TRAUMATIC LESIONS IN THE TEAT AND THEIR REPAIR IN EXPERIMENTAL GOATS

By

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C E R T I F I C A T E

This is to certify that the thesis entitled " TRAUMATIC LESIONS IN THE TEAT AND THEIR REPAIR IN EXPERIMENTAL GOATS " submitted for the degree of Master of Veterinary Science (Surgery) of the Orissa University of Agriculture and Technology, Bhubaneswar is a faithful record of bonafide and original research work carried out by Thounaojam Nanda Kumar Singh, under our guidance and supervision. No part of the thesis has been submitted for any degree or diploma earlier.

(A.K.Mitra) 28/8/82

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(J. Mohanty)

TO MY WIFE MRS. BINODINI DEVI, M. A. (English) FOR HER UNINTERRUPTED ENCOURAGEMENT AND PERFECT UNDERSTANDING DURING THE COURSE OF MY STUDY.

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(Th. Nanda Kumar Singh)

C O N T E N T S

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LIST OF PLATES

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CHAPTER I

INTRODUCTION

I N T R O D U C T I O N

Healthy teat ensures free passage of milk from the udder. Trauma to the teat results in reduced milk yield. Further if it is not attended to early, it may end in complete damage of the udder. Thus, it is of great economic importance both to the owner of the animal and for the state. Because of the peculiar placement of the udder and teat in bovine and caprine species, there is always chance of enjury, specially in the exotic breeds which have a large size udder. Sometimes the teats are very close to the ground. Both cattle and goat face similar problems with regard to teat injury. Traumatic injury to the teat is one which is frequently encountered in the field practice. The injury may result either by the animal itself or from outside source. Barbed wire is the most common offending object. The size and shape of the injury vary depending on the cause. Sometimes the injury is so extensive that the teat loses quite a large portion of its skin. A small injury communicating to the teat sinus is considered to be much more problematic than a larger surface injury.

The teats are very delicate in make up requiring careful management. The structure and consistency of the teat should be kept always normal. But the injured teat

reacts very quickly. It becomes thick with a hard consistency, when milking, free flow is hampered. Further, when the trauma communicates into the lumen, there is loss of milk through the wound. The wound allows infection to get inside resulting in mastitis. In some cases, mastitis may become so severe that the grandular tissue is completely destroyed. The animal becomes a liability to a poor farmer. He suffers from a colossal loss which he cannot compensate, develops frustration and suspicion in the animal husbandry programmes.

Recent advances in surgical technique have given hope for a recovery to many teat injuries. Many techniques have been developed to repair teat injury and teat fistula by employing various suturing patterns. But there are quite a large number of teat wounds which are not properly tseated. The failure is a great set back. Teat fistula is a challange to the veterinarian in the field. When it is neglected and the edges become fibrosed, the prognosis is very grave. The owner runs from one practitioner to the other and spends money without any success.

The problem was realized to be given immediate attendance and accordingly the present research work was taken up. The different steps in this topic were as follows:

1. repair of a surgically prepared teat fistula with two layers of horizontal mattress sutures and outside interrupted suture.

2. immediate tubed pedicle grafting after repairing the musculovascular layer in case of loss of skin from teat surface.

3. immediate tubed pedicle grafting without repair of the musculovascular layer in case of loss of skin and deeper tissue from the teat.

4. pinch grafting when a portion of skin lost from the teat surface.

5. electrocautery to open up constricted tip.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

ETIOLOGY

So far literature is concerned many workers on teat surgery have advocated different causes of traumatic injury. Neusch (1912) reported that most of the teat lesions were self inflicted traumatism. Cows frequently step on their front teats when rising and many cows with pendulous udders frequently step on the hind teats as well. He further suggested that there is also a possibility of teat contusion by pressing the teat against the floor with the hock when rising. Case (1927) also observed in his studies that 95 % of these injuries were self inflicted.

Fowler (1941) examined teat injuries in the cows with pendulous udders and opined that the barbed wire injuries penetrated deep into the lumen of the teat which lead to milk fistula. Ragged skin edge was the common feature in lacerated wounds caused by barbed wire. Bruised teat was frequently caused by the teat being stepped upon, either by the cow herself or by her neighbour in the stable. On examination, the teat was seen to be swollen, very painful, and injured from a slight bruise to complete crushing of the teat tissue. In some case the skin was found peeled of. Milk could not be drawn, due to swelling around the teat orifice and the whole teat which prevented the teat being handled.

Rattray (1943) opined that the most common cause of teat fistula is a perforation resulting from a punctured wound of the teat or udder. He further described that fistula of the teats and udder may originate where a supernumerary teat was removed by the owner during calfhood without suturing the wound. Several cases in which a teat had been laid open by a longitudinal barbed wire cut extending into the teat canal were recorded by Moore (1949). Injuries to the teat involving the teat canal frequently occur early in lactation.

Renk (1956) while investigating about the cows presenting damaged quarters could see that the affected 80 cows had an average age range between 8 to 15 years. He found that most of damaged quarters were due to traumatic injury.

According to Blood (1957), one cow out of every 100 suffered from one major teat lesion each year. The lesions could be divided almost equally into two major groups : lacerations and obstructions. Almost all of them were traumatic in origin except for a minor group of obstruction which appeared to be congenital in origin. Most lacerations were caused by barbed wire, a few by agricultural implements and occasional ones by sharp tins in water holes. In the latter case the injuries were usually very dirty and badly bruished and chances of

proper healing were poor. Barbed wire tears were most frequently encountered in recently calved cows separated from their calves so that although the lacerations were often clean and neat the oedema and engorgement of the teats caused considerable gapping of the wound and made approximation of the edges difficult. Cows on heat and confined in yards for service were another danger group. Multiple severe lacerations were likely to occur when such cows attempted to jump barbed wire fences. Most of them penetrated beyond the skin and connective tissue layer into the muscle which caused milk fistula. Most lacerations were vertical because of the manner in which they occurred, the teat being dragged over a sharp-pointed object. When the object caught the thick skin of the teat but did not cause tear, peeling occurred, usually in a downward direction and often over an extensive area. The muscle layer of the teat wall was left intact and usually the external orifice remained patent and undamaged.

Trauma of the teats of cattle might be in the form of lacerations received from barbed wire, thorns, and occasionally from animal bites (Arnold and Weber, 1957). Teats might also be stepped on and lacerated by sharp hooves. Contusion of teat usually resulted from crushing when stepped on or pressed against the edge of the gutter.

According to Kowalczyk (1963) and Khan (1967), bovine udder and teats because of their location were constantly exposed to the influence of environmental agents that caused trauma. They were commonly traumatized by other cows treading on them and were sometimes subjected to self-inflicted wounds or to mechanical injuries resulting from being bumped against solid and sharp obstacles or barbed wire. Khan (1967) further stated that teat injuries might be caused by the teeth of the young ones. Injuries of the teat might also be caused by improperly operated milking machines and in traditional way of stripping out the milk. In tropical countries during the summer and rainy season animals indulge in constant kicking to remove flies which might cause great annoyance to the animal, thus causing teat injury.

O'Connor (1965) stated that the large distended udder of the cow was exposed to injury, and was apt to be wounded by coming in contact with sharp or pointed bodies. Barbed wire was a frequent cause of lacerated wounds of the teat and gland, which might also be bitten by dogs, while goring by the horn of another beast also occasionally occurred.

Grunert and Frerking (1969) collected informations about 3,713 teat injuries treated at the Hanover clinic for bovine obstetrics between 1952 and 1967.

Barbed wire was the predominent cause of injury. Trampling increased during the period assuming great importance. Causes of the increased incidence of trampling were considered to be: increased size of udder; modern housing condition; inadequate care of the feet; and pares is due to metabolic disorders at the time of parturition.

Bodkhe (1969) said that in goats the barbed wire fencing was the major cause of trauma. Their teats being long and pundulous usually get torn during jumping and fistula was the result. Sometimes the fistula was half to one inch, or even starting from the orifice to the base of the teat, exposing complete teat canal. Generally it occurred during lactation or just prior to delivery when the pendulous shape of udder and long teats predisposed to the condition.

A common problem confronting the goat keepers is the deep lacerations of teat leading to milk fistula in lactating goats. The peculiar placement of the udder and long pendulous teats in caprines predispose to this condition. The lacerations occur in different shape and directions on anterior or anterolateral aspect of the teat and affect either of the two or both. Barbed wire fencings and thorny bushes contributed maximum in the causation of this condition, whereas agricultural implements were also responsible to a lesser extent (Angelo and Dhar, 1971).

Grommers et al. (1971) studied 471 cows with trodden teats and 181 cows with uninjured teats and found that some of the animal variables were the distance from the apex of the teat to the floor, the length of the teat and the distance between the apices of both fore and hind teats.

Grommers et al. (1972) also emphasized on the direct trauma of the mammary glands in dairy cattle. It was concluded that the hazard of teat treading would be reduced when sufficient freedom of movement is available on rising. This was found to be the case when : (1) the standing-length index is more than 105.

$$\text{(Standing-length index} = \frac{\text{effective length of standing}}{\text{effective length of body}} \times 100\text{)}$$

and (2) the height of the manger is less than 13 cm

Frenking et al. (1972) reported that teat injuries may be due to increase in size of the udder and teats during lactation, restrictive housing (particularly lack of bedding and the use of gratings over the dung channel) and less often due to neglect of hoof care or to paralysis resulting from metabolic disturbances at parturition.

In one study (Osterkamp, 1976), 72 percent of the injuries in the teat were from kicks and 28 percent occurred at pasture.

Anderson et al. (1976) opined that teat injuries are a common clinical problem in dairy practice. Injuries to the teats of stabled cattle or those kept in close confinement were mainly of crushing type, while injuries to cattle on pasture tended to be lacerations from barbed wire fences. Such injuries varied in extent from no break in the skin to penetration of the teat wall. These injuries, especially the crushing ones, often lead to slower milking, reduced production through mastitis, or loss of a quarter. They further stated that cows may injure their teats while rising by stepping on them, by dew claws or the edge of the hoof, or teats can be crushed between the hock and the edge of the gutter. Usually, when this occurs, the platform is too short.

Flank (1976) stated that the location of the udder exposes it and the teats to many adverse condition such as moisture, filth, cold, infection, and various types of trauma. When the teat is traumatized it may occur from lacerations due to barbed wire or some other sharp object, but in most cases it is due to being stepped on. The cow may step on her own teat or it is stepped on by another cow. When the cow gets up the

teat is exposed to trauma between the point of the hock and floor. It is concluded that the largest percentage of trauma are self inflicted.

According to Smith and Roguinsky (1977) problems of udder of the goat is parallel to those seen in high producing cows. Because of their pendulous udder and long teat they are especially prone to udder and teat wounds. Horns, sticks, wire and even hungry kids can cause abrasions or lacerations. Dog bites frequently cause deep jagged wounds on goats that are tethered or cornered. Rat bites may also be a problem when the doe sleeps in an infested barn.

In a study, Kubicek and Meinecke (1978) measured the distance between teat tip and floor in case of 28 cows with teat injuries and their herd mates (one to five) in comparable lactation stages. They found that 64 percent of the injured cows had the smallest distance, 86 percent of the cases had less than average teat floor distance and 93 percent had smaller distances than the majority of herdmates. The severity of lesions increased with decreasing teat floor distance. Hence, an insufficient clearance was a major contributing factor to teat injuries. The frequency and severity of lesions got increased by the decreased elasticity of the tissue due to age, parturitions and lack of exercise, or inadequate clav

care only if the height from the floor is too small. They suggested to cull the cows when they have less than 40 cm teat floor distance at the third calving.

Teat fistula caused by traumatic injury is one of the most common teat affections in goats due to pendulous udder, long teats and grazing habit in the field (Lavania and Angelo, 1980).

Radmacher (1980) investigated for cases of teat stenosis in 371 cows who were examined at the Hannover Veterinary School between 1974 and 1978, of which 69 percent were seen between November and April. In 91 percent of the cases, stenosis occurred only in one quarter, the hind quarters being most often affected. He concluded that 89 percent of the cases were traumatic in origin. Mostly age, number of lactations, parturition period and milk yield were the factors influencing the incidence.

ANATOMY OF TEAT

The shape of the teat varies from conical to cylindrical (Turner, 1939, Foust, 1941). In case of conical type, the base of the proximal end may be 5 to 7.5 cm or more in diameter, while the apical distal end is comparatively small. The thickness of the wall has little difference from the proximal to the distal end. The distal end may be pointed or rounded, flat or near

flat and disk or cone shaped (Arnold, 1957, Appleman, 1973). The external opening or the teat orifice has a ridge which is around 0.5 to 1.0 mm high and protrudes when milk is expressed. The papillary duct (streak canal, teat canal) leads from the teat orifice internally to the teat sinus. The papillary duct averages about 1 cm in length (Venzke, 1940). Circumference of the papillary duct varies throughout its length with the greatest diameter being at the proximal end and the smallest diameter near the distal extremity. (Johnston, 1938; Arnold, 1950). Some of the teats have the same circumference throughout the length of the papillary duct.

Steere et al. (1960) stated that the teat is formed embryonically from the ectoderm, the invagination of which forms an epithelial lining or mucosa of the sinus papillaries or teat cistern, and the lactiferous sinus or udder cistern. Forming the entrance to the teat itself is the streak canal which is surrounded by an annular ring of muscle, the teat sphincter. The streak canal, or ductus papillaris, is formed of stratified squamous epithelium thrown up in folds, the top of which is called Furstenberg's rosette. The structures of the streak canal, sphincter, and rosette form a mechanical barrier, protecting the gland from invading organisms; damage to these structures often leads to strictures which require surgical correction. Pouden and Grossman (1950)

opined that the rosette aids in preventing milk from leaking through the duct. The epithelial lining of the teat sinus is quite variable in its texture and topography, largely due to the accessory glands which underlie the mucosal epithelium. These glands are alveolar tissue growing as secondary sprouts during the embryonic stage. Injury to them apparently leads to a proliferation of tissue in the area and the formation of so called "teat spiders". Demarking the sinus of the udder from that of the teat is the annular fold.

According to Foust (1941) there are longitudinal, transverse and oblique folds of mucous membrane on the wall of the teat sinus (cistern). The longitudinal folds originate in the papillary duct, pass dorsally through the rosette area and the teat sinus to end in the gland sinus. The transverse and oblique folds intersect the longitudinal ones forming recesses and pockets. At the junction of the teat and gland sinuses, there may be a circular fold (Venzke, 1940 and Arnold, 1950). Fahmy et al. (1969) have observed the formation of prominent pockets in the teat canal and teat cistern of buffaloes.

