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# Skin flaps for the Gynaecologist

**H.H. Allen**

*Department of Obstetrics & Gynaecology, Division of Gynaecologic Oncology, University of Western Ontario, London (Canada)*

**Summary**

Skin flaps are becoming more frequently indicated in gynecologic surgical practice, especially in oncologic surgery. It is imperative that the gynecologic surgeon of today be well informed in the many physiologic processes of wound healing, also those factors that delay and those that promote wound healing. Knowledge of the detailed anatomy of abdomen, pelvis, vulva, peritoneum and ano-rectal area is essential. An appreciation of the specific muscular attachments, action, blood supply, collateral circulation and nerve supply are important prerequisites. Also, a working knowledge of the tissue dynamics associated with the transfer of skin, subcutaneous tissue and sometimes muscle to the required location. The important role played by vascular endothelial growth factor (VEGF), endothelial proginator cells, protein kinase C, and other factors being investigated in wound healing, is exciting. There are a number of procedures possible for most problems requiring tissue transfer. Tension free oxygenated areas for healing is essential. All the basic surgical rules for tissue handling and would healing must be carefully applied for optimum results.

*Key words:* Pelvic skin flaps; Wound healing; Tissue transfer.

## Introduction

Skin flaps are generally used for coverage of a wound that cannot be satisfactorily closed by primary approximation. Flaps can be used to close wounds in non-infected areas and often used to provide some bulk with a more natural appearance to the area involved.

Flaps can be random or axial. The *random flap* is supplied by blood vessels from the subdermal plexus but has no main vessel supplying blood to the donor tissue. The *axial flap* has a specific predictable blood vessel supplying the donor tissue. A flap that includes a large amount of tissue, especially if muscle is involved is usually constructed as an axial flap with known arterial and venous connections to the donor tissue. When considering the use of skin flaps, one must be very conscious of the mechanisms of wound healing, measures that promote wound healing as well as those that prevent or delay healing.

## Physiology of wound healing

Wound healing can be divided into phases although the timing is not *exact* and the phases overlap on each other. There is no clinical method of accelerating wound healing over the normal but there are a number of factors that can delay wound healing.

## Phase I - Haemostasis

This phase begins immediately the incision is made. Platelets adhere to the collagen exposed by the vessel injury to the endothelium. A plug is formed in the vessel. Cytokines and other proteins are released from the cytoplasm of the platelets in this process. These cytokines influence the immediate response to the wound repair, and some of the cytokines are bound in the fibrin-fibronectin complex and act as a reservoir for these protein factors. These proteins are released over time to modulate the migration of various cell types as the healing physiology progresses.

## Phase II - Inflammation

The tissue damage also stimulates an inflammatory response which begins within the first hours after the injury and is most prominent in the first 24 hours. By seven days a clean wound has very few inflammatory cells. Neutrophils are the prominent cell in the first three days but monocytes converting to macrophages soon become the main inflammatory cell present. Neutrophils engulf bacteria then die and release lysosomal pro-

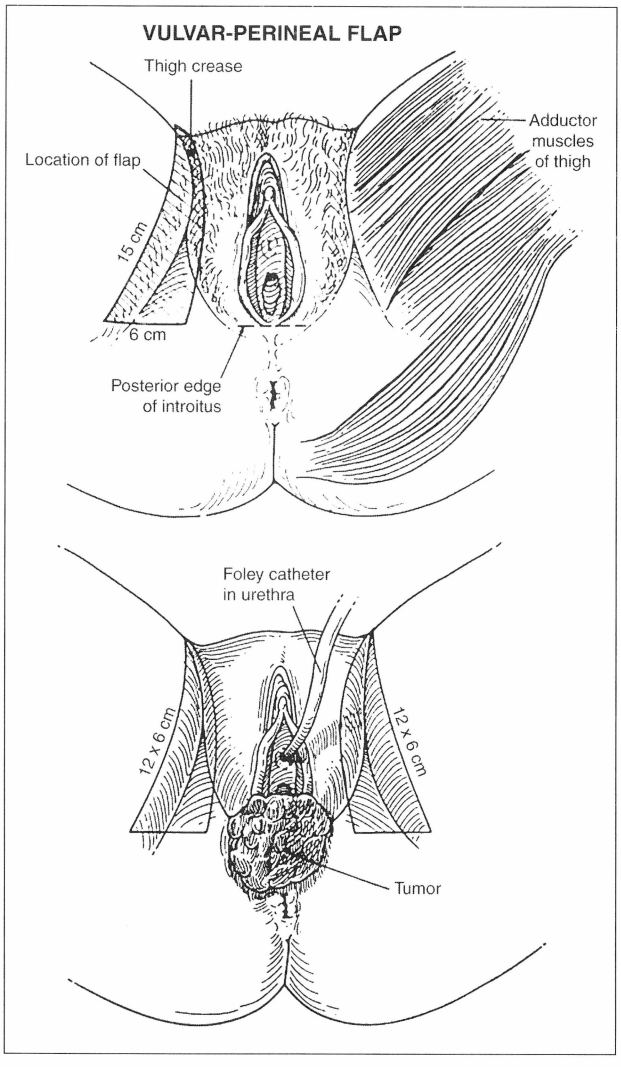



Figure 1.

