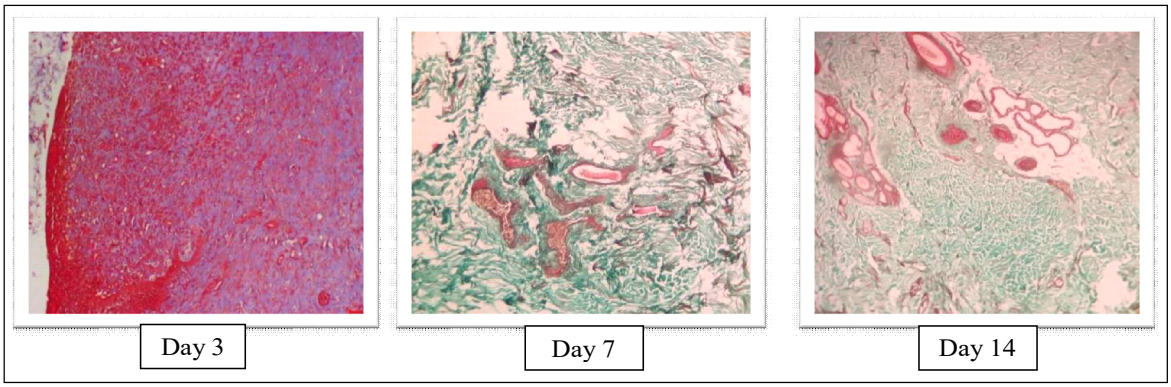


Plate 4: Masson's trichrome staining of tissues - group II collected on postoperative days 3, 7 and 14.

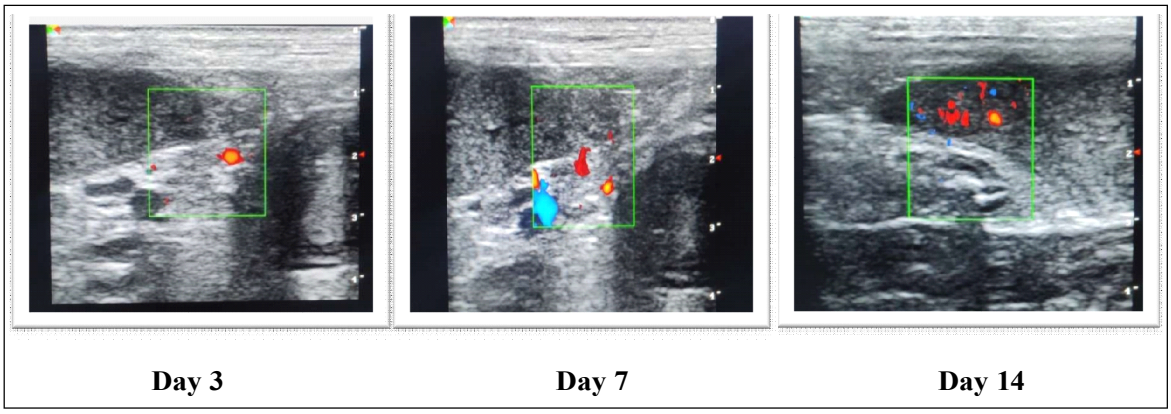


Plate 5: Colour flow doppler ultrasonography - postoperative days 3, 7 and 14 of group I.

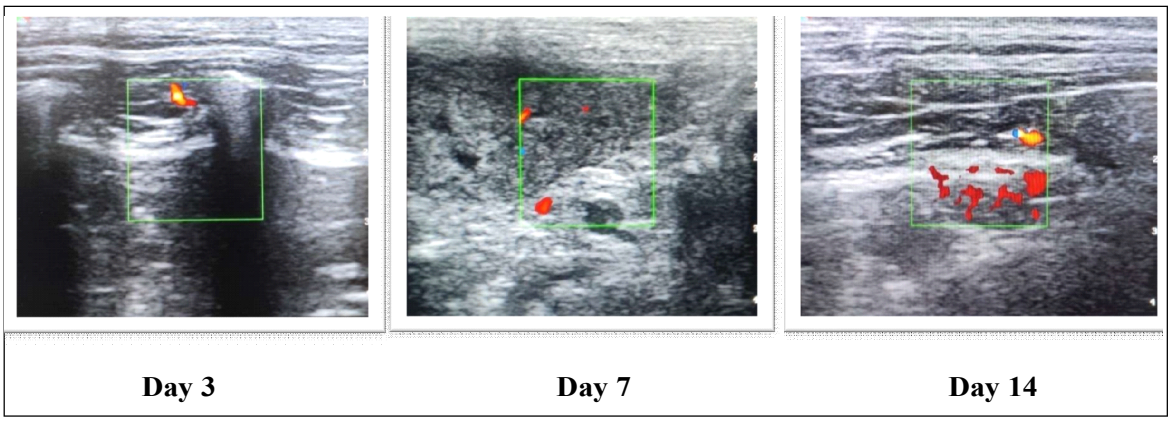


Plate 6: Colour flow doppler ultrasonography - postoperative days 3, 7 and 14 of group II.

Table 4: Postoperative pain assessment of groups I and II.

Group / Test value (Between groups)	Days			Test value (Within groups)	
	3	7	14	P-value	K-W value
I	1.83±1.22	0.5±0.5	0±0.00	0.283^{NS}	2.522
II	1.16±1.16	0.33±0.33	0±0.00	0.586^{NS}	1.069
P- value	0.699^{NS}	0.937^{NS}	1.000^{NS}		
M-W value	15.5	17.5	18.0		

NS= Non significant (P>0.05).

*= Significant (P<0.05).

**= Highly significant (P<0.01).

manner by the use of topical antimicrobial agent and regular wound dressings. The wound eventually healed by second-intention in tandem with the rest of the surgical site.

CONCLUSION

The two tension relieving techniques under the study *viz.*, Spiderplasty and Bow-tie demonstrated appreciable results in terms of tension free surgical closure of large wounds, with no formation of dog-ears at the suture ends. Both techniques exhibited certain advantages and disadvantages pertaining to wound reconstruction under clinical settings. The spiderplasty technique was more time consuming, required more surgical expertise and had slightly lower cost efficiency ratio and better be utilised to close wounds located in confined anatomical areas, as compared to the Bow-tie procedure which was limited by its requirement to resect 36% of adjacent normal tissue. The Bow-tie procedure was however, easier to perform and required less surgical time as compared to the Spiderplasty procedure (Swaim, 2006).

Conflict of interest: None.

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