Giesecke et al. (1972) claimed that the folds in the teat canal are arranged spirally, and not longitudinally. This arrangement suggests that a spiralling recoil of elastic fibres virtually wrings out and dries

the canal after extraction of milk, at the same time closing it effectively.

Hubben et al. (1966) found that the streak canal (ductus papillaris) was approximately 8 to 12 mm in length and was lined by stratified squamous epithelium which had a cornified surface. The squamous lining was folded in upon itself. It was getting stretched in the process of milking. During milking a small quantity of the cornified material was lost. Smooth muscle in the sub-epithelial structures of the teat exerted a sphincter like action at the cessation of milking and effectively closed the streak canal. The cornified lining substance was considered to have chemical and physical attributes which inhibited the entrance and growth of bacteria.

Foust (1941) reported that the papillary layer of the dermis was richly supplied with capillaries and nerves. This would explain the sensitivity of some teats and also the ease with which some teats haemorrhage when irritated. Next to the papillary layer was a muscular layer composed of smooth muscle fibres and collagenous fibres. The muscle bundles in the external part of this layer ran in a longitudinal direction while those in the interior tended to run in a circular direction. In the middle of the long axis of the teat the muscle bundles formed the principal part of the teat wall. In between

the mucosa and muscle layer, there was a connective tissue layer which contained large number of blood vessels, some nerves and lymph vessels. The connective tissue layer adhered more closely to the muscular layer than to the mucosal layer, this it helped in suturing the wall of the teat. The outermost coat of the teat was the skin which was hairless as well as free from sebaceous and sudorifarous glands. It presented many folds which formed a mosaic of intervening furrows. The epidermis had many layers of cells, pigmented throughout its extent and often it was present in the epithelium of the streak canal.

According to Bhatia and Sharker (1981) the epidermis of the teat of goat consists of stratified squamous epithelium which is further differentiated into stratum mortification, stratum corneum, stratum granulosum, stratum spinosum and stratum germinativum. The stratum mortification forms the outermost layer. It consists of a layer of desquamating epithelial cells. Next to it is a thick stratum corneum, in which 6 to 8 rows of cells are embedded.

RESTRAINT

Fowler (1941) opined that for teat operation, recumbency of the animal is a great aid. Moore (1949) conducted most teat operations on average sized cows in

standing position. The head is held or tied up high with the aid of a nose lead and her tail bent forward over her back.

Trump and Parker (1955) cited by Khan (1967) recommended that for individual cows a rope is applied on the hind leg on the side of the affected teat, and then the leg is pulled upward. For minor operations the best way is to put the cow in a travis, and the assistant may hold the head and the hind legs tied with a rope in the fashion of an "8-Knot". Arnold (1957) also suggested that the head may be secured with a halter or a pair of nose tongs, and then a tail holder is applied.

Blood (1957) preferred to perform teat operations in standing position and stated that sufficient restraint is usually supplied by a leg rope. He claimed that general anaesthesia and casting are often dangerous. Suitable clean, dust free sites are often not available and there is always an inclination to get the job done quickly and the cow up before bloating and vomiting occur.

Khan (1967) stated that cow may be controlled simply by being tied up by the head, having the tail base raised forcibly by an assistant. To prevent kicking he opined to tie the hocks together with a rope in the figure of eight manner or to apply Zwang's antikicking clamp on tendo-achilles, or by encircling the body with a

rope in front of the udder and tightening it over the lumber region. In case of nervous animals, he used to give a sedative, such as chloral hydrate orally, or a tranguilizer administered parenterally. He observed certain disadvantages.

Nair (1970), Angelo and Dhar (1971) and Lavania and Angelo (1980) obtained proper restraint in lateral recumbency with injured teat upper most.

ANAESTHESIA

Fowler (1941) stated that anaesthesia can be given to the teat by infiltration with 2 percent procaine using a 20 gauge needle, 1 inch long. The interior may be anaesthetized by injecting 5 cc of 4 percent butyn sulphate into the lumen of the teat and ensuring its reach to all parts by gentle massage for a few minutes. Moore (1949) opined that anaesthesia for any teat operation is provided by infiltrating the teat wall with a few cubic centimetres of a 2 or 3 percent procaine solution, using a 20 or 22 gauge needle. Complete anaesthesia follows in a few minutes. Edmonds (1955) used 2 percent procaine in a ring block to anaesthetize the teat. Arnold and Weber (1967) also recommended to give 6 to 8 ml of 2 percent Procaine hydrochloride solution or 1 percent cyclaine solution around the base of the teat. The wall of the teat is infiltrated down to and including the mucosal

layer. To anaesthelize the mucosal layer 2 or 4 percent bytyn sulfate is infused into the teat sinus. Steere at al. (1960) reported that procaine hydrochloride (1 %) solution can be infiltrated around the base of the teat as far as the mucosa. This circular infiltration anaesthesia is sufficient for all the layers of teat wall without interfering with normal anatomical relations along the line of incision in case of open teat surgery. Berge and Westhues (1961) preferred circular infiltration at the base of the teat, using 5 to 10 ml of a 2 percent Tutocaine solution in case of teat fistula in cattle.

Aqueous solutions of cocaine hydrochloride or procaine (2 percent of the former and 4 percent of the latter) may be applied otopically for the desensitization of a superficial abraded wound of teat. The application is made by soaking a small tampon of absorbent wool or gauze in the solution and holding it in contact with the affected area for 5 minutes (Wright and Hall, 1961).

Milling (1966) cited by Khan (1967) preferred the use of epidural anaesthesia in bovines for surgical interferences of the teat affections. He advocated the use of 60 ml of 2 percent xylocaine to obtain about one and half hours anaesthesia of teats, and for two and half hours the animal is unable to get up.

For repair of the teat lacerations or fistulae, field infiltration, local infiltration and a combination of the two gave the best results than the use of either technique alone (Nigam, 1970).

Nair (1970) administered 40 ml of 2 percent procaine hydrochloride solution as anterior epidural anaesthesia which is followed by 10 ml of 4 percent procaine hydrochloride solution to be infiltrated around the base of the teat as ring block.

Angelo and Dhar (1971) reported that local infiltration can be done with 2 percent procaine hydrochloride solution in 3 to 5 ml in case of she goat. They used to give the anaesthetic solution subcutaneously in two lines resembling the arms of inverted 'V' meeting at a point above the fistula. Philips (1972) obtained analgesia for the teat surgery by giving 2 percent procaine hydrochloride either as local infiltration or ring block.

Lavania and Angelo (1980) achieved complete analgesia of the operation field by semicircular subcutaneous infiltration of anaesthetic solution at the teat base.

Surborg (1980) described the use of local intravenous anaesthesia in the teat surgery of cattle.

REPAIR OF WOUNDS AND FISTULAE OF THE TEAT

SUTURING METHOD

Various methods of suturing for the repair of wounds and fistulae of the teat have been mentioned in literature. Hugg Begg cited by Wooldridge (1923) suggested suturing with s ilk for the mucous layer and the skin. Hudson (1928) advocated suturing of fistula in milch animals by lacing suture (closely placed continuous suture) for deeper tissues and interrupted ones for the skin.

Fowler (1941) observed satisfactory results with metal wound clips and interrupted sutures using silk. He also used No. 2 catgut for suturing the teat fistula. For small fistula he preferred needle point cautery. He opined that best repair of milk fistula is achieved when the cow is dry.

According to Rattray (1943) operative treatment is best done during dry period. He inserted interrupted single layer sutures for closing the teat wound. McAuliff and Johnsen (1946) used Mitchel wound clips for repairing the teat fistula after excising the edges of the wound. In this method they inserted catgut sutures for the deeper layers and Mitchel clips to the skin. Gold (1943) used a single layer eversion sutures with silk wormgut for closure of the teat fistula.

Hall (1947) preferred to use fine silk-worm gut for suturing the wound. He inserted interrupted sutures going in and out of the teat canal or figure of '8' suture going through the whole thickness of the teat wall. He reported that this method of suturing gives stronger stitch and holds the structures in apposition under the pressure of milk and while milking. He advised to cut the teat sphincter in cases of primepara and heavy milkers to facilitate drainage of the affected quarter. He disfavoured the use of teat tubes.

Moore (1949) reported that the teat wound is closed by inserting closely placed interrupted sutures to the mucosal layer using fine chromic catgut and the skin with metallic suture clips. In order to prevent trauma to the suture line during milking, he advised to make an opening into the milk cistern just above the base of the teat and on the medial side using an equine cecal trocar and to insert a screw cap teat tube into this opening. At each regular milking the cap is unscrewed and the quarter is emptied.

Danks (1963) opined that successful surgical repair of teat fistula is obtained when the cow is not in milk. After giving incision to the edges of the wound he closes it with perpendicular mattress sutures using a fine non-capillary suturing material.

Flank (1954) described the method of closely placed, interrupted sutures to approximate the edges of the wound. The wound is closed by inserting interrupted sutures through the skin and underlying tissue leaving the mucous membrane. In case of milking cow, he advised to insert a teat tube with a removable cap through the end of the teat and to leave it in place until the wound is healed.

Edmonds (1955) advocated that after trimming the old edges of the wound the musculature be sutured with mattress sutures using No. 1 Chromic Catgut and the skin with interrupted sutures. Constant drainage of milk is established by introducing a Larson dilator into the teat canal.

Nebraska (1955) applied electric cautery to destroy the granulation tissue of the wound edges and prepared for suturing the wound. He stated that the teat fistula is closed with two or three layers of horizontal mattress sutures using stainless steel wire and advised to keep it in situ for two or three weeks. He found delayed healing in case of the repair of teat fistula where electric cautery is used for removing the granulated tissue of the wound. So he claimed that closing the wound after excision of the edges with a sharp knife results in rapid healing.

Blood (1957) reported that satisfactory repair of teat fistula is achieved when cow is dry. The edges of the wound is prepared by freshening the wound. After pulling the tissue tight, the wound is stitched with Mitchel clips (14 mm). By using Mitchel clips he obtained perfect approximation for the whole thickness of the wall. He claimed that suturing of the mucous lining and skin muscle in two layers is unnecessary.

Arnold and Weber (1957) mentioned that the teat fistulae are best operated when the cow is not in milk. They adopted two different types of suturing methods for closing the teat fistula and teat lacerations. The suturing method applied for closing teat laceration can also be used for repair of teat fistula and vice versa. In the first method mattress tension sutures for the teat wall and interrupted sutures for the skin are inserted. In the second method, a continuous suture using 2/0 chromic catgut for mucous layer and connective tissue, mattress tension sutures for muscle and interrupted sutures for skin are advocated. For muscle and skin they used stainless steel wire (32 - or 34 gauge) or one of the new synthetic suture material. Sometimes they also used a purse string suture for closing a small fistula. They advised to use a plastic teat tube in the teat canal for stripping of the milk.

Steere et al. (1960) closed the teat fistula in cow by putting simple continuous suture or continuous interlocking suture with 3/0 catgut and figure of '8' or continuous mattress suture for the submucous tissue. The skin and musculovascular layer are closed with an interrupted vertical mattress suture of any suitable non-capillary material. They disfavoured the use of teat dilators or cannulas due to inherent danger of inducing mastitis.

Drewry (1961) described that after freshening the granulated tissue, the neglected teat wound is closed with two layers of sutures. The mucosal layer is closed with simple interrupted suture using 2/0 catgut. Then the dermal layer is closed with simple interrupted suture using fine vetafil. He advised for using teat tube to allow the milk to dribble out constantly.

Kowalczyk (1963) opined that repair of milk fistula is best achieved when the cow is dry. After cutting of layers of tissue of 1 mm thick from the surfaces of the old wound with a sharp knife, he inserted two layers of interrupted matress suture, one for submucosa and inner part of muscle and the other for the muscle and the skin. For removing milk from the affected teat he reported that plastic cannula (ByKanula) works with better effect and the shape of the cannula is such that it does not come out.

Mohanty *et al.* (1963) reported suturing the teat fistula in milch animals. They repaired the milk fistula with three layers of sutures. The mucosal layer is closed with continuous interlocking suture and then the submucosa is sutured with continuous mattress suture. The muscle and skin are closed with vertical mattress sutures.

Moussu cited by O'Connor (1965) closed the deep portion of the wound with Halsted suture using fine nylon thread and interrupted sutures for skin. He inserted a plastic tube into the teat canal and remove the milk from the affected teat thereby decreasing the pressure of milk on the suturing line.

Heidrich and Renk (1967) advocated to give a double layer of interrupted or continuous mattress suture for repairing the teat wound. According to them unsatisfactory result is marked for the button or interrupted sutures or sutures with straight pins and vertical mattress sutures because of their poor tension created in the suturing line. They used mattress sutures (Halstead or wolf sutures) and Mitchel clips for closing the teat wound. Amman (1942) cited by Heidrich and Renk (1967) sutured the teat wound with figure '8' pin suture (safely pin suture) and claimed to have the following advantages, (1) absence of complications, (2) rapid trouble-free

healing and (3) secure union of wound edges.

Bodkhe (1969) used to place milk syphon in the teat canal while repairing the teat fistula in goats. He closed the edges of the mucous membrane with 1/0 catgut in continuous pattern. Then the deeper part of the wound is sutured through the skin with nylon thread in Halstead suture pattern and finally the skin by simple interrupted sutures. He described the use of a cycle rubber valve tube for dribbing of the milk and claimed to have the advantages, (1) prevents escape of milk through fistula hence aids early healing without complication, (2) keeps the gland empty by allowing continuous flow of milk, thus having no pressure on teat (3) the valve keeps the teat orifice open in cases of through and through fistula where there is always possibility of cicatrisation and closing of the orifice, (4) There is no need of passing milk syphon daily. (5) There is no necessity to wait till the animal becomes dry for healing. (6) As rubber is flexible, no injury is caused to teat and the animal does not feel any discomfort even after it is kept for 8 to 10 days.

Heinze (1970) mentioned about the repair of teat fistula and teat laceration using two layered suture. In case of teat fistula, first of all he trimmed the edges of the wound and inserted several simple interrupted

sutures to the deep layer (mucosa and submucosa) using 3/0 catgut. Then the remaining tissue and skin are closed with fine non-capillary suture material, using simple interrupted sutures. He reported that in case of teat laceration, the mucosa and submucosa are sutured with 3/0 catgut using a simple continuous suture pattern. The muscle and skin are closed with simple interrupted sutures. For reducing the hydrostatic pressure developed in the teat due to accumulation of milk inside the teat he inserted the plastic teat tube with cap into the teat sinus so that milk can escape through it drop by drop after removing the cap.