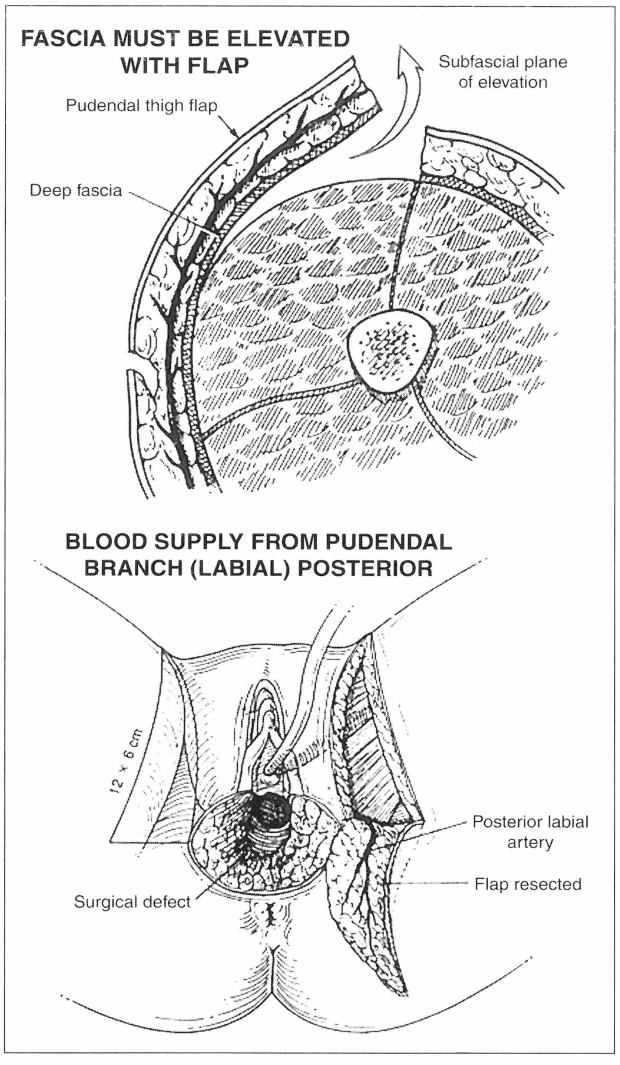


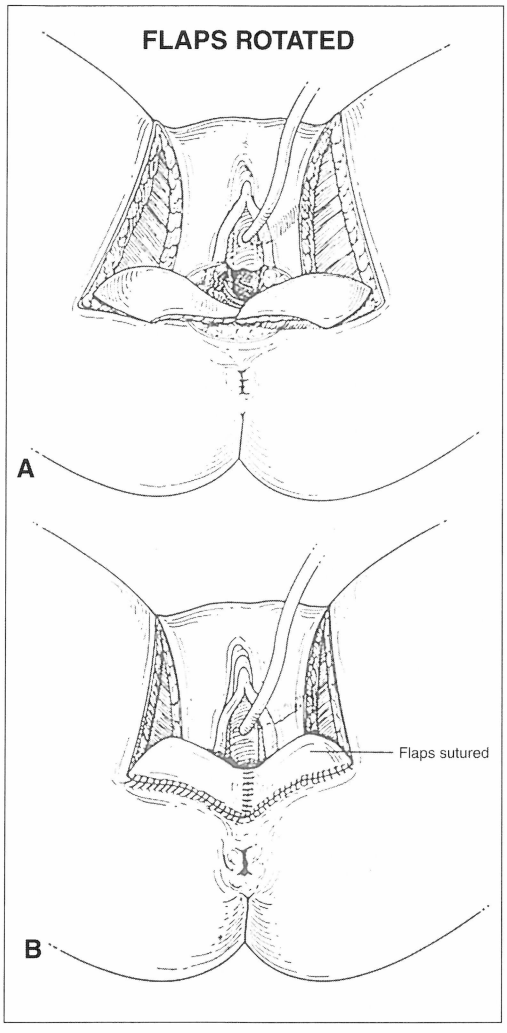

Figure 2.

teolytic enzymes that contribute to tissue damage and promote inflammation. Macrophages on the other hand secrete matrix melalloproteinasis that break down necrotic tissue. They also survive much longer than neutrophils as they do not die after taking in bacteria or necrotic tissue. If infection develops, large numbers of neutrophils are present which die and release proteinases that break down tissue in the area and therefore, excesses delay wound healing. Both substances are the main content of pus. Macrophages are essential for the healing process, neutrophils are not.

## Phase III - Migratory

Fibroblasts and mesenchynral cells are attracted into the wound by several cytokines. These cells are very important in the tissue repair process. Angiogenesis also begins three or four days after wounding. Platelets and macrophages are largely responsible for stimulating new vessel formation and decreasing the hypoxic, high lactic acid, acidic wound micro environment. These vessels join other capillaries of the opposite side and enlarge as is necessary to deliver $O_2$ and nutrients to the wound. The local blood supply may be increased 30 to 40 times in the early normal healing process.

Where skin healing is involved, epithelialization occurs. This migration of the basal layer of the epidermis across the wound begins in the first 24 hours and by 48 hours in a normal healing environment has sealed the skin surface.

