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A COMPARATIVE STUDY OF ADVANCING FLAP AND AUGMENTED CLEFT CLOSURE TECHNIQUES FOR PILONIDAL SINUS

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Wound complications and high recurrence rates contribute to the unsatisfactory results that are frequently associated with pilonidal sinus. The methods of asymmetric excision are reported to be associated with very low recurrence rates and better wound healing. In this work, a standard asymmetric procedure (Karydakis' advancing flap, KAF) was compared with a new one (augmented cleft closure, ACC). The latter was designed to address wound problems in the KAF procedure on mechanical basis (tension pattern modification). The study included 40 consecutive patients in 2 groups: group KAF (16 patients) and group ACC (24 patients). The KAF and ACC groups were comparable as regards age (22.7 ± 5.1 versus 24.8 ± 4.5 years), sex ratio (7:1 male-to-female ratio in both groups), duration of follow-up period (generally 9 to 17 months, 13.0 ± 2.5 versus 12.5 ± 2.5), and disease severity according to a devised scale. Post-operative pain, according to a combined scale, was comparable in the two groups for the first 2 days after surgery but better in the ACC group after one week. The ACC procedure showed better results concerning the duration of stay in hospital (1.3 ± 0.46 versus 1.6 ± 0.51 days, $p < 0.05$), time to return to work (16.7 ± 3.9 versus 20.2 ± 5.8 days, $p < 0.025$), healing type (primary in 100% versus 69%, $p < 0.001$), healing time (13.4 ± 1.4 versus 20.9 ± 10.1 days, $p < 0.005$), and incidence of wound complications (zero% versus 31%, $p < 0.025$). Recurrence occurred in one case of the KAF group (statistically insignificant). The superior results in the ACC group were mostly attributed to the lower incidence of wound complications which supported the design concepts. It is hoped that the presented new technique would contribute to improvement of the outcome of surgery for pilonidal sinus.

INTRODUCTION

Despite the benign and localized nature of pilonidal disease, the results of its surgical treatment are frequently unsatisfactory[1]. This can be attributed to delayed wound healing, frequent wound complications (infection, collection, bleeding, and secondary break-down), and high recurrence.

Any attempt to improve the results of surgery for pilonidal disease should focus on 2 areas: complete elimination of the known underlying causes, and solving technical and design factors that contribute to wound complications.

The pathogenesis of pilonidal sinus is not clearly understood. Evolution of epithelium-lined skin pits is currently believed to be the initial event. These are produced by widening of skin pores (of hair follicles and gland orifices) due to the combined effects of mechanical stretching[2,3,4], and local infection[5]. Mechanical stretching is produced by a unique tension pattern, the ***tension trap***. During adolescence, rapid development of the glutei produces skin and deeper tissue tensions towards the midline area[2]. The skin in this area is adherent to the sacral bone by deep fascia. Midline fixity converges gluteal tensions, focuses them into the midline, and prevents them from diffusion into the opposite side. This tension trap results in maximal stretching of the skin pores and widens them to produce pits, (Fig.. 1A). Contrary to previous

concepts, the role of hair in disease is secondary. Hair is not a constant finding in sinuses. It was observed in one half to three quarters of cases[4,5]. Hair insinuation establishes infection in the pits. Infected pits may rupture into the subcutaneous fat resulting in acute abscess formation[6].

The classical midline excision of pilonidal sinus is associated with many wound complications. Tension pattern is probably a major contributing factor. After limited excision (that does not reach deep fascia), the tension trap (described above) persists and results in ripping skin suture lines predisposing to their disruption. In deep excision, bilateral gluteal tensions affect suture lines (in skin and deep tissue planes) destabilizing both of them, (Fig. 1B). The shearing and ripping of deep suture lines result in development of a large dead space, collections, and infection. These factors also contribute to ischemia of the floating unsupported skin edges. These problems have encouraged the recent trend of avoiding the midline ditch in pilonidal surgery by resorting to asymmetric excision[6].