Nair (1970) described that the wound created for removing the teat obstruction is closed with two layers of sutures. Intramural stitches are inserted to the mucosal layer using 3/0 medium chromic catgut and the skin is closed by vertical mattress sutures using nylon thread. A polythene tube is then inserted into the teat canal and kept in situ by means of adhesive tape to ensure drainage.

Angelo and Dhar (1971) reported that the teat fistula in she goats are repaired with two layered sutures. They closed the deep layer (connective tissue and musculovascular layer leaving mucous membrane intact) with continuous vertical Lembert pattern using 5/0 silk.

Then the superficial layer (dermis and epidermis) is closed with silk or cotton thread in simple interrupted fashion. Nine millilitres of sterile physiological saline is infused into the teat in order to test the leakage of the suturing line. They advised to remove milk by pressing at the tip of the teat three times a day so that the pressure in the teat sinus will be reduced. They claimed that using of milk tube or any other device in the teat canal to dribble constantly leads to mastitis. Mammography is taken to ascertain extent of narrowing of the lumen of the teat 10 days after repair. A 50 percent aqueous suspension of propyliodone (Dionosil, glaxo Lab. Ltd) in 5 ml amount diluted with an equal volume of water is used as a contrast medium and is introduced into the teat sinus with the help of teat cannula attached to a syringe. The technical factors used by them for radiography were KVP 40; Mas 9; Time 0.4 second and FFD 36 inches. Nigam (1967) cited by Angelo and Dhar (1971) closed the teat fistula in goat by two or three layers of sutures using silk which was reported to give satisfactory results among the various suturing materials used. Sharma et al. (1968) cited by Angelo and Dhar (1971) reported suturing of two clinical cases of milk fistula in goat. They closed the fistula by inserting interrupted sutures for mucous layer and interlocked mattress sutures for muscle and skin.

Philips (1972) repaired the teat wounds in five clinical cases of milch animals. After placing a teat syphon in the teat canal, the edges of the wound is excised to make it a fresh wound. Then the wound is closed with three or four layers of intraumural sutures (a continuous non-removable buried type of suture inserted in the fashion of Gushing's suture) using 2/0 catgut. The submucosal layer is closed by one layer of intramural suture using 2/0 catgut and musculovascular tissue with one or two layers of sutures and then the subcutaneous tissue. Finally the skin is closed with interrupted sutures using nylon thread. He advised not to pierce the mucosal lining of the cistern while suturing the submucosal layer. A polythene tube of suitable diameter is inserted into the teat canal and milk is removed. He reported that rapair of teat wound is best done when animal is dry. Hallgren (1942) cited by Philips (1972) recommended interrupted sutures after making an 'H' incision on the skin, with the bar of 'H' over the fistula. Gotze et al. (1956) cited by Philips (1972) inserted two layers of interrupted or continuous mattress sutures for teat wound. They advised not to pierce the mucous layer to prevent suture fistula and to bandage the teat to prevent sepsis.

Flank (1976) also reported that the teat wound can be closed with continuous stitches to the musculovascular layer above the mucosa. The skin is also closed with continuous sutures.

Lavania and Angelo (1980) studied the efficiency of different types of suturing methods in the repair of teat fistula in milch she goats. They divided the animals in three groups. A tourniquet is applied at the base of the teat and the wound is debrided. The musculature is sutured with simple continuous suture in the 1st group and cushing suture in the 2nd group and double row of cushing sutures without involving mucous membrane in the 3rd group, using cotton thread (coats No. 40). The skin is closed with mattress sutures using the same thread. They reported that best result is achieved by using double row cushing sutures in the muscle and mattress sutures to the skin. He opined that using polythene tube in the teat may lead to the recurrence of fistula. He advised to strip out the milk 3 to 4 times in a day with minimum tension over the sutures by grasping the tip of the teat.

Pande and Kulkarni (1980) reported a new technique for drainage of milk from the affected teat after its repair. This new apparatus consists of a polythene tube of about 12 to 15 cm in length and a rubber balloon about 7 cm length. After closing the teat wound, the said apparatus in inserted in the teat canal. Air is pumped into the balloon so that it created a moderate pressure on the teat mucosa and prevented the milk to come in contant with the line of sutures. Then the end of the balloon is tied so that air can be retained inside the

balloon. He successfully practised this technique in many operations of teat. He advised to remove the apparatus after 72 hours.

AUTOGENOUS SKIN GRAFTING

In animals the risk of traumatic damage to certain parts of the body causing extensive skin loss is high. So skin grafting is the only source of successful repair for this malady. Several thousands years ago attempts were made by "the members of the tile makers" cast in India who used to graft the skin of the gluteal region for repairing the nasal defects. (Davis, 1919). Reconstruction of judicially amputated ears and noses were practised by Sushruta and his pupils during 450 AD (Saunders, 1972). Baronio (1804), an Italian physiologist was the first man to perform a successful experimental autografts in sheep and described that the free full thickness skin (12.5 x 7.5) cm was grafted to the new sites. Carpue (1816), an English surgeon advocated two cases of nose reconstruction by Indian method of skin grafting.

Bunger (1822) an Europian surgeon reported the first successful free graft on skin (10 x 6 cm) in man. Skin grafting operation was conducted by Warren in 1840 being the first surgeon to perform skin grafting in U.S.A.

Reverdin (1869) reported about his experiment on epidermic graft and stated that there was an occasional island of epithelium in the centre of a granulating area and the spreading of the epithelium from such an island. This is also known as "Reverdin graft". His application of small pieces of thin split-thickness skin to denuded granulating surfaces gave world-wide fame to the entire subject of skin transplantation.

Better results were achieved by using full thickness skin grafts (Wolfe, 1875 and Krause, 1893). Davis (1919) reported about modified Reverdin's technique of pinch grafts (small deep grafts) which included the deeper layers of dermis.

Classification of skin grafts

The skin grafts can be classified into three main groups basing on biological relationship (Fenon, 1960), species difference (Stark, 1962), biochemical relationship (Boyd, 1967), species relationships of donor recipient and surgical technique (Ross, 1968) and donor recipient relationship (Boyd and Hanselka, 1971).

1. Homografts - A homograft is tissue removed from one individual and transferred to another individual of the same species.

2. Heterografts - A heterograft is tissue removed from one individual and transferred to another individual of different species.

3. Autografts - An autograft of skin is removed from one location and transferred to another location in the same individual.

Homograft and Heterograft

Due to antigen antibody reaction the Homografts and heterografts are rejected and do not take. Death of the graft may be due to an acquired immunity on the part of the host (Longmire and Smith, 1951 and Payne, 1961).

Converse (1962) suggested that immunological process was the cause of homograft rejection. Destructive immune response was greater in case of heterografts (Boyd and Hanselka, 1971).

Autografts

The problem of immunological reaction does not arise in case of autotransplants. Therefore, autotransplants do not evoke any rejection phenomena (Neal, 1961 and Cawley, 1965).

PEDICLED GRAFTS

In this type of grafting probability of success is more because the graft received blood supply by retaining an attachment between the graft and donor site. Tubed pedicled graft is used where the skin is not available in abundance. Keefe (1946) described three different methods of skin grafting in a clinical case of three-years-old cat. Immediate tubed pedicled graft was prepared with a strip of skin (3/4" x 4") on the lateral aspect of the left hind leg. He also performed delayed tubed pedicled graft with a strip of skin (1" x 5"). 15 days after preparation of the tube it was transplanted over the defect. He found that the tube got shrunk to half of its breadth. After fourteen day of transplantation the pedicle was detached.

Conway (1952) opined that adequate circulation of blood in the tubed pedicles was achieved on the 14th to 18th post surgery days.

While performing flap method of horn amputation sometimes the skin did not come into apposition, for which plastic surgery, similar to cherry's operation (sliding flap) for blemished knee, might be done (Wilson, 1962).

Epstein (1956) mentioned that rejection of pedicled tubed graft was due to the strangulation of blood supply in the pedicled tubes.

Cawley and Francies (1958) recorded the use of pedicle grafts and described the technique as tedious, hazardous and lengthy. They reported that tubular pedicled graft required careful and skillful design and caused discomfort to the animal and involved the owner in costly expenses.

Jensen (1959) preferred delayed tubed pedicled grafts because of their viability percentage and reported that the delayed tubed pedicle grafts were the best. He conducted both immediate and delayed pedicled grafts in dogs. In case of immediate tubed pedicled graft he observed inadequate blood supply to the grafted skin. In delayed ones, he grafted the tubes on the recipient site after 12 to 40 days of preparation. If the circulation in the tube prior to completion of the transplant was adequate, the change in colour of the grafted skin following its transplantation was less. Better cosmetic appearance of the grafts were noticed in case of delayed pedicled grafts.

According to Fomon (1960) tubed pedicled grafts had little danger of contamination and less need for dressing. He noticed minimal cicatrical tissue formation, greater flexibility and less shrin-kage. He claimed that difect infiltration of anaesthesia to the site of donor might destroy anatomic orientation and lower the resistence of tissue.

Neal (1961) emphasized that the use of pedicled grafts in horse was rare due to the inability of obtaining suitable loose skin.

Arnall (1961) reported that the pedicled tubes took nearly two weeks for the establishment of an adequate blood supply. After this time one-end of the tube could be excised and grafted to the recipient bed.

The dermal and sub-dermal plexus seemed to be the most important parts of the vascular system of pedicled flap (Converse, 1962). He advised that when the length of the flap exceeded one and one half times the width of the pedicle the viability of the flap could not be assured.

Wallace et al. (1962) reported that pedicle graft was one of the methods of skin graft which could give sound repair in chronic inflammatory skin lesion in dog.

Dixon (1963) described the V - Y closure, rotation flaps and sliding flaps and concluded that an uninjuried flap would survive provided the length base ratio was less than one.

Markowitz et al. (1964) reported that to improve the chances of 'take', the skin was transferred into a pedicle at a preliminary operation in order to retain

the blood supply in tact. Then, one end of the pedicled tube could be grafted to the wound and when healed in place, the other end was severed.

Cowley (1965) advocated that the chance of successful take for pedicle graft was more than free grafts.

Ross (1968) was satisfied with the pedicle grafting in canine.

Smith and Marks (1968) observed the difficulty of pedicle tube graft and flap methods of skin transplantation in case of horse and stated that for the preparation of flaps or tubes sufficient loose skin was essential.

Doganeli (1969) suggested tubed pedicled grafts to repair superficial wounds on teats of dairy cows. Good results were achieved in four out of five cases with this method. He reported that teats were suitable for milking after 12 days postoperative.

In the experimental pig, Milton (1969) prepared pedicled grafts and noticed that blood flowed faster along the flaps in the beginning, then slowly and finally became stagnant which made the blood to flow in the reverse direction. He claimed that ligation of arteries reduced survival time of pedicles and ligation of all the viable veins had no measurable effect. He opined that the more the width of the pedicle the more supply of blood would be received by the grafted skin.

Successful result was achieved by Pullen (1969) while repairing an extensive lacerated skin wound on the left lateral thorax of a German shepherd bitch with sliding 'H' full thickness flap. Using such type of graft he observed rapid healing and better cosmetic appearance.

Quine (1969) described the use of skin for pedicle graft in a cat from the flank and covered the exposed area of tail region up to the third coccygeal vertebra.

Twaddle (1969) preferred to use rotation flap grafts for closing the wound in any part of the body. In small animals, repairing the wound by this method was excellent.

Kumar (1970) observed complete cosmetic appearance in pedicled grafts. However, he noticed limitations with pedicle grafting such as lengthy procedure and non-availability of skin in most of the areas of hock in buffalo calves.

Twaddle (1970) suggested that sliding flap grafts were very satisfactory for canine and feline wound repair. These plastic techniques depend on the facts that the skin is elastic and that both the dog and cat have loose subcutaneous tissue over most of the body. He

reported that this method of graft was useful in a lesion on the face between the eyes where skin could be brought down from the forehead. He advised that sutures should not be tight as there was often considerable swelling of the graft and pressure necrosis would cause the sutures to cut out.

Hattangady et al. (1971) advocated the use of autoplastic flap over a granulating wound of a dog and reported that successful result was achieved on the fifteenth post operative day.

The denuded area following a horn amputation in a bullock was repaired with a full thickness tubes pedicle prepared from the skin of neck region. There was proper healing after fifteenth post operative day (Sahu and Singh, 1971).

Deokiouliyar and Wilson (1972) said that pedicle graft had the advantage of its own blood supply at all times and was successful in a larger percentage to repair the major defects. The tubed pedicle had minimum infection and very little shrinkage due to the absence of raw surface. In case of delayed tubed pedicled grafts they incised one end of the tube and made it slit open for transplantation after a delay of 10 to 33 days. They reported that 100 percent successful 'take' was achieved in all the delayed tubed pedicled grafts whereas the

immediate transferred tubed pedicled grafts were partially successful with a viability varying from 30 to 75 percent. They opined that delaying of the tube prior to migration offered a greater chance of survival of grafts because the delaying in migration seemed to increase the vascularization and reorientation of the vessels. The cosmetic appearance of the graft was good but the demarkation of the border was visible.

Dhablania et al. (1978) studied on pedicle skin grafting for the repair of extensive wounds on the parotid, mandibular and atlantal regions in buffalo calves. They mentioned the importance of this technique for repairing those areas where direct suturing became impossible. The grafts from pedicle tubes, formed parallel and oblique to the vertibral column, were rejected when transplanted. Uncomplecated acceptance was observed with vertical pedicle tubes. They opined that the rejection of graft might be due to the strangulation of blood supply in the pedicled tubes. They found that grafts were equally accepted in fresh and granulating wound and advised to use methylated spirit for daily dressing in order to prevent infection.

Sahu (1974) cited by Sastry and Rao (1981) advocated that pedicle grafts from neck region were worth exploring to cover recipient sites at hump, thorax and even proximal region of the forelegs.

PINCH GRAFTS

Billingham and Medawar (1951) after performing pinch graft on lab: animals opined that though pinch grafts took longer time to heal soundly, yet gave functionally better results.

Woolsey and Schaffer (1952) reported the use of seed grafting on the granulated wounds of the lower extrimities of horses. Epithelium for the grafts was obtained from a region just lateral to the anus, a shaved area about 1 inch square being removed with a razor under local anaesthesia. The epithelium was cut into seed grafts about 2 to 3 mm in size, which were placed in sterile normal saline. The grafts were implanted in the granulating wound by grasping each in turn with a sharp pointed forceps and thrusting them to a depth of about 3 to 5 mm in the granulation tissue. The grafts were placed at intervals of about 1 cm until the whole of the wound was covered. Grafting proceeded from the lower portion of the wound upwards so that haemorrhage which occurred did not obscure the untreated area. They described that about 80 to 90 percent of the grafts were embedded without difficulty and of them about 20 to 25 percent lived or took. They reported that due to the movement of the limb, a number of grafts were squeezed to the surface and eventually died. Grafts applied directly to the surface

of the granulation tissue were dislodged by friction between bandage and the wound surface with resulting necrosis. "Takes" were usually observed within two to four weeks after grafting but in one case they did not appear for seven weeks. Satisfactory result was obtained in 5 out of 7 cases of excessive granulation.