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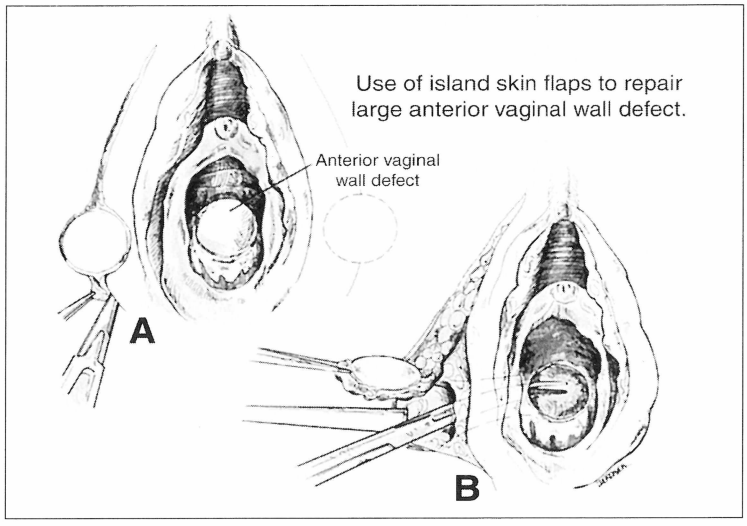


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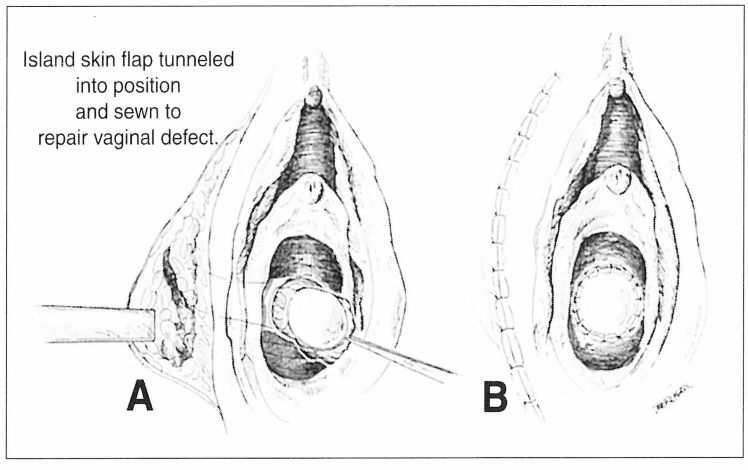


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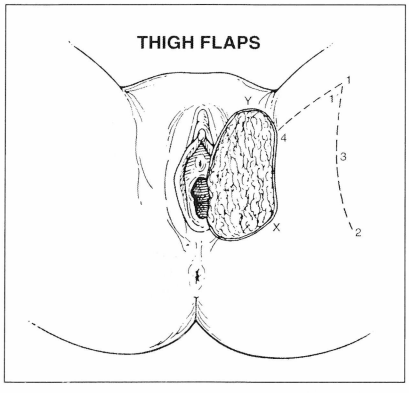


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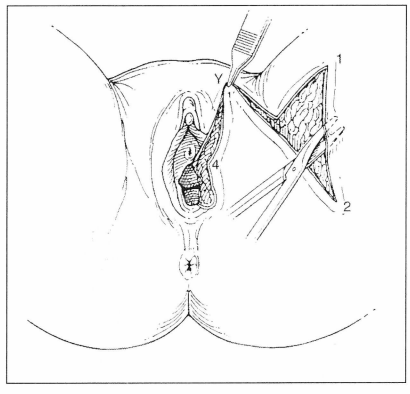

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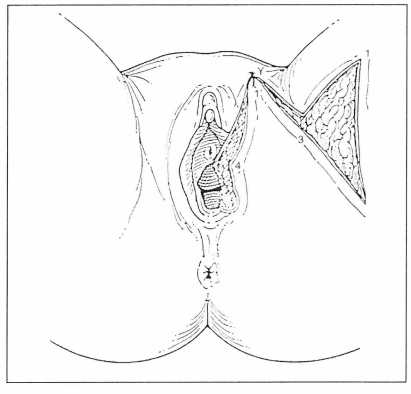
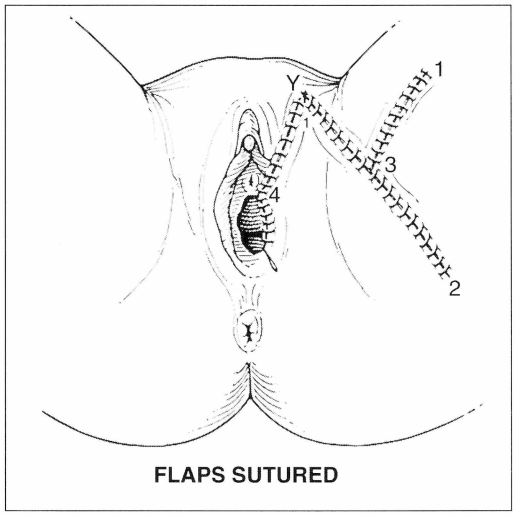


Figure 8.

## Phase IV - Proliferative

The fibroblasts that have migrated into the wound begin to extrude collagen. This usually begins on about the fourth to fifth day. The collagen first produced is not as strong as that produced later in the healing process. The most rapid production occurs in the first three weeks.