As an elaboration of the previously defined criteria by Allen-Mersh (1990)[1], an ideal procedure for pilonidal sinus should achieve immediate, short-term, and long-term objectives. Complete eradication of irreversible pathology is the immediate objective. The short-term objective is to reduce the negative impact of surgery on patient's life (wound-related pain, activity limitations, frequent visits for dressings, and extended off-work periods). The long-term objective is prevention of recurrence by eliminating the underlying cause[1,7].

Despite the availability of many surgical approaches for pilonidal sinus, none could satisfy these objectives fully. Asymmetric excision methods are claimed to achieve superior results in comparison with other methods[7]. In this work, a new procedure for asymmetric excision of pilonidal sinus (augmented cleft closure, ACC) is presented. It was specifically designed to address some drawbacks in previous methods. Its results were compared with those of a standard asymmetric method, Karydakis' advancing flap technique[8].

PATIENTS AND METHODS

The study included 40 consecutive patients who presented with "chronic" pilonidal disease. Patients who presented with acute abscess, requiring incision and drainage before planning for definitive surgery, and those with extensive disease, involving both gluteal regions beyond retrosacral area, were not included. Severity of "chronic" pilonidal disease was assessed according to a devised simple scale of 5 grades, (Table 1).

The studied patients comprised 2 major groups according to the surgical technique employed in their treatment. Group "KAF" (16 patients) were operated upon by Karydakis' advancing flap method, and Group "ACC" (24 patients) were operated upon by augmented cleft closure techniques.

In the ACC group, 18 patients had Type-I of the procedure (ACC-I) while 6 patients had type-II (ACC-II). (Table 2) summarizes the preoperative data of the studied pati1ents. The two groups were comparable for age, sex, severity of disease, and duration of follow-up period.

Techniques

In Karydakis' procedure was performed as described by Karydakis[8] and Kitchen[9]. The sinus is excised with a vertical eccentric elliptical excision that includes the midline and an area lateral to it. A thick flap is created by undercutting the medial edge and mobilizing the flap down to the sacral periosteum. The flap is advanced laterally to be sutured to the sacrococcygeal fascia. The skin wound is closed and the whole suture line is thus forced laterally, (Fig. 2A).

The ACC-I procedure

The following description refers to the "near" and "opposite" sides, in relation to the midline, according to the position of the surgeon who stands on one side of the patient. The latter attains a prone position.

A) The skin incision The incision is either a straight line or a flat C-shaped one, with the long limb made parallel to and two cm lateral to the midline. It is chosen on the less damaged side and extended in length to parallel all the pits and potential deep cavities. The two short limbs connect the vertical limb with the midline, (Fig. 3).

B) Dissection-excision The incision is deepened till it uniformly reaches the deep fascia (Fig. 4). This level defines the deep dissection plane. The superficial dissection plane is then initiated at the dermoepidermal junction of the skin within the concavity of the "C", along its entire length (Fig. 5). Dissection proceeds towards the midline till the tracts of the sinuses are encountered. These tracts are dissected towards their orifices so that they become included intact in the excised mass (Fig. 6). When the mouths of the sinuses are reached they are excised with minimal skin (1 mm) around them (Fig. 7). Dissection of the superficial plane proceeds medially to end two cm lateral to the midline, on the "opposite" side. Dissection of the deep plane then proceeds towards the midline over the fascia then the sacrum. The mass of tissue within the two dissected planes is finally excised, including all sinuses, cavities, and tissues underlying the midline (Fig. 8).

C) Mobilization of the tissue flap A thick tissue flap is developed by dissection in a plane over the sacrum

then the deep fascia on the "opposite" side to mobilize the fat over it. This proceeds till the tissue is judged to be freely mobile to reach the near side without tension.