Neal (1958) described the use of seed graft to repair three cases of wounds in horses. He followed the method of Woosley and Schaffer's seed grafting. In one case out of 120 seeds implanted he found 30 seeds 'took'. Epithelium from the grafts gradually spread over the granulating wound. After two months of grafting, the wound was completely covered by a thin layer of epithelium. The advantage of the seed graft method was that owing to the small size of the grafts, and the fact that they were embedded in granulation tissue, they were unlikely to be affected by movement of a neighbouring joints or tendon. He also described that the major disadvantage of the said method was the prolonged period of healing which in the 2 successful cases was approximately 5 months. He advised to use pressure bandage and also emphasized that this was an essential factor for its success.

Hogle *et al.* (1959) advocated the treatment of wounds below the knee and hock of the horse using pinch grafts and small deep grafts. After giving anaesthesia

a needle was thrust into the skin and raised to elevate a cone of skin which was excised with a scalpel. This freed a small disk of skin of full thickness in the centre with diminishing thickness at the periphery. A number of such grafts were simply placed on the recipient bed and bandaged. It was noticed that those disks became adherent a few days, then they appeared to loosen and came away with the bandage. They further reported that microscopic examination revealed that a few cells did survive on the recipient area and contributed slightly to the healing process. They found slow rate of healing and absence of hair growth in this type of graft.

Jensen (1959) reported the use of seed grafts in the repair of wound in canine. He observed a "Cobblestone" or "Pitted" effect which resulted on the healed area, both at donor and recipient sites. He mentioned that at the areas, where coalescing of the adjacent islands of skin was poor owing to long distance between the grafts, the new granulating tissue was very prone to trauma. For better immobilization to the grafts he sutured the dressings to the adjacent tissues.

Grunert (1958) cited by Steere et al. (1960) commented about the repair of extensive superficial teat wound using small deep grafts. The transplants were taken with scissors from the teat base or from the supernumerary teats and inserted with a fine scalpel. Twelve to

40 transplants, 2 to 3 mm in diameter were used for each teat wound. He advised to change the bandage every second or forth day. During treatment, milk was let off through a teat syphon every 1 to 3 days and the affected quarters was treated with antibiotics.

Because of the small size and thinness of the small thin split skin grafts (Reverdin's) the developing epithelial covering had a marked tendency to contract and break down under slight provocation (Fomon, 1960).

Neal (1961) said that pinch grafting appeared an easy method of grafting usually resulting in high percentage of 'take'. Because of their small sizes they were least succeptable to the effect of movement.

Archibald (1965) described that for obtaining better healing results pinch grafts (Reverdin, Thiersch) could be used to repair old granulating wounds in the legs of horses.

Uberreiter (1956) cited by Boyd (1967) stated that split thickness grafts were applied successfully to 4 horses by burying the grafts deeply in the granulation tissue.

Smith and Marks (1968) stated that pinch graft could double in size every week therefore a complete cover

of the wound was achieved in three to four weeks. They claimed that using pinch graft the healing time was reduced about 80 percent.

Ross (1968) defined seed grafts as full thickness disc shaped plagues of skin of about 3 mm in diameter which were applied to repair granulating wounds. He observed that the seed grafts took well in areas of bacterial contamination or over granulating surfaces in canines.

Doganeli (1969) conducted an experimental study on skin grafting of large superficial wounds on dairy cows teat. He concluded that the use of small deep grafts to repair the teat wound was unsuccessful.

Boyd and Hanselka (1971) suggested the use of skin punch technique of full thickness graft on the extensive areas of skin loss and excessive granulated wound of the lower part of the limbs in horses. They reported that the survival rate of the grafts on seven animals was from 75 to 95 percent.

Deokiouliyar and Wilson (1972) advocated pinch grafting on fresh wounds in canine. To get pinch graft, tip of a straight atraumatic suturing needle of large size, was inserted into the dermal layer of skin and was elevated to make a cone. This elevated portion of skin

was cut with a sharp scalpel or blade to form a graft. A number of such grafts were placed immediately on the recipient area, a little apart. The grafts were firmly pressed in place by a multifolded gauze. They said that pinch grafting performed on fresh wound gave promising results. They observed scar tissue at the edges of the small grafts. The successfully grafted areas did not give a good cosmetic appearance.

Singh and Khan (1975) described about successful pinch grafting to repair experimentally created wound in the limbs of buffalo calves. They reported that most of the grafts were found viable and the nonviable grafts cast off with bandage on first change of dressing. The remaining viable grafts were found capable to cover the entire wound with epithelium. On 14th day they appeared like islands of skin on raw area, which spread towards each other and finally coalesced, thus covering the entire raw surface with new tender epithelium. They found that the area became toughened with passage of time and suggested that this method of grafting was suitable in animals like bovine where cosmetic appearance had little value.

Deokiouliyar (1967) cited by Singh and Khan (1975) opined that pinch grafting was easy to perform but it did

not give smart appearance at donor as well as recipient sites. It was mentioned that this type of graft was resistant to infection and gave good results even on infected wound. Large areas of skin loss in bovine can be easily treated by this type of grafting.

ELECTROCAUTERY

Wooldridge (1923) stated that point firing cauterization could be used successfully for the treatment of chronic arthritis of the hock. He also suggested this method of cauterization for the treatment of articular disease, ostitis, rheumatic arthritis in dog and for treatment of cyst and abscess. He advised to avoid cautery in the early stage of inflammation and suppuration or any oedematous condition. Cauterization removed the pain and stimulated the reparative process.

Davis (1942) reported the use of pure carbolic acid for through cauterization of the granulation tissue in plastic and Maxillofacial surgery.

For the repair of teat fistula, Nebraska (1955) had used electrocautery to destroy granulation tissue from the wound. He claimed that healing was delayed due to the presence of a necrotic surface left by electric cautery.

Epstein (1966) stated that surgical cauterization was mainly concerned with the destruction or removal of tissue by heat. It had the greatest value in destruction of malignant tumours, precancerous dermatoses, deep fungus infections, tuberculosis etc. He opined that cautery surgery was simple and this approach had much to offer in eradication of visible malignant neoplasms. Most of the bleeding points could be eliminated by touching with the hot cautery. Healing was achieved by development of normal granulation tissue. Complete epithialization required four to five weeks after the cauterization. Healing on the breasts, scalp and legs were particularly sluggish. Local infiltration could be given but it has no importance as cautery itself got so hot that no pain could be felt. He advised to apply pressure to the wound for ten minutes to check bleeding. Because of the presence of burned margins in the wound a purulent looking material would be seen to discharge within 2 to 4 days. This might last for 14 days which would be followed by healing. He said that the wound was sterilized by the heat of the instrument. Thus, cauterization sealed the wound from entrance of microorganisms. Post-operative pain was unusual. He concluded that cosmetic results following cautery were unpredicable and sometimes unsatisfactory.

Meigs (1956) opined that in case of a shallow transverse laceration with exposure of the endocervix, cauterization of the cervix was a satisfactory procedure. A series of deep linear striations was made in the cervix with a moderately hot cautery tip at spaced intervals from the external os out into the normal tissue and upward to the level of the internal os. He advised to protect the adjacent tissues with moist gauze to prevent accidental burning.

Dickinson (1929) and Hyams (1934) cited by Douglas and Stromme (1957) mentioned about the use of high frequency current for electrocoagulation as a method of sterilization. The instrument was inserted through the cervix and reached the small funnel like structure where the fallopian tube entered the uterus. They opined that success depended on the production of a slough in that area which extended through the mucosa to the muscularis. The resulting scar permanently occluded the opening to the tube. Healing was completed after some weeks.

O'Connor (1965) defined firing as the application of actual cautery to the skin, or deeper tissues which was the severest form of counterirritation and indicated when other measures had failed. He assumed this method as an unnecessary, crude and crud method of treatment. He claimed that it was more harmful because the burned tissues were never as strong as those undamaged by fire.

Greenhill (1969) reported about the use of electric cautery for the removal of polyp. Carcinomas of the cervix could be treated by electric cautery. Bleeding was checked by cauterization.

Rickards (1969) suggested that electric cautery was the most efficient method for the treatment of an erosion. Cauterization left a sloughing ulcer which took about 6 weeks to heal.

Haik at al. (1972) reported the use of electro-cautery in anterior vitrectomy. Bleeding stopped simultaneously after a few minutes. They further emphasized that haemorrhage from other sources was easily controlled with application of the battery powered cautery.

Lambert (1979) described about the successful use of electrocautery for the treatment of the rupture of cranial cruciate ligament. He said that electrosurgery was a simple alternative and did not obviate a surgical approach. He concluded that there was acute inflammation which resulted in functional stability of a joint within a week.

Kuhns (1981) reported the use of electrocautery to control haemorrhage in the operation of the entire membrana nictitan at its base in a 15 year old female pekingese.

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

Fifteen milch she goats were brought from the goat breeding farm, O.U.A.T. for the use of this experiment. The age and weight of those animals were in between 2 to 3 years and 35 to 45 killograms respectively. All the animals were found apparently healthy as evidenced by preliminary routine examination. They were free from any skin disease. For each animal two measures of Helatac* were given for deworming. They were fed with crushed horse gram, wheat bran, oil cake and green leaves and kept for one week under personal observation prior to surgery. They were separated from their kids.

DESIGN OF THE EXPERIMENT

Fifteen animals were divided into five groups. Each group consisted of three animals. All the goats were subjected to experimental teat injury with communication into the teat sinus and loss of skin. Five different methods of repairing of teat wounds were adopted e.g. (a) simple suturing in two layers using horizontal mattress for vasculomuscular layer and interrupted for skin, (b) immediate tubed pedicle skin grafting after repair of vasculomuscular layer, (c) immediate tubed pedicle

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* Helatac - A preparation of M/S S. K & F Company containing 4 percent parabendazole B. Vet. C.

skin grafting without repair of vasculomuscular layers, (d) pinch skin grafting after repair of muscle layer and (e) electrocautery.

Table I shows the distribution of animals for different surgical technique and the grouping pattern.

SELECTION OF SITE

In Group I the incision extended over the central aspect of the teat from the base upto the middle. The recipient areas in cases of Group II and III were on the lateral sides of the teats whereas, the donor areas were the lateral sides of the udders. In case of Group IV the recipient site was similar to Group II and III but the donor site was the inner aspect of the ear. Tip of the teat was the area for expprimental creation of stenosis in Group V.

EXPERIMENTAL CREATION OF TEAT WOUNDS

Experimental wounds on the teats were created in all the 15 animals of Groups I, II, III, IV and V. In animal No. 1 of Group I, teat syphon was inserted into the teat canal and incision was given on the base of the teat with the help of a non-sterilized blade. The mucosal layer of the teat canal was severed thereby creating a milk fistula (Plate 1). Same procedure was followed in

the remaining two animals of this group where the line of incisions were on the middle of the teats. The teats of the goats in group II, III and IV were also subjected to similar type of wounds, covering the middle of the lateral aspect of teats. The incised wounds were left neglected for 10 days to become infected and granulated. Surgical repair was attempted after this period of delay. For Group V wounds were created in the tip of the teats with the help of a non-sterilized blade. The streak canal and the tip were incised by introducing the blade into the streak canal in different directions. The wound were left unattended for 10 days to produce scar tissue and constriction.

ASEPTIC SURGICAL PREPARATION

After a delay of 10 days attempts were made to give a surgical repair. The teat and the site were prepared aseptically for different surgical steps as per group requirement.

POSITIONING OF THE ANIMALS

The animals were restrained on the operation table in lateral recumbency.

ANAESTHESIA

Ring block i.e., the subcutaneous injection of local anaesthetic solution around the base of the teat,

using 2 percent xylocaine* was the method of analgesia adopted in all the animals of Group I, II, III, IV and V. For ring block, 5 ml of xylocaine was given in each animal. The donor sites of the animals of Group II, III and IV were given local infiltration, 6 to 8 ml per animal.

OPERATIVE TECHNIQUE

Teat syphon was introduced into the teat canal to drain of the milk from the affected portion of the udder. The edges of the wound were trimmed deep upto the lumen and artery forceps were applied to control haemorrhage. The teat wounds of the goats of Group I were closed by three layers of suturing, applied to submucous, vasculomuscular and skin. But in case of goats belonging to Group II and IV, only the submucous and vasculomuscular layers were sutured and the skin was prepared for grafting i.e. tubed pedicle grafting in Group II and pinch grafting in Group IV. In case of Group III skin was prepared for tubed pedicle grafting without suturing the tissue layers. After freshening the wound edges chloromycetin topical* was applied. Chromic catgut 3/0 with swaged on half-curved

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* 2 % xylocaine - Lidocaine hydrochloride with sodium chloride and Methylparaben. A preparation of Suhrid Geigy Limited.

* Chloromycetin topical - A preparation of M/S Parke Davis containing chloramphenicol and Prolylene glycol.

atraumatic needle was used for closing the deeper tissues and fine monofilament nylon with traumatic needle for the skin. The needle was grasped with the help of a small artery forcep for suturing the deeper layers. Suturing was started from the lower commisure of the wound. The needle was inserted through the submucous layer of the tissue about 1 mm above the mucosal layer in the pattern of horizontal mattress. In this way three to four stitches were given in the submucosal layer. Number of stitches depended on the length of the wound. The ends of all the individual stitthes were kept secured with the help of forceps and were tied only after all the sutures of this layer were placed (Plate 2). While inserting the 1st layer care was taken not to pierce the mucosal wall. Same method was followed for the second suture layer of horizontal mattress which was applied to the musculovascular tissue. After closing the deep tissues (Plate 3) the skin was closed with simple interrupted sutures using fine monofilament nylon. Then the teat syphon was removed and milk was let off from the teat by pressing at the base of the teat just to ascertain the efficiency of the suture line. Spirit acriflavine was applied over the suturing line. Then the teat was protected with bandage and adhesive tape.

Pendistrin* intramammary ointment was infused into the teat canal and a very soft and thin polythene tube which was suitable for the size of the teat canal was inserted into the teat canal for daily drainage of the milk. The end of the tube was sealed and kept in position with adhesive tape.