There are many types of collagen but for skin flaps and skin healing, Type I collagen makes up 80% or more of the collagen. Type III makes up most of the remaining 20%. A very important aspect of collagen pro-

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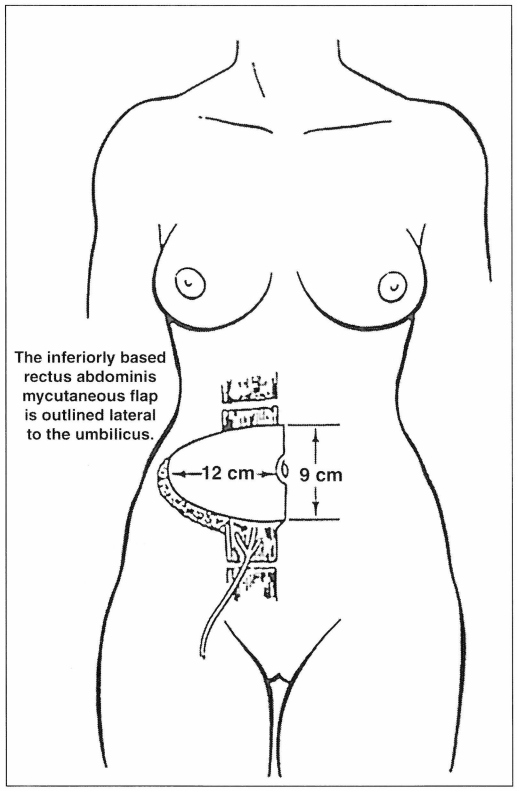


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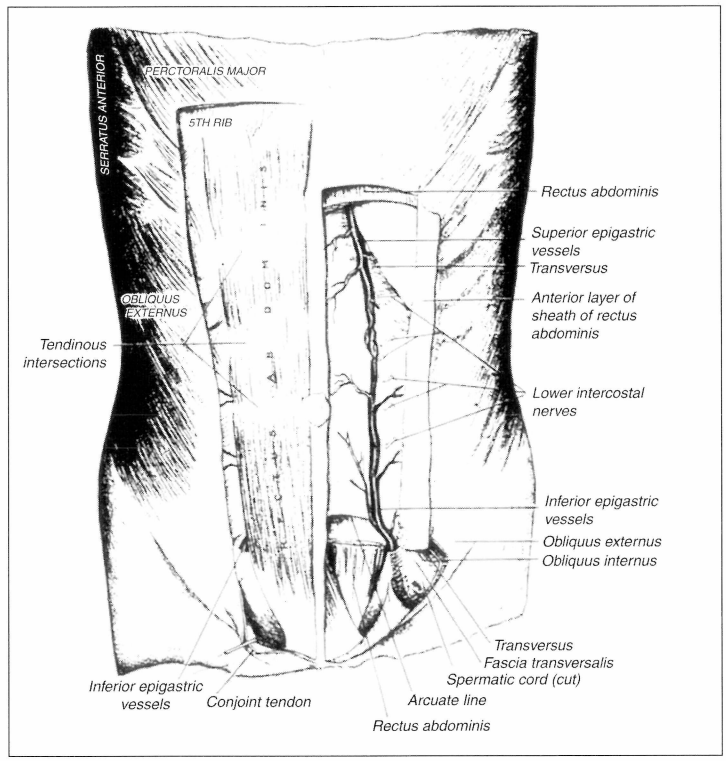


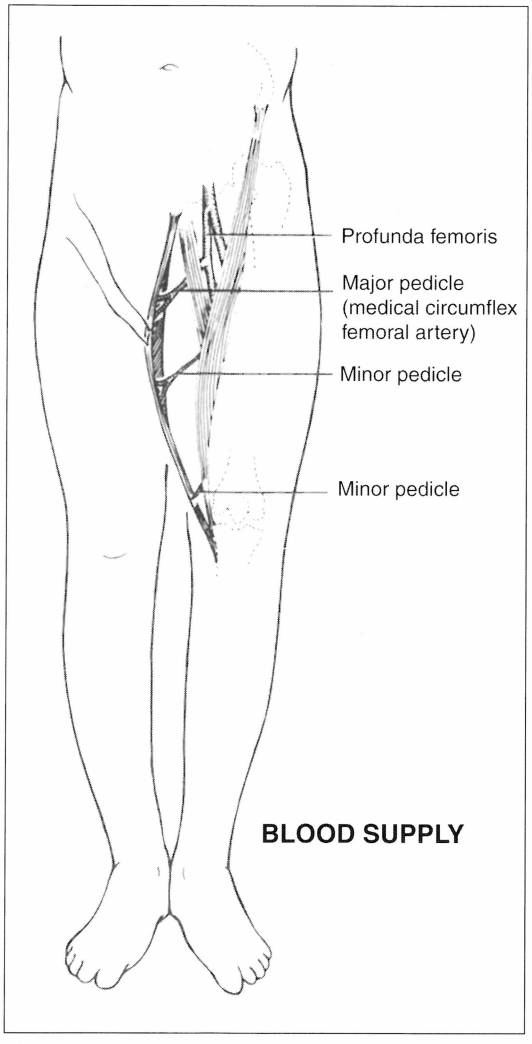

Figure 10.

duction is hydroxylation of lysine and proline within the collagen bundle. Oxygen, vitamin C and ferrous iron are critical cofactors in this process which contributes largely to wound strength. Inadequate oxygen, or vitamin C or enzyme suppression by corticosteroids, can cause reduced hydroxylation with weakened wound repair.

## Phase V - Scar remodelling

During this phase, the rapid production of collagen is down-regulated. Old collagen molecules are broken down. New stronger collagen is produced along lines of stress. There is little change in total collagen content during this extended time that begins about three weeks and lasts for one and a half to two years. The rate of increase in strength of the wound does plateau at about six weeks. There is very slow increase in strength from six weeks to two years. The repaired area does not reach the strength of native tissue.