D) **Preparing the bed for the skin flap**. The skin flap is pulled by hand towards the near side and placed over the intact skin so that the subcutaneous tissue fills the whole space without tension (Fig. 9a). The area of overlap, of the flap and near skin, is marked in the intact skin. This area is subsequently deepithelialized (Fig. 9b) and a 2-mm lateral edge is created for subsequent sutures.

E) Closure Four sets of sutures are employed. The subcutaneous tissue is sutured to the deep fascia in the depth of the near side of the wound by absorbable stitches. The skin flap is fixed to the deepithelialized surface by 2 groups of stitches: 1) a few stitches which fix the middle of the flap to the medial edge of the deepithelialized surface (Fig. 9C), and 2) stitches (or staples) which approximate the edge of the flap and lateral edge of deepithelialized area (Fig. 10). The open holes in the skin flap (after excision of the mouths of sinuses) are either closed by sutures or left open over the deepithelialized surface (Fig. 10). Suction drain is placed in the depth of the wound.

The ACC-II procedure

In patients with wide, multiple, or confluent openings (particularly recurrent cases), a modification of the procedure was employed (ACC-II) as the integrity of the skin flap was expected to be compromised. In the ACC-II, the skin was excised from the midline to the edge of the original flap. The two procedures were similar in all other aspects.

Post-operative assessment

In the early postoperative period, the two groups of patients were compared concerning pain, wound healing, wound complications, duration of stay in hospital, and off-work time.

Postoperative pain was assessed on basis of a color-supported numeric rating scale (NRS), i.e. employing a colored plate combined with a numerical scale. Every patient selected the color and number that closely described the severity of his/her pain ranging from 1 or blue (minimal pain) to 10 or red (unbearable pain)[10]. Pain was assessed one day, two days and one week after surgery.

Wound healing was assessed on basis of its type (primary or secondary) and time. Primary healing was defined as one ending with removal of sutures and staples with no further sequels requiring professional care. In contrast, secondary healing was defined as one that required care following removal of staples and stitches due to any of two situations: 1) early removal of staples and stitches to drain collection or infection, to stop bleeding, to debride ischemic skin edges or other causes, or 2) wound gaping or major breakdown in suture line after staples and stitches were removed presumably at optimal time.

Wound Healing time was defined according to the type of healing. In primary healing, healing time was marked by the day where stitches and staples were totally removed. In secondary healing, it was marked by complete epithelialization of the surface that was not followed by subsequent breakdown for at least 2 weeks.

Every patient was scheduled for follow-up every 3 months, where he/she was assessed for any delayed wound complications and recurrence.

RESULTS

The immediate postoperative pain (first and second days) was comparable in the two groups of patients. After a week, the improvement in pain intensity was more marked in the ACC group, Table III. This is explained by the fact that 5 patients had complications associated with pain. The duration of stay in hospital was significantly shorter in the ACC group, and the return to work was earlier, (Table 3).

Primary healing occurred in all patients of the ACC group and 69% of those of group KAF (statistically significant, Table 3). Major wound complications (infection, collection and gaping) occurred in 5 patients of group KAF (31%) but none in group ACC (statistically significant, Table III). Minor complications (stitch sinus, trivial flap edge losses, limited dehiscence at edge) occurred in 4 patients of group KAF and 3 patients of group ACC. In general, wound healing time was significantly longer in group KAF, (Table 3). This was mainly due to the prolonged healing time in those patients who had wound complications (5 patients who had an average healing time of 34.2 days, ranging from 26 to 44 days). Return to work was significantly faster in group ACC, (Table 3).

During the follow-up period, one recurrence was observed in group KAF and none in group ACC.

Table (1) : ***Proposed severity scale for pilonidal disease.***

Grade	*Description*
0	Midline pits, unassociated with tracts.
I	One midline portal of a sinus tract but no cavities.
II	Any of the following: • Multiple (two or more) portals and sinuses. • A cavity, chronic abscess or cysts (=/> 2 cm in diameter).
III	Recurrent cases with G-I or G-II criteria.
IV	Extensive disease involving gluteal regions (lateral to retrosacral area).