On the eleventh postoperative day mammography was undertaken for the animals of Group I to ascertain the efficiency of the suturing line. Fifty percent barium sulfate solution was used as a contrast medium. One millilitre of this solution was introduced into the teat sinus with the help of a small polythene tube attached to a syringe. The technical factors used for radiography were KVP 60; mA10; Time 0.25 sec and FFD 36 inches.

SURGICAL PREPARATION OF RECIPIENT BED FOR SKIN GRAFTING

Teat syphon was introduced into the teat canal and milk was removed. Keeping the teat syphon in situ a rectangular piece of skin measuring 8 mm x 16 mm was incised

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* Pendistrin - Procaine penicillin & streptomycin sulphate. A preparation of Sarabhai Chemicals, Baroda - 390001, India.

from teat with a sharp blade encircling the experimental teat wound. Then the skin along with some muscle tissue was removed (Plate 4). This procedure was adopted in case of Group II and IV but in Group III the skin was removed along with pieces of masculovascular tissue. Bleeding was checked with gauze pressure and artery forceps. Then the recipient bed was covered with sterilized gauze moistended with sterile physiological saline.

IMMEDIATE TUBED PEDICLE GRAFTING

A piece of X-Ray film was cut in the size of the recipient area. Then it was placed on the donor site on the lateral aspect of udder and incision was given a little bit away from the margin of the X-Ray plate to allow for a fair amount of shrinkage of the skin. Proximally the incisions of both the sides were made parallel in the region of the graft piece. Towards the pedicle the incisions were somewhat divergent to prepare a wider base which would carry sufficient blood supply along the tubed pedicle. Fifty millimetre to sixty millimetre long incision was given for getting the skin flap from the donor area. The proximal end of the flap was lifted with the help of a pair of forceps and separated along the whole length of the flap by undermining with the help of a B.P. blade. Thus, the flap was made free from the donor area keeping one end attached (Plate 5). It was then covered with sterilized gauze soaked in sterile physiological saline.

After putting some drops of chloromycetin topical inside the wound, the donor area was repaired by a series of simple interrupted sutures.

The gauze was removed from the skin flap. From the graft area at the proximal end of the flap, fat and underlying fascial tissue of the skin were excised with the help of a saving blade to make it almost uniformly thin. Removal of fat and fascia could be done carefully by spreading the graft pieces over a glass slide. Then the graft was spread over the recipient area and sutures were placed at four corners for fixing it in position. This was followed by introduction of more number of interrupted sutures along the three free margins of the recipient bed and the graft. For the margin lying under the pedicle only a few mattress stitches were put slightly to provide approximation. This was carefully done to provide a free blood flow to the graft area along the flap.

The remaining portion of the flap was sutured to prepare a tube by inserting a number of interrupted sutures using fine nylon thread. Thus the immediate by tubed pedicle grafting was prepared (Plate 6).

Chloromycetin topical was applied along the suture lines of the grafted portion and pedicle tube.

Sterilized gauze was folded and cut in the size of the grafted skin. Four to five layers of such gauze pieces were placed on the grafted skin. These were kept in position with the help of two to three rounds of bandage roll followed by application of adhesive tape to get better immobilization (Plate 7). This technique was followed in the animals of Group II and III. In case of Group III since musculovascular layer was also removed there was no possibility of any suturing to this layer. The graft was kept in position by applying additional gauze layers followed by bandage and adhesive tape.

The teat syphon was removed from the teat and pedistrin intramammary was infused. A polythene tube which was put inside the teat as in Group I to provide for subsequent drainage of milk.

Every alternate day the sealed end of the polythene tube used to be cut open to remove milk and put one millilitre of chloromycetin topical. Parenteral antibiotic injection (Dicrysticin S*) was given daily for 10 days.

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* Dicrysticin S - A preparation of M/S Sarabhai Chemicals containing 400,000 units of penicillin and 0.5 g of streptomycin sulphate.

On the twelfth postoperative day the bandage and adhesive tape were removed. The two ends of the tubed pedicle were excised and the remaining portion of the margin of the recipient wound was sutured after freshening its edge with the severed end of the graft. Chloromycetin topical was applied on the suturing line followed by immobilization dressing. The grafts were kept under observation upto the seventeenth postsurgery day.

PINCH GRAFTING

Pinch grafting was adopted in the goats of Group IV. After proper disinfection a piece of skin flap (10 x 40) mm was removed from the concave surface of the pina. While excising the flap care was taken to obtain the skin without any cartilage material. The graft material was put in a container of sterile physiological saline. The donor area was applied with spirit acriflavine and covered with a sterilised gauze and bandaged. The graft material was further prepared by removal of fat and fascia by spreading it over glass slide and carefully manipulating with a sharp saving blade.

Recipient bed was prepared by treating it with chloromycetin topical solution. Circular small pieces of skin about 3 mm diameter were cut from the graft

material with scissor. These were placed on the recipient bed starting from the upper end downward to cover the whole area. In case of animal No. 10 seven small grafts were implanted whereas in animal No. 11 and 12, eight small circular pieces of skin were grafted in each animal (Plate 8).

Three to four pieces of sterilized gauze prepared in the size of recipient bed were placed over the grafts and bandaged very carefully so that there was no displacement of the grafts. For better immobilization adhesive tape was applied over the bandage which was again supported by two to three pieces of adhesive tape sticking to the wall of the udder.

Chloromycetin topical was applied daily to the grafted portion through the bandage by pouring it drop by drop so that it would spread throughout the grafted area. Parenteral antibiotic was given for ten days.

The grafts were kept under observation upto twenty-first postsurgery day.

ELECTROCAUTERY

In case of Group V, the goats had their teat almost closed due to formation of granulation tissue on the streak canal and the tip. The teat was aseptically

prepared for electric cauterization. Philips electrocautery machine* was connected to the main line. The grounding plate of the transformer was placed below the body. Necessary adjustments were made and the cautery pin was pressed slowly through the tip after pressing the foot switch (Plate 9). Due to cauterization the closed end of the teat orifice got opened.

The teat was squeezed to remove milk. Pendistrin intramammary ointment was infused into the teat canal and a small polythene tube (mentioned before) was inserted into the teat canal to keep the streak canal open. The end of the tube was placed in position on the side of the teat with adhesive tape.

POSTOPERATIVE MANAGEMENT

All the operated animals were housed in good sanitation and were maintained on normal diet.

Dierysticin S (small vial) was injected intramuscularly for 10 days to every operated she goat.

Milk was removed through the polythene tube every alternate day. This method was continued upto 10 to 20 postoperative days. Each time after removal of milk one millilitre of chloromycetin topical was infused

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* Philips electrocautery machine - Philips M/S Precision Industries Pvt., Limited.

through the polythene tube before resealing.

Sutures and polythene tubes were removed on the tenth postoperative day in case of all the animals of Group I. A loose bandage was applied to the teat to avoid trauma.

From the day of repair of the teat upto the 15th postoperative day, chloromycetin topical was applied to the grafts through the dressings. Every fifth day, the dressings were changed in case of all the animals of Group II and III, while removing the bandages care was taken to soak them with sufficient sterile physiological saline so that there was no displacement or disturbance of the grafts.

In case of the pinch grafts of the animals of Group IV, chloromycetin topical was given through the bandage daily upto 20th postoperative day. Dressings were changed every 10th day after repair.

SURGICAL PATHOLOGY

All the repaired teats of the animals of Group I, II and III were amputated on the 17th postoperative day for histopathological study. In case of the animals of Group IV the repaired teats were amputated on the 21st postoperative day for the same.

The tissues collected were preserved in 10 percent formolsaline solution for histopathological examination.

After 48 hours of fixation in 10 percent formolsaline solution, representative pieces of tissues of 1 to 2 cm thick were taken for dehydration. Following dehydration the tissues were embedded in routine paraffin embedding procedure and sectioned at 4 to 5 micron thickness and stained by the routine Haematoxilin and Eosin method.

TABLE I

DETAILS OF THE DISTRIBUTION OF ANIMALS FOR DIFFERENT SURGICAL TECHNIQUE AND THE GROUPING PATTERN

Group	Shegoat No	Interval between wound created and repair in the teat in days	Surgical technique adopted for repairing the teat wounds
I	1	10	Incision and simple suturing in 2 layers using horizontal mattress for vasculomuscular layer and interrupted for skin
	2	-do-	-do-
	3	-do-	-do-
II	4	-do-	Excision of a piece of skin and pedicle skin grafting after repair of vasculomuscular layer
	5	-do-	-do-
	6	-do-	-do-
III	7	-do-	Excision and pedicle skin grafting without repair of vasculomuscular layer
	8	-do-	-do-
	9	-do-	-do-
IV	10	-do-	Pinch skin grafting after repair of vasculomuscular layer
	11	-do-	-do-
	12	-do-	-do-
V	13	-do-	Cauterization on the constricted end of the teat orifice
	14	-do-	-do-
	15	-do-	-do-

CHAPTER IV

RESULTS

R E S U L T S

SUTURING METHOD

The goat No. 1, 2 and 3 of Group I which was subjected for three layer suturing of the teat wound had no major abnormal reaction. When the stitches were removed on the tenth postoperative day, teat wound of goat No. 1 showed a slight swelling with the scab appearing little wet. On stripping no leakage of milk could be seen. The wound line was given application of Terramycin ointment. The wounds of goat No. 2 and No. 3 had perfect healing and there was no leakage. Both of them had a dry scab on the suture line.

Contrast radiography of the teats of all the animals of Group I showed no leakage at the suturing line. It also revealed that there was no narrowing of the teat canal after repair (Plate 10).

On the seventeenth postoperative day the scabs were cast off while removing the bandages (Plate 11). The wounds had nice healing. All the teats of animals No. 1, 2 and 3 were amputated for histopathological examination. Then, after processing the tissues for the same, they were examined under microscope and showed the following changes.

There was a healthy granulation tissue on suture line which was indicated by regular arrangement of fibroblasts and newly forming capillaries. There was partial dissolution of suture material associated with intense mononuclear cell infiltration in the vasculomuscular layer and the corium. The papillary duct revealed hyperplasia of squamous epithelium with Keratinisation (Plate 12).

IMMEDIATE TUBED PEDICLE GRAFT

(grafting after repairing vasculomuscular layer)

Group II goats (she goats No. 4, 5 and 6) who had immediate tubed pedicle graft following repair of the vasculomuscular layer did not show any sign of leakage of milk on the 5th day when the first dressing was changed.

In she goat No. 4 the graft was pale in colour. There was good union between the graft and the recipient site. A small portion of the tube near the recipient area showed unhealthy appearance with increased inflammatory sign closely.

Healthy skin was present in case of she goat No. 5. No contraction of the graft was observed. The healing process around the recipient bed appeared normal and the graft had adhered to its bed. The tube was healthy.

Same observations were marked in she goat No. 6. The junction of the graft and recipient skin appeared to have perfect opposition.

On the tenth postoperative day when the stitches on the pedicle were removed and a new dressing was applied, perfect healing was noticed in the goat No. 5 and No. 6. The grafts, though felt hard had healed at and united at edges. Satisfactory adherance had developed between the wound and the graft. In case of goat No. 4 some portion of the pedicle appeared somewhat necrosed with a black discolouration. The graft was cold, dry and tough.

On the twelfth day while excising the pedicle it could be seen that a portion of pedicle was completely necrosed and there was also partial necrosis of the graft which came off the upper portion of the recipient area. The recipient bed had good granulation.

On the 16th day while removing the stitches at the graft site, the transplants of goat 5 and 6 presented a normal take. The colour of the grafts in these animals appeared normal. The grafts were felt thickened on the seventeenth postoperative day. In case of goat No. 4 all the remaining portion of the graft appeared rejected. While removing this necrosed portion the recipient bed started bleeding.

In case of goat No. 5 and No. 6, the grafts were well seated and normal in appearance except some thickening of epidermis. There was complete union between the graft and recipient site.

Microscopical examination of the site of grafting in goat No. 5 and goat No. 6 revealed that the take was not so satisfactory. The examination showed that at the site of the graft there was a canthosis with downward prolongation of retepegs apart from hyperkeratosis and parakeratosis. The stratified squamous epethelium of the epidermis revealed intense hyperplasia which was indicated by large number of mitotic figures. The graft persistent and adhered to skin. Beneath the graft the healthy granulation tissue joined the wound edges as well as the graft (Plate 13). Neutrophils constituted the predominent inflammatory cells though few mononuclears were also present. The blood vessels in the vasculomuscular layer were sclerosed due to medial hypertrophy. There was neutrophil infiltration in the entire wall of the teat.

IMMEDIATE TUBED PEDICLE GRAFT

(grafting without repair of vasculomuscular layer)

The she goats of Group III (No. 7, 8 and 9) were subjected to immediate tubed pedicle grafting without repair of vasculomuscular layer.

On the fifth postoperative day while changing the dressing, it was found that the bandage over the graft of she goat No. 7 stuck tightly to the graft. Some stain was observed on the bandage. After soaking the bandage with sterile physiological saline it was removed very carefully. Both the graft and tube showed healthy appearance. The graft looked a bit whitish. No leakage around the grafted area was seen. The junction of the wound and graft showed the sign of proper healing.

In she goat No. 8 difficulty arose while removing the bandage. The bandage was cut around the graft leaving only the small portion of the same on the grafted skin. After soaking the bandage thoroughly with sterile physiological saline, the bandage was removed layer by layer. After removing the bandage, the graft was seen to be healthy with a faint colour. It also showed proper progress and had firm adhesion to the recipient bed. Leakage of milk from the suturing lines were not marked. The tube appeared healthy.

She goat No. 9 also had the same good result on the grafted area excepting wound on the side of the tube from which exudate oozed out.

On the tenth postoperative day while carrying out the second time dressings for all the animals (No. 7,

8 and 9) the bandages could be removed from all the animals without any difficulty.

The graft of she goat No. 7 appeared quite healthy. The tube also appeared normal. Slight change in the colour of the graft to pinkish was marked. The graft was not hard to palpation. The suturing line around the graft showed proper healing.

Goat No. 8 showed a wrinkle on the upper surface of the graft. Most of the area of the graft was dominated by pink colour. Intimate adhesion of the graft to the recipient bed was marked. Proper healing was seen at suture line. Tube was also healthy.

The graft of she goat No. 9 had healthy appearance with slight change of colour from its original skin colour. The graft appeared to be adhered on the recipient bed. The oozing area of the tube was showing to have healed up completely and healthy.