There is considerable new information on the mechanism of wound healing coming from molecular biology investigators. Research continues to support the importance of cytokine and growth factor influence on the physiology of normal and delayed wound healing and also, the importance of integrin signalling in the production of collagen. The topical effect of vascular endothelial growth factor (VEGF) to enhance healing especially in diabetic wounds has been recently demonstrated by Galiano and associates [1]. The suggested mechanism of increased wound vascularization is to some extent due to the increase in endothelial progrinator cells. Park and associates [2] also demonstrated the positive effect of endothelial progrinator cells in the skin flap model. The presence of these cells in ischemic regions correlated with increased survival, probably by increased wound vascular growth.

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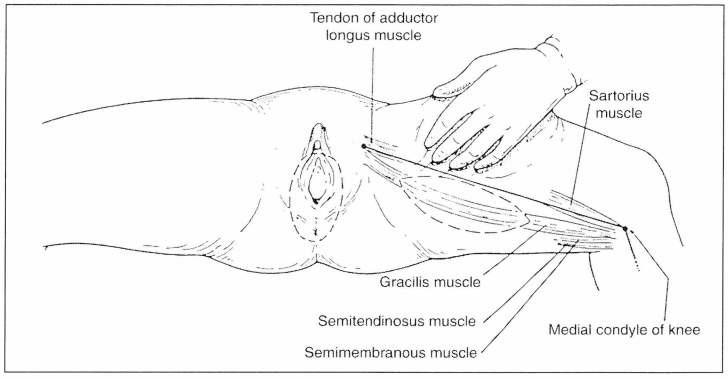


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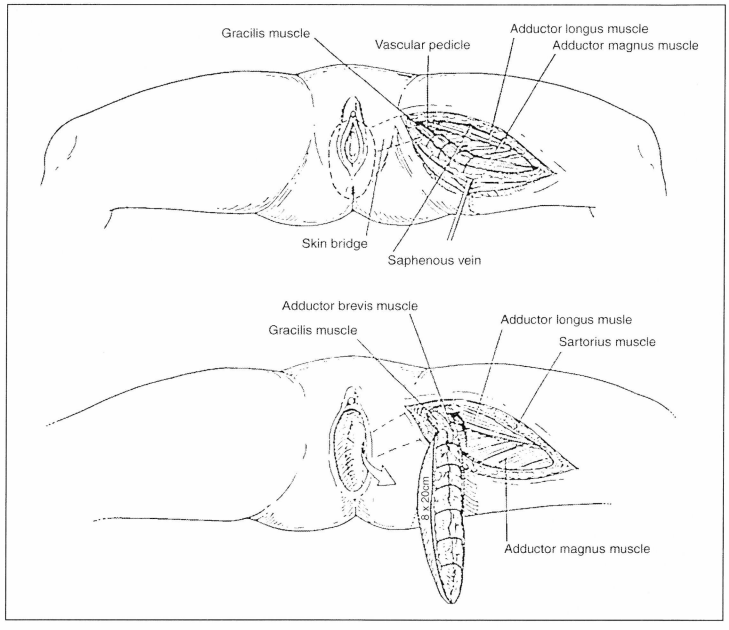



Figure 14.

Cross *et al.* [3] has shown gene expression to be activated by oxygen in human dermal fibroblasts, supporting the concept of oxygen as a possible signal transducer. Maldonado and co-workers [4], using a muscle flap model demonstrated the protective effect of preconditioning was largely dependent on an isoform of the enzyme protein kinase C. These and many other advances in our understanding of wound healing and flap physiology are sure to be followed by tissue engineering and progress that will be most helpful to all clinicians working in this fascinating area.

## Factors delaying wound healing

Local and systemic factors influence the primary processes of wound healing.

*Local factors* delaying wound healing:

1. Infection

Four factors determine infections:

a) Size of the inoculum;

b) Virulence of the organism;

c) The media where they fall;

d) The ability of the host to respond.

These factors must be carefully addressed in all surgeries, especially if flaps are being used as they usually have some decreased ability to defend against infection.

2. Ischemic hypoxia of the wound.

3. Wound tension (predisposes hypoxia from decreased venous return).

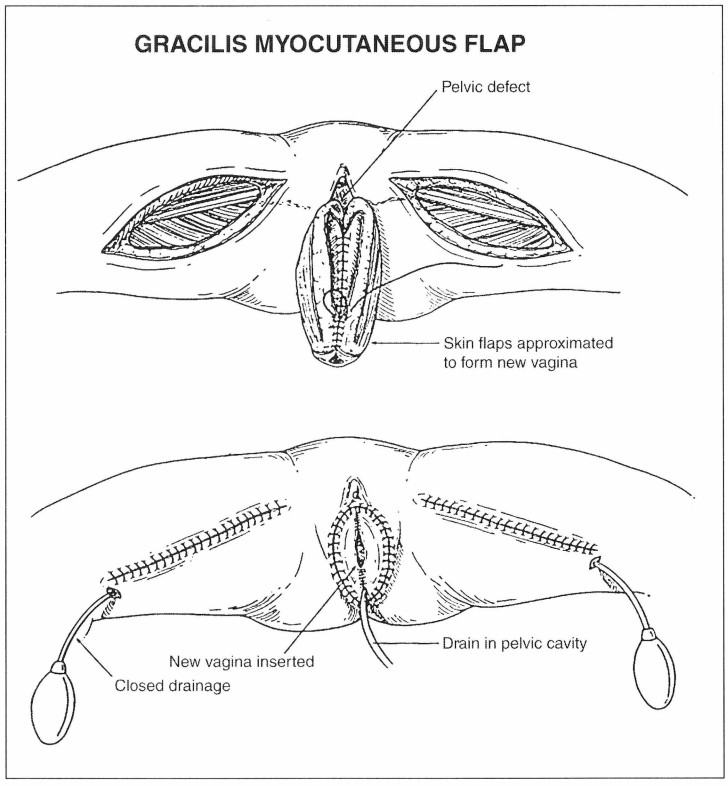



Figure 15.