Table (2) : ***Clinical data [* presented as: average ± SD (range), ** presented as male-to-female ratio, insignificant refers to statistical significance] .***

Parameter	*All patients*	*Group KAF*	*Group ACC*	*Significance*
Number	40	16	24	---
Age*	23.9±4.8 (16-33)	22.7±5.1 (16-31)	24.8±4.5 (16-33)	Insignificant
Sex**	35:5	14:2	21:3	Insignificant
Severity (grade)				
I	17 (42.5%)	9 (56.3%)	8 (33.3%)	Insignificant
II	13 (32.5%)	4 (25%)	9 (37.5%)	Insignificant
III	10 (25%)	3 (18.8%)	7 (29.2%)	Insignificant
Follow-up period*	12.8±2.5 (9-17)	13.0±2.5 (9-17)	12.5±2.5 (9-16)	Insignificant

Table (3) : ***Results [* means expressed as: average ± SD (range), insignificant refers to statistical significance].***

Parameter	*Group KAF*	*Group ACC*	*Significance*
Postoperative pain (NRS)			
• After 1 day	3.1±1.8 (0-6)	2.5±1.6 (0-5)	Insignificant
• After 2 days	2.4±1.4 (0-5)	1.8±1.2 (0-4)	Insignificant
• After a week	2.4±2.5 (0-7)	0.9±1.3 (0-4)	P < 0.025
Duration of stay in hospital (days)*	1.6±0.51 (1-2)	1.3±0.46 (1-2)	P < 0.05
Days off-work*	20.2±5.8 (12-33)	16.7±3.9 (11-25)	P < 0.025
Wound healing			
• Primary healing	11/16 (69%)	24/24 (100%)	P < 0.001
• Time (days)*	20.9±10.1 (12-44)	13.4±1.4 (12-16)	P < 0.005
Wound complications	5 (31%)	0 (0%)	P < 0.025
• Infection	2	0	
• Collection	2	0	
• Bleeding	0	0	
• Spontaneous breakdown	1	0	
Recurrence rate	1 (6.3%)	0 (zero%)	Insignificant

Table (4) : ***Results of different surgical approaches to pilonidal sinus. (* these authors closed the wound primarily, ** these are the complications that required surgery, superscripts refer to references).***

Approach	*Wound complications*	*Recurrence*
Open midline	5.1%[14]	Zero%[14] - 8%[15] - 12%[16] - 13%[17] and 1-43%[1]
Closed midline	3.3%[18] - 8%[19], 14%[17], 23%[20], 69%[21].	zero%[18] - 9%[21] - 11%[17] - 14%[15] - 17.5%[19] - 18%[20] - 20%[16] and 0-37%[1]
Limberg flap	zero%[21,27] - 7%[31] - 7.5%[32] - 12.5%[33] 13.5%[34]	zero%[21,27,33,34] - 2%[31]
Bascom's open method	10%[36] - 11%[37*]	7.3%[38] - 8%[3] - 9%[37*] - 10%[36]
Bascom's cleft closure	67%[7]	zero%[7]
Karydakis' advancing flap	7.1%[41] - 12%[39**] - 18%[42] (11% non-healing and 7% secondary break-down).	zero%[39] - 1%[40,41] - 4%[9,42]