After removing the dressings from all the grafts of the animals (Nos. 7, 8 and 9), the tubes were excised on the twelfth postoperative day. Excellent blood supply from the tubes to the grafts were shown by the evidence of bleeding from the severed edges of the grafts. No

abnormal changes were marked on the grafts except slight leathery nature of the grafts.

On the fifteenth postoperative day after removal of the stitches from the grafts of she goats No. 7, 8 and 9 the following were noted.

The graft of she goat No. 7 showed a slight blackish appearance. When touched it was soft and leathery (Plate 14). The suture line appeared to have perfectly healed up.

In the grafts of she goats No. 8 and 9 almost good results were marked like the animal No. 7. The grafts showed proper adhesions to the recipient beds and perfect healing around the suture lines.

On the 17th postoperative day dressings of all the grafts of animals No. 7, 8 and 9 were removed. No changes were seen in the grafts excepting slight change of colour. The upper surfaces of the skins were felt little hard when touched. Healing was perfect in all the grafts.

Gross examination of the grafts of the goats of Group III while dissecting showed that all had 100 Percent viability. Better results were marked in this method of grafting in comparision with the method in

Group II. Resistence to friction was comparatively better than Group II.

The microscopical examination showed that at the site of graft there was a canthosis with downward prolongation of retepegs apart from hyperkeratosis and parakeratosis. The stratified squamous epethelium of the epidermis revealed intense hyperplasia which was indicated by large number of Mitotic figures. The graft persistent and adhered to skin. Beneath the graft the healthy granulation tissue joined the wound edges as well as the graft. Neutrophils constituted to be the predominant inflammatory cells though few mononuclears were also present. The blood vessels in the vasculomuscular layer was sclerosed due to medial hypertrophy. There was nutrophil infiltration in the entire wall of teat. The granulation tissue extended throughout the vasculomuscular layer (Plate 15).

PINCH GRAFTING

All the animals of Group IV (she goats No. 10, 11 and 12) were subjected to pinch grafting. Initial dressings for all the animals were done on the tenth postoperative day. After removing the adhesive tapes, clotted blood stains on the bandages over the sites of the recipient areas were observed. Care was taken to remove

the bandages by cutting them around the grafts. Proper soaking of the bandages with sterile physiological saline was done. Then they were removed layer by layer carefully. No leakage of milk was seen in any of the animals.

In goat No. 10 out of seven small grafts six grafts showed 'take'. When the last layer of the bandage over the grafts was removed one of the small grafts came off the bed along with the bandage. The rest six small grafts were quite healthy with pinkish in colour. They adhered nicely to the recipient bed. New epithelium started to spread around the small grafts. Healthy granulation was seen in between the grafts. Chloromycetin topical was applied on them and bandaged.

Goat Nos. 11 and 12 showed excellent 'take' of the grafts. All the grafts had taken. They also showed spread of new epithelium around them. Granulation tissues were also marked. After application of chloromycetin topical they were bandaged and taped with adhesive tapes.

On the twentieth postoperative day when dressings were again renewed no stains on the bandages were marked. When the bandages were removed from all the grafted areas of the animals numbering 10, 11 and 12, it was found that all the scabs from over the grafts were cast off along with the bandages leaving the new tender grafts. After removing

the bandages the recipient areas appeared as it covered with islands of small grafts. The tender small grafts of she goat No. 10 showed successful 'take' with the evidence of epithelization around them. The new epithelization of the grafts covered the whole area of the granulation tissue of the recipient bed. As usual the dressing was done with chloromycetin topical and applied loose bandage to protect from trauma.

In case of she goats No. 11 and 12, wonderful islands of pinkish and tender small grafts were seen in the recipient beds (Plate 16). All the grafts had taken covering the recipient beds with new epithelium. Viability of the grafts was marked in this Group IV.

On the twenty-first postoperative day bandages of all the grafts of Group IV were opened. No other visible changes were marked excepting texture of the grafts tending towards normal.

The microscopical examination of the grafted areas of the teats showed that there was a canthosis of the epidermis and the corium revealed healthy granulation tissue. In addition there was marked mononuclear infiltration throughout the corium particularly around the perivascular tissue (Plate 17).

ELECTROCAUTERY

The she goats of Group V (Nos. 13, 14 and 15) were subjected to electrocautery. All the animals of Group V showed inflammation of the teat after electrocauterization. Dressing with pendistrin intramammary ointment was continued upto the tenth postoperative day. A polythene tube was kept in the teat with adhesive tape.

Inflammation of the teat in she goat No. 13 was more marked. Sloughing of the scar tissue at the external orifice was observed to occur. After sloughing pendistrin intramammary ointment was infused into the teat canal and the polythene tube was inserted after proper sterilization and retained with adhesive tape. The other animals (Nos. 14 and 15) had the same fate like No. 13.

Inflammatory signs persisted at the tip region for three consecutive days. Only on the fourth day of electrocautery there was some reduction in inflammation. By the sixth day inflammations completely subsided in goat No. 13 and 15 and tips appeared almost normal.

For another two days some sloughings took place from the teat orifice. By the ninth day the wounds healed up with healthy granulation tissue. The treated teats appeared normal. On the tenth postelectrocautery day the polythene tubes were removed from the teats of the animals Nos. 13, 14 and 15 and free milking was done in all the teats without any complications.

TABLE II

DETAILS OF SUTURING METHOD PERFORMED ON SURGICALLY PREPARED WOUNDS IN GROUP I

Sheep No.	Repair area	Suturing material for deep layer	Suturing material for skin	No. of suture layer in vasculomuscular layer	Pattern of suture in vasculomuscular layer	Pattern of suture in the skin	Effectiveness of suture line	Result of contrast radiography	Length of observations in days	Remarks
1	Lateral aspect of the base of the teat	2/0 chromic catgut	Fine nylon thread	2	Horizontal mattress suture	Simple interrupted	Perfect healing	Perfect healing	17	Biopsy material collected on the 17th day showed perfect healing
2	Lateral aspect of the middle of the teat	-do-	-do-	-do-	-do-	-do-	-do-	-do-	-do-	Healing normal
3	-do-	-do-	-do-	-do-	-do-	-do-	-do-	-do-	-do-	Healing normal

TABLE III

DETAILS OF IMMEDIATE TUBED PEDICLE GRAFTING PERFORMED ON SURGICALLY PREPARED WOUNDS (AFTER REPAIR OF VASCULOMUSCULAR LAYER) IN GROUP II

She goat No.	Donar area	Recipient area	Length and breadth of the flap for tube	Result of grafting	Viability percentage in each graft	Length of observation in days	Remarks
4	Lateral aspect of the udder	Lateral aspect of the middle of the teat	60 mm x 9 mm	Rejected	Nil	17	Rejected on the 15th day
5	-do-	-do-	50 mm x 9 mm	Taken	100	17	Biopsy material collected on the 17th day. Healing normal
6	-do-	-do-	50 mm x 9 mm	Taken	100	17	Healing normal

TABLE IV

DETAILS OF IMMEDIATE TUBED PEDICLE GRAFTING PERFORMED ON SURGICALLY PREPARED WOUNDS (WITHOUT REPAIR OF VASCULOMUSCULAR LAYER) IN GROUP III

She goat No.	Donar area	Recipient area	Length and breadth of the flap for tube	Result of grafting	Viability percentage in each graft	Length of observation in days	Remarks
7	Lateral aspect of the udder	Lateral aspect of the middle of the teat	50 mm x 9 mm	Taken	100	17	Biopsy material collected on 17th day. Healing normal
8	-do-	-do-	60 mm x 9 mm	Taken	100	17	Healing normal
9	-do-	-do-	50 mm x 9 mm	Taken	100	17	Healing normal

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TABLE V

DETAILS OF PINCH GRAFTING PERFORMED ON SURGICALLY PREPARED WOUNDS IN GROUP IV

She Goat No.	Donar area	Recipient area	Size of the small graft	Result of grafting	Viability percentage in each graft	Length of observation in days	Remarks
10	Internal aspect of the ear	Lateral aspect of the middle of the teat	3 mm	Taken	100	21	One small skin graft cast off along with bandage when it was removed.
11	-do-	-do-	3 mm	Taken	100	21	Perfect graft 'take' showing epithelisation
12	-do-	-do-	3 mm	Taken	100	21	Perfect epithelisation with graft 'take' Biopsy material collected on 21st day.

CHAPTER V

DISCUSSIONS

CHAPTER V

DISCUSSIONS

D I S C U S S I O N

Restraint is an important factor for success in teat surgery. Even though teat operation was performed in standing position by Moore (1949), Trump and Parker (1955), Blood (1957), Arnold and Weber (1957) and Khan (1967), this could not hold good in this study since the animals used were not so docile. Adequate restraint was achieved in the present study by lateral recumbency method which was followed by Fowler (1941), Edmonds (1955), Nair (1970), Angelo and Dhar (1971) and Lavania and Angelo (1980).

Ring block anaesthesia which was followed by Edmonds (1955), Berge and Westhues (1961), Philips (1972) and Lavania and Angelo (1980) proved as a successful technique in this experiment.

In case of Group II, III and IV local infiltration was successfully done for the donor sites.

Even though Wooldridge (1923), Fowler (1941), Rattray (1943), Hall (1947), Moore (1949), Flank (1954), Steere et al. (1960) and Heinze (1970) were of the opinion that teat wounds and fistulae were treated best when the animals were not in milk, lactating goats were taken for this study. The workers supporting their view are

Gold (1943), McAuliff and Johnston (1946), Danks (1953), Goetze et al. (1956) cited by Philips (1972), Arnold and Weber (1957), Drewry (1961), Kowalczyk (1963), O'Connor (1965), Bodkhe (1969), Nigam (1970) and Philips (1972).

The teat injury and fistula usually occurs in lactating animals because the udders are pendulous and teats are enlarged during that period. Further sutures are properly placed to have proper approximation and to prevent leakage. Adhesion is also prevented due to milk flow. Of course there is a likely hard of delay in healing in case of seepage of milk into the wound but it is taken care of by frequent drainage of milk through polythene tubes. A small and thin polythene tube gave satisfactory result in this experiment to help drainage of milk. Bodkhe (1969) and Nigam (1970) recommended for rubber tube valve and capped plastic canula respectively. Very recently Kulkarni (1980) produced a new device which consisted a polythene tube with a rubber balloon and reported that it was successfully used for postoperative drainage of milk in teat surgery.

SUTURING METHOD

The experimentally created milk fistulae of the goats of Group I, II and IV were successfully repaired in this study by three layer suturing in Group I and two layer suturing in Group II and IV. All had found

Gold (1943), McAuliff and Johnston (1948), Danks (1953), Goetze at al. (1956) cited by Philips (1972), Arnold and Weber (1957), Drewry (1961), Kowalczyk (1963), O'Connor (1965), Bodkhe (1969), Nigam (1970) and Philips (1972).

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SUTURING METHOD

The experimentally created milk fistulae of the goats of Group I, II and IV were successfully repaired in this study by three layer suturing in Group I and two layer suturing in Group II and IV. All had found

uneventful healing. In order to evacuate the milk from the quarter and also to guide the needle while suturing, a sterilized teat syphon was introduced into the teat canal. This method was also adopted by Hall (1949), Bodkhe (1969) and Philips (1972). The teat wound was closed by two layers of horizontal mattress sutures for musculovascular layer and an additional suture to skin in interrupted fashion in case of Group I. But in Group II and IV only two layers of horizontal mattress sutures were given for musculovascular layer and the skin was repaired by skin grafting.

Various suturing materials such as catgut, silk, silkworm, nylon, wire, metal clips and vitafil with different techniques have been used while repairing the fistulae and lacerations by many workers. In this present study chromic catgut was found efficient for this purpose since it gets dissolved.

Fowler (1941), Rattray (1943), Gold (1943), Hall (1947), Denks (1953) and Flank (1954) inserted a single layer suture, Hudson (1928), Moore (1949), Nebraska (1955), Edmonds (1958), Gotze *et al.* (1956) cited by Philips (1972), Arnold and Weber (1957), Drewry (1961), Kowalczyk (1963), Moussu cited by O'Connor (1965), Heidrich and Renk (1967), Sharma *et al.* (1968) cited by Angelo and Dhar (1971), Heinze (1970), Nair (1970),

Nigam (1967) cited by Angelo and Dhar (1971), Angelo and Dhar (1971) and Flank (1976) used two layers of sutures, Nebraska (1955), Arnold and Weber (1957), Steere et al. (1960), Mohanty et al. (1960), Bedkhe (1969), Nigam (1967) cited by Angelo and Dhar (1971), Philips (1972) and Lavania and Angelo (1980) chose to give a three layered suture for closing the teat wounds. Mitchel wound clips alone was used by Fowler (1941), McAuliff and Johnson (1946), Blood (1957) and Nigam (1970) for closing the teat wounds and fistulae.

In this study three layers of sutures were used for closing the milk fistulae. The musculovascular layer was closed with two layers of horizontal mattress sutures for better apposition. Mucosa was excluded from suture in order to prevent constriction and suture fistula. Interrupted suture to skin was almost an universal choice. Fowler (1941), Flank (1954), Edmonds (1955), Gotze et al. (1956) cited by Philips (1972), Kowalczyk (1963), Heidrich and Renk (1967), Philips (1972), Flank (1976) and Lavania and Angelo (1980) did not like suturing the mucous layer.

Kowalczyk (1963), Heidrich and Renk (1967) and Philips (1972) advised not to suture the mucous layer to prevent suture fistula.

After closing the milk fistulae, the teat syphon was removed and milk was let off from the teat by pressing at the base of the teat just to ascertain about the efficiency of the suture line. Arnold and Weber (1957) used to infuse sterile water into the teat for examining the leakage of the suturing line. Nigam (1970) also reported the use of 1 ml of Terramycin with 9 ml distilled water for infusing into the teat in order to see the effectiveness of the suturing line.

Though Angelo and Dhar (1971) are against the use of milk tube, successful result was obtained in this study by using polythene tube for drainage of milk. During postoperative period when there was pain and inflammation, drainage could be carried out easily. There was no need to press the teat to milk out which might result in wound rupture.

On the tenth postoperative day the dressings were removed from all the animals. Uneventful healing at first intention was observed in all the cases. No leakage of milk was seen. Sutures were removed on the same day.

On the 11th day after repair, contrast radiography of the teat was taken and it showed that there was no leakage of the contrast medium along the line of suture

and no constriction. Same method was followed by Angelo and Dhar (1971) for examining the narrowness of the teat canal following repair.

Tissue section was collected on the 17th postoperative day. The microscopical examination showed that there was a healthy granulation tissue on suture line which was indicated by regular arrangement of fibroblasts and newly forming capillaries.