4. Smoking (causes vessel spasm, decreased $0_2$ delivery).
5. Venous insufficiency (decreases $O_2$ & nutrient delivery from decreased blood flow).
6. Radiation (decreases local host defense response capability).
7. Foreign bodies in the wound (causes increased local inflammatory response).

*Systemic* conditions delaying wound healing:

1. Diabetes
2. Cancer
3. Malnutrition
4. Old age
5. Alcoholism
6. Corticosteroids
7. Uraemia.

All these conditions significantly interfere with the production of cytokines and utilization of energy substrates necessary in the anabolic process of wound healing.

## Flap physiology

Flaps of all types are very sensitive to conditions that reduce $O_2$ supply. Great care must be taken for all flaps to maintain $O_2$ and nutrient delivery.

Factors therefore that are very important to *avoid* are:

1. Hypothermia as it produces vascular spasm and reduced blood flow.
2. Hypotension.
3. Patient hypoxia.
4. Infection.

These are the commonest problems that interfere with wound flap healing.

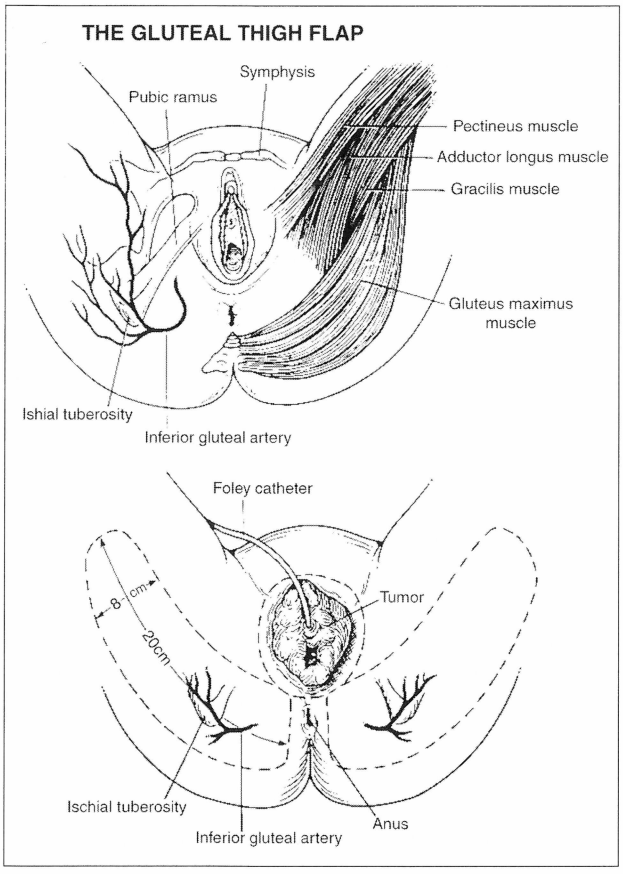
## Vulvar area (pudendal) flap

This is not a bulky flap. Skin and subcutaneous tissue are removed from the inner aspect of the thigh and groin on one or both sides if required. It is usually used where a total vaginectomy has been carried out. The length of skin flap used can be determined on the basis of the amount required. The usual length is 12-14 cm x 6-7 cm in width. This graph should not come further posterior than the level of the posterior boundary of the vaginal introitus. The dissection should start anteriorly. In removing the skin and subcutaneous tissue, the fascia overlying the deep muscles must be reflected with the skin and subcutaneous tissue. This assists in preserving blood supply to the skin flap - a branch of the perineal artery.

The flap is then turned in, to form the posterior and lateral wall of the vagina on each side and can only rotate 70°. If a bridge of skin remains at the introitus, this part of the graph can be denuded to fit the local geography. This skin almost always is outside the radiated pelvic area and therefore is a method of importing local, non-radiated skin and subcutaneous tissue to form the vaginal tract in previously radiated patients. This method is used in patients where no bulk to fill the empty pelvis is required. A prosthesis is not necessary when this method is used. A good length of vagina can be obtained.

There is a high percentage take with this method.

*Crawley et al.* [5] described a fasciocutaneous flap from the lateral aspect of the labia and skin of the groin that can be used to enlarge the introitus or can be made long enough to increase the calibre of the vagina. It

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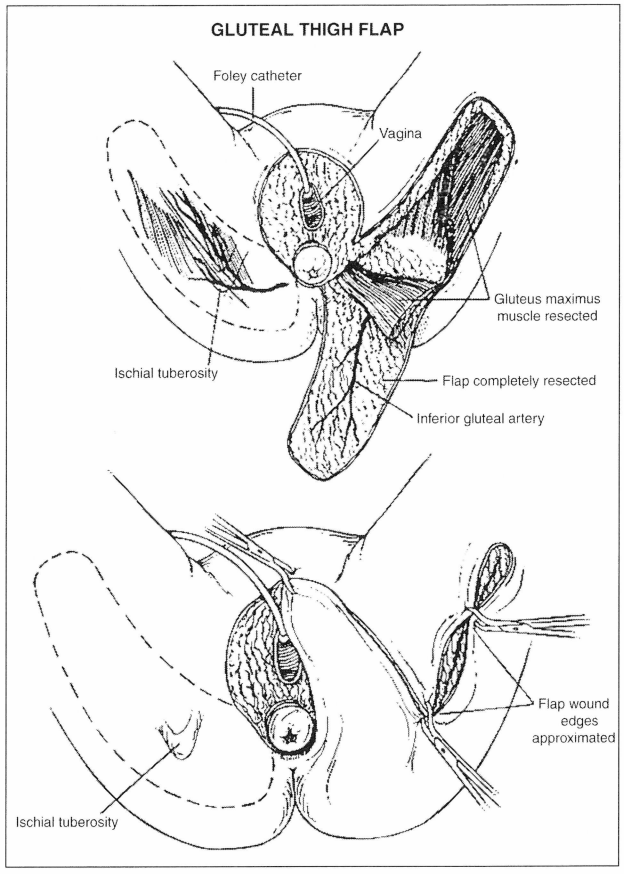