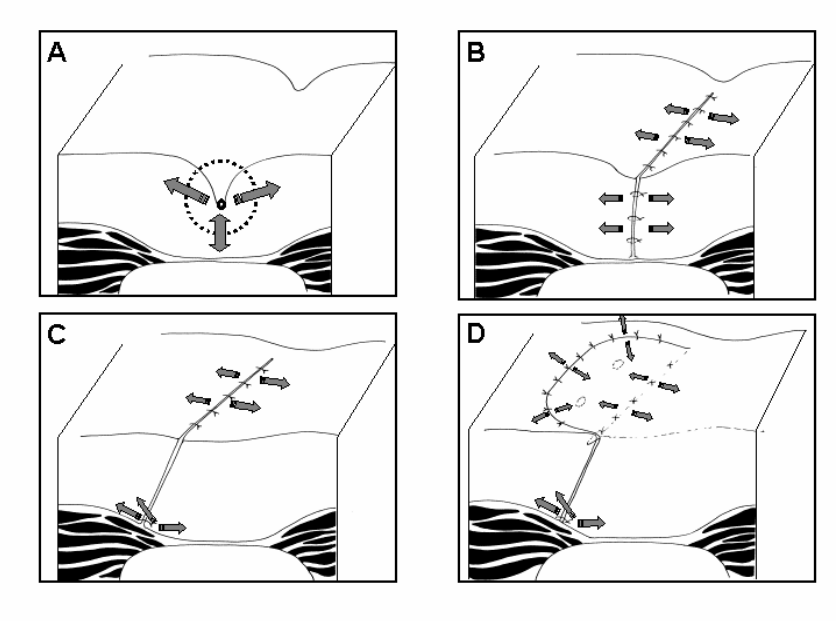

Fig.(1): Tension lines. A) The tension trap: bilateral gluteal tension + midline fixity result in maximal stretching of the midline and predispose to pit development. B) After deep midline excision, skin and deep tension fronts predispose to wound dehiscence. C) Karydakis procedure is associated with re-routing of deep tension of one side due to the suture to deep fascia. ACC procedure results in deep tension re-routing (as in Karydakis procedure) + skin tension scattering to 3 fronts.

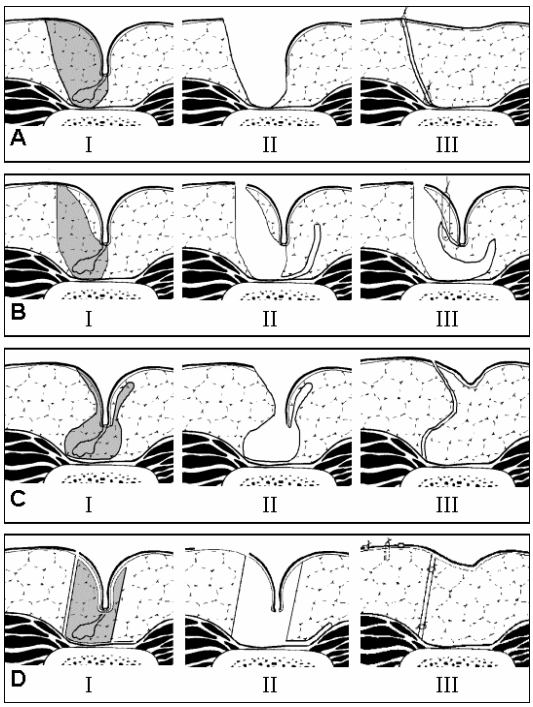

Fig.(2): Asymmetric methods for excision of pilonidal sinus. A) Karydakis' method. B) Bascom's open procedure. C) Bascom's cleft closure procedure. D) Augmented cleft closure method. (I: excised part, II: After excision, III: reconstruction).

Fig.(3) : The incision.

Fig.(4): Deepening the incision.

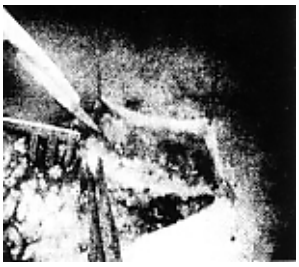

Fig (5): Superficial dissection (raising the flap).

Fig.(6): Dissection of sinus tracts.

Fig.(7): Excision of mouths of sinuses.

Fig.(8): Excision of the whole mass.

I

II

III

Fig (9): Reconstruction, I) Placing the flap over skin to estimate the area for deepithelialization.
II) Deepithelialization. III) After deep stitches.