IMMEDIATE TUBED PEDICLE GRAFTS

All the six she goats (Nos. 4, 5, 6, 7, 8 and 9) of Group II and III were prepared for skin grafting by removing pieces of skin from the lateral aspect of teat which would stimulate similar type of wounds in the teat caused by barbed wire. In Group III goats some amount of muscle was also removed. Pedicle skin grafting was chosen in these two groups with an intension of providing a natural skin covering. Graft material was obtained from the lateral aspect of udder. Immediate grafting was preferred so that there is a quicker and better chance of preventing complication. Pedicle graft was adopted because it maintains an attachment to the donor site during the period of healing. The greater chances of 'take' in pedicle graft is due to a regular supply of nutrition through a

pedicle from the donor site (Neal, 1961 and Ross, 1968). Deokiouliyar and Wilson (1972) opined that tubed pedicle graft was useful on the part where the skin was not available in abundance. This is the case in teat where there is no extra skin.

Most of the surgeons (Fomon, 1960; McGregor, 1968; Ross, 1968; Singh, 1971 and Deokiouliyar and Wilson, 1972) preferred to make the tube before the graft was stitched on the recipient wound. But the present study did not follow their method because of inconvenience at the time of grafting. Preparation of tube after stitching the graft skin on the recipient wound was found suitable.

While suturing the flap of skin on the recipient bed, interrupted sutures were put first at each corner of the flap and then all around except the proximal end where the graft was continuous with the tube. At this end only a light mattress stitch was put to keep better contact between the edges and recipient bed. The tubed portion was severed on the twelfth postoperative day and then the graft margin which was left free was sutured to the proximal edge of the recipient bed. This method was done by Deokiouliyar and Wilson (1972). But Singh (1971) did not mention about the closing of the cut edge of the graft to the recipient wound.

Dressing is the backbone in the skin grafting provided the operation is conducted systematically and aseptically. It should be non-adherent, non-irritant, absorptive, protective and capable of exerting firm pressure and immobilizing the graft. Therefore, in this study better pressure on the graft was achieved by using cut pieces of gauze, bandage roll and adhesive tape. The sutures of the tubes were removed on the tenth postoperative day allowing sufficient time for its complete healing.

Blood flows faster along the flaps in the beginning, then slowly and finally becomes stagnant (Milton, 1969). Due to insufficient nutrient to the graft after a lapse of 28 to 48 hours, there might occur desquamation of epithelium. In this present study the desquamation of the superficial epithelial layer of the graft also occurred during the early period when the blood flow was slow in the tube. After removal of the desquamated layer the graft looked shiny which showed the sign of healthy regeneration.

Failure of the graft in goat No. 4, might have happened due to twisting or kinking as reported by Ross, 1968. All the remaining grafts were 100 percent successful and healed uneventfully. Care was always taken to maintain the length breadth ratio of 3:1 as suggested by Fomon (1960) and Ross (1968). They advocated that there was chance

of inadequate circulation when the length breadth ratio of the graft increased beyond 3:1. But this was not always true. Milton (1969) proved experimentally that the survival of the pedicled grafts did not depend on the length breadth ratio. The author agrees to some extent with the statement of Milton (1969) because the graft of animal No. 8 had successful graft take and uneventful healing even though the length was proportionately more. In the animal No. 8 the tubed pedicle was brought vertical to the recipient bed whereas the tubed pedicle of animal No. 4 was not so. This might agree with the opinion of Dhablania *et al.* (1978) who reported that the vertical pedicle tube would have always successful take. The position of the tubed pedicle might be one of the factors to cause the death of the graft in the goat No. 4. The grafts in case of Group II goats appeared dull and dry which might be due to insufficient amount of nutrition due to improper blood supply. In case of Group III the grafts did not show much change indicating adequate blood supply present in them and as such healing was much better. The two important factors for successful take are proper length-breadth ratio and proper positioning of the pedicle. Tolerance to friction was good due to the presence of dermal contents in accordance to Sprawl (1962) and Wallace *et al.* (1962). The grafts of Group III had more tolerance to friction than Group II. In author's view it might be due to the deep

penetration of the granulation tissue from the graft into the recipient bed.

It was confirmed from the microscopical evidence that there was granulation tissue formation with appearance of neutrophillic infiltration at the graft recipient junction which indicated successful take of the graft at the recipient bed.

This type of grafting has some limitations. It is a lengthy procedure and cannot be used at places where enough loose skin is not available. It is tedious and hazardous procedure (Cawley and Francis, 1958). However, the author's view is not so. In his opinion it is easy to perform and has better success.

Neal (1961), Twaddle (1967), Smith and Marks (1968), Kumar (1970) and Sastry and Rao (1981) described about the difficulty of availability of loose skin in the body of large animals. But in this study since enough skin could easily be obtained from the lateral aspect of the udder for grafting the teat wound, the problem of skin for preparing the graft did not arise.

PINCH GRAFT

In this study three surgically prepared wounds on the lateral sides of teats of the she goats No. 10, 11 and 12 were repaired by pinch graft procured from the inner

aspect of the ear. Hundred percent viability and take were obtained in the animals No. 11 and 12. But in case of animal No. 10, one small seed graft was cast off on the first day of dressing. In this, all efforts were made to pay maximum attention to avoid surgical errors so as to provide better field for the seed graft's vascularization, since, according to Hogle et al. (1959) a graft is actually a parasite structure until it establishes its own blood supply. Until that time, it must be maintained by osmosis and diffusions from the fluids bathing its inner surface from the recipient bed. It is advised that the recipient area should be free from bleeding points to avoid formation of haematoma and the bed must be smooth so that contact is complete (Hogle et al., 1959 and Neal, 1961). In this experiment all the bleeding points of the recipient bed were controlled by digital pressure and pressure of sterilized gauze.

In this study a rectangular piece of skin from the inner aspect of the ear was excised and removed. Then it was cut with a sharp scissor into small seed grafts in the size of 3 mm diameter. Similar method was advocated by Woolsey and Schaffer (1952) and Grunert (1958). They described the use of scissor for cutting the pieces of skin graft measuring about 2 to 3 mm diameter. Neal (1958) used razor to cut the seed grafts about 2 to 3 mm in size, which were placed in sterile normal saline. To get seed

graft, tip of a straight needle of large size, was inserted into the skin and was elevated to make a cone of skin which was excised with a sharp scalpel or blade. By doing this a free small disk of skin of full thickness in the centre with diminishing thickness at the periphery was obtained (Hogle at al., 1959; Deokiouliyar and Wilson, 1972 and Singh and Khan, 1975). Inspite of doing the said technique in the preparation of small seeded grafts they found very less success of graft 'take' and viability whereas in this present study though care was not taken so much while preparing the seeded grafts the viability and take were almost 100 percent.

Immediately after harvesting a small graft, it was placed on the recipient bed. In this way all the grafts were arranged on the recipient wound about 1 mm apart. These were firmly pressed in place by a mulfifolded gauze and the bandaging was done on the similar pattern as that of Group II and III. This was in agreement with Deokiouliyar and Wilson (1972), who followed same procedure as in this study. In this study the grafts were transferred with minimal amount of handling in order to achieve better graft take which is related to the opinion of Smith and Marks (1968).

Even though there was every chance of soiling and contamination of the grafted area in this study, most of the pinch grafts were found successful without any

complications. Ross (1968) opined that failures of seed grafts were few. These grafts could 'take' well even in areas of bacterial contamination or even granulating surfaces.

Inspite of all the precautions, one seed graft failed to 'take' in she goat No. 10. The failure of the graft to take, in the author's view, might be due to the disturbance of the graft while changing the dressing. Except the said one seed graft of animal No. 10 all others had taken. On the tenth postoperative day after removing the dressings islands of small skin grafts were found on the recipient beds. Small fingers of new epithelium started cripping on the granulation tissue. Singh and Khan (1975) noticed islands of small grafts on raw areas on the fourteenth postoperative day.

For successful grafting the lesion should be in a site which could be bandaged for an indefinite period (Neal, 1968). Doganeli (1969) did not find successful result while repairing the teat wound with pinch grafting. He opined that small deep grafts to repair the teat wound was unsuccessful. He did not mention about the removal of milk from the affected teat. But in this study milk was let off every alternate day through the polythene tube. Unexpected 100 percent successful pinch grafting was achieved in this study by overcoming all these difficulties.

On the 20th postoperative day complete epithelisation of wound was observed. The success obtained for complete epithelisation of wound by the said grafting was very encouraging. Almost all the wounds healed up uneventfully and were found covered with growth of tender epithelium from the small pinch grafts. Though in animal No. 10 one small graft failed its viability and was cast off, yet the remaining viable grafts proved capable of covering the entire wounds.

Hogle et al. (1959) opined that all the grafts would come off the recipient bed while removing the bandage. It would appear as if the entire graft had been rejected. But within a few more days, islands of epithelium would become distict over the graft area and appear like delicate pink epithelium. Neal (1961) and Singh and Khan (1975) also observed that pinch grafts which had 'taken' formed islands of skin in the granulated areas, from which epithelium grew outwardly coalescing with that of neighbouring grafts. Finally the whole wound areas was covered with new epithelium. It appeared from the present experiment that pinch grafting was simple and effective for the repair of extensive teat wound in milking animals like cow and she goat. Rapid healing and high percentage of take were achieved in this type of grafting. She goats started free milking without any difficulties on the 20th postoperative day. This view might agree with the findings

of Singh and Khan (1975). They inferred that this method of grafting gave high percentage of 'take' as well as functional repair. Billingham and Medawar (1951) advocated that though pinch grafts took longer time to heal soundly yet gave functionally better results.

So far the cosmetic appearance is concerned all the successful pinch grafted areas of the teats did not show good cosmetic appearance. As the utility and value of the teat is greater than the cosmetic appearance it is of little significance in caprine and bovine. Ross (1968) also opined that cosmetically it had undesirable 'Cobble stone' appearance on the healed wound. Singh and Khan (1975) reported that cosmetically it provided a blemish.

ELECTROCAUTERY

The surgically created constrictions in the tips of teats of she goats (Nos. 13, 14 and 15) were treated successfully by electric cauterization. Uneventful healing of the wounds were achieved in this method of treatment.

After application of electric cauterization, all the teats were found swollen which persisted for about 5 days. But in she goat No. 14, swelling was seen upto the sixth postoperative day. In the next dressings all were found well. According to author's opinion, the

swelling might be due to acute inflammation following artificial creation of the burn.

During cauterization, bleeding was not seen even though the teats are very vascular. This effect is due to heat coagulation of bleeding vessels. This procedure makes use of the method of haemostasis as suggested by Epstein (1956), Greenhill (1969) and Haik et al. (1972). Normally constrictions in the teat are treated by incising the tip in crucial manner (O'Connor, 1965). But this results in more and more of constrictions. Proved flesh is treated by cauterization. Hence there is enough justification to apply cauterization to get rid of excess scar tissue from the constricted tip of the teat.

On the first day of dressing slough at the external orifice was noticed. Progressive healing was observed after 5 or 6 days. In author's opinion the slough might have resulted from the burnt tissue after cauterization. Normally external cauterized wounds take about 6 weeks to heal because of the discharge present, (Dickinson, 1929; Hyam, 1934 and Rickards, 1969). But in the present case this was not seen.

On the 9th postoperative day most of the sloughs came out along with the milk showing perfect healing. On the 10th postoperative day milk tube was removed and milking was done successfully.

Nebraska (1955) opined that healing might be delayed due to electriccauterization. O'Connor (1966) also claimed that cauterization was an unnecessary crude and cruel method of treatment.

According to Epstein (1956) the wound area was sterilized by the heat of the instrument so cauterization of the tissue sealed the wound preventing the ientrance of micro organisms.

In author's view repair of the wound at the tip of the teat by electriccauterization is simple, very less time taking process and also very effective. Uneventful healing was obtained in all the animals treated by electriccautery.

Regarding the cosmetic appearance Epstein (1956) expressed that cosmetic results following cautery were unpredictable and sometimes unsatisfactory but in this study good cosmetic appearance was achieved in all the animals.

CHAPTER VI

SUMMARY

S U M M A R Y

In this study 15 lactating she goats were utilized for various methods of repairing the teat wounds by three layers of suturing, immediate tubed pedicle skin grafting, pinch grafting and electrocautery. The animals were divided into 5 groups consisting of 3 animals in each group. All the groups were subjected to different methods and techniques of repair. The experimentally created milk fistula was successfully treated with two layers of horizontal mattress sutures applied to the vasculomuscular layer using 3/0 catgut and outside interrupted stitch to the skin with monofilament nylon. Drainage of milk from the teats through polythene tubes every alternate day was the daily practice for all the groups which was continued upto tenth postoperative day. The polythene tubes were removed from all the animals on the tenth postoperative day.

Surgically created extensive wounds of the teats were repaired by immediate tubed pedicle grafting and pinch grafting in the goats of Group II, III and IV. In case of immediate tubed pedicle grafting two methods of repairing were adopted i.e., grafting after repair of vasculomuscular layer (Group II) and grafting without repair of vasculomuscular layer (Group III). In the

Group II, one of the grafts was rejected on the 15th postoperative day. In Group III, there was successful take in all the goats. The graft material was taken from the lateral aspect of the udder. In pinch grafting the small grafts measuring 3 mm diameter were prepared from the inner aspect of the pina and they were grafted to the surgically prepared wound on the teat. All had taken except one which came off the bed along with the bandage. Islands of new epithelization tissues were seen on the recipient beds on the twentieth postoperative day. Microscopic examination revealed 100 percent viability of the successful grafts. Most effective repair of the extensive wound of the teat was observed in the pinch grafting method.

The surgically prepared wounds at the tips of the teats were successfully treated by electrocautery. On the tenth postoperative day all the wounds at the tips of the teats were found to have complete healing.

BIBLIOGRAPHY

B I B L I O G R A P H Y

Anderson, J. F., Arnold, J. P. and Farnsworth, R. P. 1976. Amputation of bovine medial dew claws on the hind legs as an aid in controlling- teat trauma. Vet.Med.Sm.Anim.Clin. 71:73.

Angelo, S. J. and Dhar, S. 1971. Surgical repair of milk fistula in goat. Ind. Vet. J. 48:419.

Appleman, R. D. 1973. Subjective evaluation of teat canal anatomy. J. Dairy Sci. 56:411-413.

Archibald, J. 1965. Procedures in plastic surgery. J. Am. Vet. Med. Assoc. 147:1461.

Arnall, L. 1961. Repair of a skin slough by a cervical pedicle skin graft. J. Sm. Anim. Pract. 1:286.