Figure 17.

uses the labial branch of the perineal artery. A flap 15x6 cms can be transferred to the area required. Bilateral flaps can be used if necessary. This flap is generally suitable for vaginal stenosis at all levels. It has been used successfully in radiation stenosis of the vagina. It is a fairly simple flap to isolate; care must be taken to preserve the posterior labial vessel.

*Cruickshank* [6] has also described a procedure using a small axial flap of the labia skin that can be transported with its blood supply to areas at the introitus or on the anterior or posterior vaginal wall. The method of selecting the graph is the same as selecting a martius flap for improved blood supply to a fistula repair or a stenosed scarred area of the vagina. The difference being that the skin required for the repair area (i.e. size and shape) is included with the labial vessels. The blood supply can be preserved either from the anterior labial area as shown or from the posterior area and the labial branch of the perineal artery. A much larger area of skin can be transported with this basic method if required. It can be placed wherever necessary for the repair. This is an easily selected axial graph with a high percentage take.

*Margolis* [7] has described a martius type myocutaneous graft that included varying sizes of skin from the thigh anteriorly supported by the branch of the pudendal artery with the bulbocavernosis muscle. The skin can be taken from the anterior thigh near the groin or posterior thigh adjacent to the labia.

This also is a very good flap that can be easily obtained with a very high percentage take, usually used for vaginal wall or perineal defects.

*Wierrani and Grunberger* [8] have described a method using "deepithealized vulvar tranposition flaps". They have used deepithelialized dermis from the labia majora on the lateral side of both labia to form a tube that is inserted into the space created between the bladder and rectum in the case of congenital total vaginal atresia. The method has also been used for stenosis following radiation with good results and very low complication rate. The texture of the vaginal walls seems to become relatively normal over time with this method.

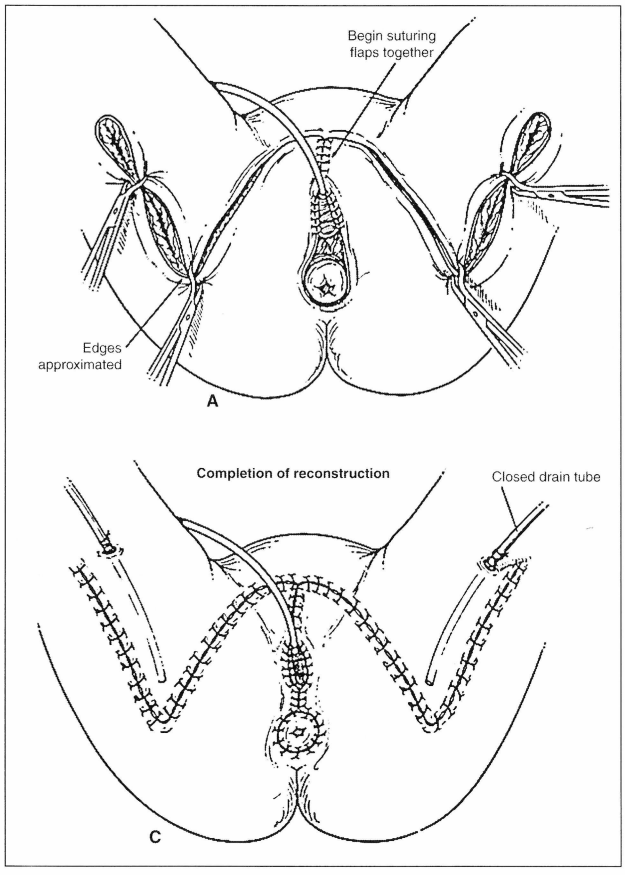


Figure 18.

## Thigh or rhomboid flaps

Thigh and buttock graphs are relatively easy to obtain. Thigh graphs usually are skin and 1-1/2 to 2 cm of subcutaneous tissue. They can help with the lower part of the vagina in the region of the introitus but are generally speaking, not long enough to be used for the full length of the vagina. The thigh graphs can be moved from the medial aspect of the thigh in whatever form or shape is required to cover the defect and reconstruct the lower part of the vagina in a functional manner. There is no definite vessel involved in most thigh flaps. The width of the base of the skin flap should therefore be half the length of the flap for safe skin flap perfusion.