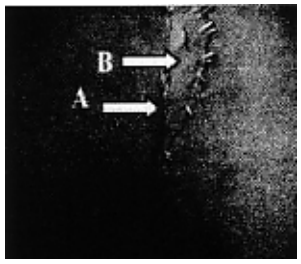

Fig (10): After closure, A) stitches of flap to deep tissue, B) stitches closing mouths of sinuses.

DISCUSSION

Several strategies and many techniques have been employed to face the two basic problems in pilonidal surgery (wound problems and recurrence). These strategies included: 1) open approach, 2) meticulous space occlusion, 3) minimized intervention, 4) flaps or other plastic techniques, and 5) asymmetric excision. (Table 4) presents a review of the incidence of wound complications and recurrence rates that were recently reported for different approaches.

Methods of the open midline approach include: open excision[11,12], marsupialization[13], and incision and curettage[14]. These methods are associated with prolonged healing time that may take more than 3 months[1]. In some cases the wounds never heal spontaneously[7]. The incidence of these healing problems is not known with certainty because reports focus on recurrence rather than healing failure[7]. Return to work was reported to take, on average, 4 weeks[12]. Reported recurrence rates ranged from zero to 13%[1,14-17], (Table 4). Because of the distressing healing problems associated with open excision, it was suggested that this method should be abandoned[1].

Meticulous midline closure of the cleft with deep stitches is associated with high incidence of wound infection and dehiscence, reported to occur in up to 69% of patients[17-21]. Healing is frequently secondary and healing time may reach 50 days[1]. The reported average period to return to work is 26 to 31 days[20,21]. Recurrence rate may reach 20%[1,15-21], (Table 4). These results, encouraged resorting to alternatives which avoid the midline ditch[6].

Resorting to more limited procedures minimizes wound complications. Several methods have been proposed, including: Lord Millar's procedure, i.e. limited excision of the portals and extraction of the hairs with a brush[22], phenol injection[23], electrocautery[24], and cryo-destruction of sinuses[25]. These methods are commonly associated with significant failure rates[6]. They also require life-long local care to avoid recurrence, as the etiological factors are not addressed.

Several flaps and plastic procedures have been employed in pilonidal disease, e.g. Limberg flap[21,26,27], V-Y advancement flap[28], Gluteus maximums flap[29], and Z-plasty[30]. The most commonly practiced methods are the Limberg flap and Z plasty. The Limberg flap is associated with reported complication rates of up to 13.5%[21,27,31-34], recurrence rate up to 2%[21,27,34], and a 17 to 23 day period to return to work[21,33,34], (Table 4). The objection against these methods is in their large magnitude and associated disfiguring[7].

Asymmetric methods for excision of pilonidal sinus are all based on the principle of lateralizing the skin wound to avoid the complications of the midline ditch. Recurrence is commonly very low. This is attributed to excision of pits and to flattening of natal cleft. The latter, alone, reduces recurrence by 50%[1]. The more widely practiced procedures in this group are: advancing flap technique[8], (Fig. 2A), open asymmetric excision[3], (Fig. 2B), and the cleft closure method[35], (Fig. 2C).

In Bascom's open method[3], (Fig. 2B), the sinus is excised via a lateral incision. The skin pits are excised with minimal wounds which are subsequently closed by subcuticular sutures. The sutured wounds are supported by mobilizing a flap from the opposite wall of the excised tissue. The cleft is left open to heal by granulation, drained through the open lateral incision. This method was reported to be associated with wound complications in 10 to 11% of cases[36,37], and recurrence rates of 7 to 10%[3,36-38], (Table 4).

Bascom's cleft closure technique[35], (Fig. 2C) was originally intended for non-healing wounds after excision of pilonidal sinus. It could be employed for primary excision as well. This method entails excision of the sinus (or unhealed wound) through a midline approach, raising a skin flap from the less damaged side, excision of a lateral strip of skin on the other side, then pulling the skin flap to be sutured laterally. This method has not yet become widely practiced. A 67% incidence of secondary wound healing and zero% recurrence were recently reported with this method[7], (Table 4).