## Myocutaneous graphs

*1. Rectus muscle graphs*

Myocutaneous graphs using the rectus muscle are very popular. They are relatively easy to obtain. They are brought from above the umbilicus in the non-radiated area of the pelvis using the inferior epigastric vessels for blood supply. They are readily transported down into the pelvis. The size of the graph depends on the length required and the amount of bulk required to fill the empty pelvis. It may be as large as 8 cm x 13 cm on the skin surface. The donor area may be linear or transverse whichever seems most appropriate for the area required. The amount of muscle and rectus sheath removed can be considerably less, if bulk is not required it can be down to 3-4 cm width of muscle and fascia of the anterior rectus sheath. However, if there is concern about the maintenance of blood supply or if more bulk is required, the entire rectus muscle from the donor site on the skin, inferior to the insertion of the rectus muscle, can be used. The insertion of the rectus is not detached from the pubis. One must be extremely careful to maintain the inferior epigastric vessels. The entire inferior epigastric artery and vein is moved down with the graph. The blood supply is usually very good and the chance of a vascular accident is not great if care is taken not ot kink the vessels.

The inferior epigastric vessel is isolated on the posterior aspect of the rectus muscle below the umbilicus and followed to its origin. The previously selected area of skin, subcutaneous tissue and muscle is mobilized and moved down with the intact vessels. It can be folded over in a lengthwise direction to form a tube and then sutured to the vaginal stump if there is any normal vaginal tissue remaining or sutured to the perineal skin if no vaginal tract remains. It can also be used as a flat graph to a denuded area.

The donor site is closed when the abdominal incision is closed. The posterior rectus sheath can be closed separately with very little tension and the anterior sheath is also usually closed by primary closure, both with non-absorbable monofilament suture. Occasionally the skin requires mobilization by undercutting the subcutaneous area on the rectus sheath to allow the skin to move more freely to cover the defect. By undercutting on one or both sides, the cutaneous defect can readily be closed by primary intention. As stated above, because the fascial defect is not as great it can be closed with the abdominal closure using monofilament non-absorbable suture. If all or most of the rectus muscle is used it presents a more difficult closure unless care is taken to preserve more rectus sheath.

*2. Gracilis myocutaneous flap*

The gracilis myomutaneous flap was described in 1976 by McGraw *et al.* [9] and has had varying degrees of success in centres around the world. This myocutaneous graph can be quite a bulky flap that is designed to

fill the empty pelvis. The flaps can be brought from one or both sides. If total vaginectomy has been carried out, bilateral gracilis myocutaneous flaps are usually necessary. A line from the pubic tubercle to the median tibial condyle is drawn. This then represents the anterior aspect of the gracilis muscle. The tendon of the gracilis is located just above the knee anterior to the semitendonosis tendon and posterior to the sartorius muscle. The sartorius muscle fibres are oblique. The gracilis muscle runs linearly. The skin is then marked over the muscle and again, more skin can be taken than the width of the underlying muscle. A dissection is begun distally with division of the tendinous part of the gracilis. The deep part of the muscle is dissected carefully as there are usually three vessels entering the muscle. The distal two vessels are minor and can be sacrificed. As ne progresses more proximally, the larger neurovascular bundle should be identified and preserved. It is about 13 cm from the pubic tubercle or at the junction of the middle and proximal third of the gracilis muscle. The neurovascular bundle emerges between the adductor longus anteriorly and the adductor magnus posteriorly. The muscle is then attached to the skin edge with fine absorbable sutures to prevent some element of retraction.

The saphenous vein should be kept anterior to the dissection plane. It usually will be seen in the anterior aspect of the field of dissection.

The myocutaneous flap is prepared, the blood supply identified and preserved. The distal end of the flap is rotated anteriorly and inserted under the bridge of perineal skin. The two flaps are first sutured on the posterior aspect with 4 or 5 sutures only, and next sutured on the anterior to form the vaginal tube. They are then inserted into the pelvis if they are being used to form the vagina. They can also be used on vulvar area if necessary.

*The short gracilis flap* is a modification proposed by Soper *et al.* in 1989 [10]. A 12x6 cm elipitical area of skin is outlined just posteriorly to the line from the pubic tubercle to the medical femoral condyle. The fascia is exposed and attached to the skin edge in the usual way. The gracilis muscle is exposed and vessels isolated and ligated in the part ot be reflected. The shorter flap relies on anastomotic blood from terminal branches of the obturator artery as outlined by Radke [11] some years ago, in his book "Collateral Circulation in Clinical Surgery". Necrosis can be a problem with this method; the incidence is not clear. I have no experience with this method.

*3. Gluteal flaps*

Buttock flaps are most often used to cover large areas of the vulvar and perineal area that have resulted from resections of tumour in this area. Buttock myocutaneous graphs use a small part of the gluteus maximus muscle. They can be as long as 20 cm. The size should be carefully planned and selected before any incision is made. This flap can be used for vaginal reconstruction as well as reconstruction or covering of the vulvar and perineal area following radical excisions. If the anus and rectum have been removed and widely excised, the gluteus maximus myocutaneous graph is very useful. It can reform a perineal body and will maintain some vaginal sensation as well. It is a graph that almost always maintains its viability. If care is taken to preserve the posterior cutaneous nerve of the thigh, good sensation can be maintained. It comes from outside the radiated area as a rule and has a good blood supply from the inferior gluteal artery which must be carefully preserved in securing this myocutaneous flap. If fascia and some muscle is included in the flap, the vessel will almost certainly be retained.

Skin flaps can be very helpful in covering denuded areas, improving blood supply to ischemic areas of repair. As the gynecologic surgeon becomes more familiar with them the more useful they become, especially in difficult surgical procedures in gynecologic surgery. The liberal use of skin flaps with modifications of the standard methods to suit the specific requirements in each case has become the standard of care in many gynecologic units.

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Address reprint requests to:
H. H. ALLEN, M.D.
Department of Obstetrics & Gynaecology
Division of Gynaecologic Oncology
University of Western Ontario
London (Canada)