The main advantage of Karydakis' procedure is the very low recurrence rate that ranges from zero to 4%[9,39-42]. This low recurrence may be attributed to 2 factors: complete extirpation of irreversible pathology by en-block excision of pits, sinuses and surrounding tissues, and elimination of the tension trap by release of midline fixity. The tension trap predisposes to 3 problems: evolution of disease, wound dehiscence, and recurrence. On the other hand, the procedure resists wound dehiscence by 2 mechanisms that address superficial (skin) and deep components of gluteal tension. These mechanisms are: tension trap elimination (for superficial component) and deep tension re-routing (for deep component). The tension trap elimination protects skin by allowing diffusion of tensions over a wide area. Meanwhile, tension re-routing protects deeper tissues by shifting deep gluteal tension from the contralateral side of the wound to the tough ipsilateral deep fascia (by deep stitches). The later action abolishes the effect of ipsilateral gluteal tension and dampens that of the contralateral one, (Fig. 1C).

Despite these mechanisms, wound complications are still frequent with Karydakis procedure. Reported rates of wound complications ranged from 7 to 18%[39,41,42], (Table 4).

This may be explained on basis of 2 problems: occasional exceedingly high tension at sutures lines, and the placement of skin and deep tissue sutures in one vertical plane. The undue tension at suture lines is more likely when there is an obligatory increase in the width of the original ellipse to include lateral extension of the disease. Moreover, the nature of the procedure (en-block excision of pits, sinuses and cavities) favors excision of a significant mass of tissue. The location of deep stitches and skin stitches in one vertical plane distributes tensions uniformly into both. When gaping occurs in either group of stitches, it is likely to occur in the other due to the subsequent increase in tension load to the intact sutures.

The ACC procedure was designed to address wound healing problems in the other asymmetric methods by 2 mechanisms: targeted excision, and tension scattering. Targeted excision means limiting the excision to the actually involved tissues. This was made feasible by the excellent visualization of sinuses and cavities (as they are seen sideway) that allowed more limited, yet complete, resection of irreversible pathology, (Fig. 6).

Tension scattering, in the ACC procedure, is the way of distributing superficial gluteal tensions that replaced simple elimination of the tension trap in Karydakis' procedure. It means distributing superficial gluteal tension of the opposite side of the wound into 3 wide fronts: skin flap edge, skin flap surface, and deeper tissue through the skin flap (by proximal stitches). Shifting skin stitches more laterally distributed tensions into points of variable distances instead of one vertical plane as in Karydakis' method. The skin flap scattered tensions into a wide surface area instead of a narrow linear edge. The frictional resistance of the skin flap, particularly with healing, contributed to further resistance to tensions. The skin flap was better supported as it was placed over an intact continuous dermal layer instead of a mobilized interrupted layer made of the sutured fatty tissue as in Karydakis' method, (Fig. 1D).

The previous studies that reported results of surgery for pilonidal disease presented heterogenous forms of results that were sometimes difficult to compare. In many cases, some aspects were ignored altogether or partially reported, e.g. healing failure[7]. In this work, an emphasis was made on defining reported parameters to avoid confusion. In assessing pain intensity, color-supported, coupled VAS and NRS scales were used. Both scales proved to be reliable and consistent in pain assessment[10]. Scale coupling, and color support were intended to address patients of different cultures, levels of education, and ages[43].

The superiority of the ACC procedure in wound healing parameters and return to work are explained on basis of the lower incidence of wound complications that are the causes of secondary healing. This supports the theoretical basis of the procedure as explained above.

In conclusion, a new procedure, the ACC technique, was suggested for treatment of pilonidal sinus. It was designed to maintain the advantages of other asymmetric methods and to overcome wound problems. This was addressed on mechanical basis by redistributing tissue tensions in a more favorable way. Results revealed superiority of the method and further supported the theoretical expectations. It is hoped that the presented technique would have a place in the surgery for pilonidal sinus and contribute to improving the results of surgery.

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