Arnold, J. P. 1950. Anatomy and pathology of bovine teat. J. Am. Vet. Med. Assoc. 116:112

Arnold, J. P. and Weber, A. P. 1957. Teat Surgery. Vet. Med. 52:417.

Baronio, G. 1804. Degli innesti animali. Milan Stamperia e fonderia del genio (cited by converse, J. M. 1962. Skin Surgery. Epstein, E. ed. Henry Kimpton, London. 2nd Ed.).

Berge, E. and Westhues, M. 1966. Vet. Oper. Surg. 1st. Ed. Med. Book Company, Copenhagen.

Bhatia, S. K. and Sharker, V. 1981. Histomorphology of the teat of domestic goats (capra Hircus). Ind. Vet. J. 48:473-477.

Billingham, R. E. and Medawar, P. B. 1951. The technique of free skin grafting in mammals. J. Exp. Biol. 28:385.

Blood, D. C. 1957. Surgical conditions of the bovine teat. Aust. Vet. J. 33:101.

Bodkhe, U. C. 1969. Milk fistula in goats and an easy method of treatment. Ind. Vet. J. 46:536.

Boyd, C. L. 1967. Equine skin autotransplants for wound healing. J. Am. Vet. Med. Assoc. 151:1618.

Boyd, C. L. and Hanselka, D. V. 1971. A skin punch technique for equine skin grafting. J. Am. Vet. Med. Assoc. 158-82.

Bunger, C. H. 1823. F. d. Chir, U. Augent., Berlin, 4, 569 (cited by Rogers, B. O. 1959. Transplantation of tissues Vol. 11. Peer, L. A. ed. The Williams and Wilkins Company, Baltimore.)

Carpue, J. C. 1816. An account of two successful operation for restoring a lost nose from the integument of the forehead. London- Longmans. (cited by Koch, S. L. 1941. The transplantation of skin and subcutaneous tissue to the hand. Surg. Gynec. Obst. 72:1).

Case, C. H. 1927. Operations upon the udder and teats. J. Am. Vet. Med. Assoc. 71:21.

Cawley, A. J. 1966. Canine Surgery. Archibald. J. ed. American Veterinary Publication, Inc. Illinois.

Cawley, A. J. and Francis, S. M. 1968. Pedicle graft in a dog. A case report. cornell Vet. 48:1.

Converse, J. M. 1962. Skin Surgery. Epstein, E. ed. Henry Kimpton, London. 2nd Ed.

Conway, H. C. 1952. Clinical tests for the evaluation of circulation in tubed pedicles and flaps. Ann. Surg. 135:62.

Danks, A. G. 1953. Surgical treatment of teat fistula. The N. Am. Vet. 34:360.

Davis, J. S. 1919. Plastic Surgery - Its Principles and Practice. P. Blackiston's and Son. Philadelphia.

Davis, J. S. 1942. Manual of standard practice of plastic and Maxillofacial surgery. 1st. ed. W. B. Saunders Company. Philadelphia.

Deokiouliyar, U. K. 1967. Autogenous skin grafting in canine. M. V. Sc. Dessertation No. 12. Madras University, Soudern Regional Inst. of Post graduate studies. (cited by Singh, D. P. and Khan, A. A. 1975. Ind. Vet. J. 52:703-706).

Deokiouliyar, U. K. and Wilson, F. D. 1972. Studies on the experimental free autogenous skin grafting in caninos. Ind. Vet. J. 49:204.

Deokiouliyar, U. K. and Wilson, F. D. 1972. Studies on experimental tubed pedicle graft in canines. Ind. Vet. J. 49:393-397.

Dickinson, R. L. 1929. Sterilization without unsexing, Surgical review with special reference to 5,820 operations on insane and feeble minded in California. J. Am. Med. Assoc. 92:373 (cited by Douglas, R. G. and Stromme, W. B. Operative obstetrics. Appleton century crofts Division of Meredith Publishing Company, New York.)

Dixon, A. C. 1963. The secondary closure of wounds Vet. Rec. 75:1133.

Dhablania, D. C., Rama Kumar, V. and Tyagi, R. P. S. 1978. A study on skin transplantation in buffalo calves. Ind. J. Anim. Sci. 48:727-729.

Doganeli, M. Z. 1969. An experimental study on skin grafting of large superficial wound on dairy cows teat. Vet. Fak. Derg. Ankara Univ. 16:207. (Vet. Bull. 40:Abst. 4675).

Drewry, G. R. 1961. Suturing technic for neglected teat wounds. Vet. Med. 46:509.

Edmonds, H. W. 1955. Teat Surgery Vet. Med. 50:166.

Epstein, E. 1966. Skin Surgery. Lea and Febiger, Philadelphia, Pa. 1st. Ed.

Fahmy, M. F. A., Morcos, M. B. and Elgafary, M. 1969. Ind. Vet. J. 46:856.

Flank, E. R. 1954. Repair of teat wounds. The North Am. Veterinarian. 35:292.

Flank, E. R. 1976. Veterinary Surgery. Scientific Book Agency, 22 Raja Woodmunt Street, Calcutta 1. 7th Ed.

Fomon, S. 1960. Cosmetic Surgery: Principles and Practice. J. B. Lippincott Company, Philadelphia.

Foust, H. L. 1941. Surgical anatomy of the teat of the cow. J. Am. Vet. Med. Assoc. 98:143.

Fowler, G. R. 1941. Bovine Surgery. J. Am. Vet. Med. Assoc. 98:393.

Frerking, H., Ahlers, D., Luhmann, F. and Adrich, S. 1972. Examinations about two methods of teat amputation after serious teat wounds in cows with high milk production. World Association of Buiatrics. 594-607. (En, de, fr) Tierarztliche Hochschule, Hannover, W. Germany. (Vet. Bull. 1973. 143: Abst. 969).

Giesecke, W. H., Germeke, W. H. and Rensburg, I. B. J. V. 1972. The morphology of the bovine teat canal a preliminary report. J. South African Vet. Assoc. 43: 351-354. (Vet. Bull. 1973. 43: Abst. 3171).

Gold, T. W. 1943. Vet. Rec. 55: 363-368.

Gotze, Von. R., Achnelt, E. and Merkt, H. 1956. Dt. Tierarztl. Wschr., 63: 27. (cited by Philips, P. J. 1972. Intramural suture in Surgery of the teat - a preport on five cases. Ind. Vet. J. 49: 623-630).

Greenhill, J. P. 1969. A hand book of operative surgery-Surgical Gynecology. Year book medical Publishers. Inc. Chicago 4th Ed.

Grommers, F. J., Braak, A. E. Van De. and Antonisse, H. W. 1971. Direct trauma of the mammary glands in dairy cattle. 1. Variations in incidence due to animal variables. Brit. Vet. J. 127: 271-282.

Grommers, F. J. Braak, E. A. Van De. and Antonisse, H. W. 1972. Direct trauma of the mammary glands in dairy cattle. 11. variations in incidence due to housing variables. Brit. Vet. J. 128: 199.

Grunert, Von E. 1958. Zur behandling der zitzenschalwunden beim rind unter besonder beruckrichtigung der hauttransplantation. Deutschetierarztl Wehnschr. 65: 285-289. (cited by Steere, J. H., Moody, K. M. and Nealy, J. 1960. Open teat sinus surgery for correcting teat occlusions Part. I J. Am. Vet. Med. Assoc. 75: 81).

Grunert, Von E and Frerking, H. 1969. The increase in severe teat injuries in North Western Germany during the past fifteen years. Dt. tierarztl. 76: 1-4 and 7. (Vet. Bull 39: Abst. 3507).

Haik, G. M., Coles, W. H. and Mc. Fetridge, E. M. 1972. Intraocular injuries. Henry Kimpton Publishers, London. 1st Ed.

Hall, F. A. 1947. Teat Surgery. J. Am. Vet. Med. Assoc. 110:232.

Hattangady, S. R., Wadia, D. S. and Kudade, M. L. 1971. Autoplastic Surgery in a dog - a case report. Ind. Vet. J. 48:1275.

Heidrich, H. J. and Renk, W. 1963. Diseases of the mammary glands of domestic animals. 1st Ed. W. B. Saunders Company. Philadelphia.

Heinze, C. D. 1970. Repair of teat fistula and laceration. Bovine Medicine and Surgery. ed. Gibbons. W. J., Catcott, E. J. and Smithcors, J. F. American Veterinary Publications. Inc. Illinois.

Hogle, R. W., Kingrey, B. W. and Jensen, E. C. 1959. Skin grafting in horses. J. Am. Vet. Med. Assoc. 135:165-170.

Hubben, K., Morse, G. E. and Mealy, M. M. 1966. Studies of bovine mastitis. Histochemical observations on the "Streak canal" epithelium. Cornell Vet. 56:648-668.

Hudson, R. 1928. Some diseases of the udder and teats of the cattle. Vet. Rec. 8:205-215.

Hyams, M. N. 1934. Sterilization of female by coagulation of uterine cornu; Preliminary report. J. Am. Obst. & Gynec. 28:96. (cited by Douglas, R. G. and Stromme, W. B., Operative obstetrics. Appleton Century Crofts Division of Meredith Publishing Company New York).

Jensen, E. C. 1959. Canine autogenous skin grafting. Am. J. Vet. Res. 20:898.

Johnston, T. 1938. Anatomical and experimental study of the treatment of the cow with particular reference to streptococcal mastitis. J. Comp. Path. and Therap. 51:69.

Keefe, F. 1946. Skin grafting in cat. J. Am. Vet. Med. Assoc. 108:43.

Khan, A. A. 1967. Surgical diseases of the bovine teat, FAO dissertation. Vet. Faculty for FAO fellows and scholars, the Royal Vet. and Agri. College, Copenhagen, Denmark.

Kowalczyk, S. 1963. Observations on suturing perforating teat wounds by means of a modification of Goetze's method and the use of polyethylene cannulas. The Cornell Vet. 53: 191-198.

Krause, E. 1893. Verhandl. deutsch. Gesellsch. Chir. 22:46. (cited by Fomon, S. 1960. Cosmetic Surgery: Principles and Practice. J. B. Lippincott Company, Philadelphia.)

Kubicek, J. and Meinecke, B. 1978. Frequency and degree of severity of injuries to cow's teats caused by treading, in relation to the distance between the teat and the floor. Zeitschrift fur Tier Zuchtung und Zuchtungs-beilogie. 94: 312-318. (Vet. Bull. 48: Abst. 6178.)

Kuhns, E. L. 1981. Replacement of canine membrane nictitans with a lip graft. Modern Vet. Practice. 62: 773.

Kumar, R. V. 1970. A study on some factors influencing wound healing and an investigation into the possibility of skin grafting in buffalo calves. M.V.Sc. thesis submitted to H. A. U. Hissar.

Lambert, R. D. 1979. Electrosurgical treatment for cranial cruciate ligament rupture. Modern Veterinary Practice. 60: 557.

Lavania, J. P. and Angelo, S. J. 1980. A note on the surgical management of Caprine teat fistula. Ind. J. Vet. Surg. 1: 33-34.

Longmire, W. P. Jr. and Smith, S. W. 1951. Homologous transplantation of tissues- A review of the literature. Ann. Surg. 62:443.

Markowitz, J., Archibald, J. and Downie, H. G. 1964. Experimental surgery. The Williams and Wilkins Company, Baltimore.

McAuliff, J. L. and Johnson, S. D. 1946. Cornell Vet. 36:222-240.

Meigs, J. V. and Parsons, L. 1956. Operative technic in specialty surgery. Appleton-Century Crofts. Inc. New York. 2nd. Ed.

Milling. 1966. (cited by Khan, A. A. 1976. Surgical diseases of the bovine teat. FAO dissertation. Veterinary Faculty for FAO Fellows and Scholars. The Royal Veterinary and Agriculture College, Copenhagen, Denmark.)

Milton, S. H. 1969. The tubed pedicle flap. Brit. J. Plast. Surg. 22:53.

Mohanty, J., Sahu, S., Patnaik, B. C. and Mitra, A. K. 1963. Orissa Veterinary J. 1:57.

Moore, G. R. 1949. Teat Surgery. The N. Am. Vet. 30:91-94.

Moussu (cited by O'Connor, J. J. 1965. Dollar's Veterinary surgery. Bailiere Tindall and Cox. London.)

Nair, K. N. M. 1970. Open teat surgery for obstruction of teat canal in milch Cows- Case reports. Ind. Vet. J. 47:512-515.

Neal, P. A. 1958. Skin grafting in horses- A report of 3 cases. Vet. Rec. 70:701.

Neal, P. A. 1961. Skin grafting in the treatment of granulating wounds of the horse's leg. Vet. Rec. 73:1399.

Nebraska, M. 1955. Treatment of teat fistula. The North American Veterinarian. 37:557.

Neusch, A. 1912. Zitzen- Selbst quetschungen und ihre Behandlung, Schweiz. Arch 7-Tierheil. 54:128.

Nigam, J. M. 1967. (cited by Angelo, S. J. and Dhar, S. 1971. Surgical repair of milk fistula in goat 48:419.)

Nigam, J. M. 1970. Bovine and Caprine teat surgery. Paper presented at the summer institute in Vet. surgery on 28th May 1970.

O'Connor, J. J. 1965. Dollar's Veterinary Surgery. Baillere Tindall and Cox. London. 4th. Ed.

Osterkamp, A. 1976. Teat amputation in cows with reference to antibiotic treatment. Inaugural Dissertation. Tierarztliche Hochschule. 81 pp. (Vet. Bull. 1978. 48:Abst.571.)

Pande, S. V. and Kulkarni, P. E. 1980. Technique of Novel method of using polythene tube with rubber balloon within the teat canal for post operative drainage of milk open teat surgery. The Indian Society for Veterinary Surgery. Fourth all India Symposium No. 16-17. Technical Bulletin and Souvenir. Page 14.

Payne, J. M. 1961. Symposium on tissue grafting: The relevance to Veterinary Surgery of modern work on tissue grafting and immunity. Vet. Rec. 73:1395.

Philips, P. J. 1972. Intramural suture in Surgery of the teat - a report of five cases. Ind. Vet. J. 49:623-630.

Pouden, W. D. and Grossman, J. D. 1950. Wall structure and closing mechanisms of the bovine teat. J. Am. Vet. Res. 11: 349.

Pullen, C. M. 1969. Surgical repair of skin defect by full thickness sliding flap - a case report. Vet. Med. Sm. Anim. Clin. 64: 589.

Quine, J. P. 1969. Tail reconstruction in a cat using a pedicle graft - case report. Canadian Vet. J. 10: 24.

Radmacher, D. 1980. Aetiology, treatment and prognosis of teat stenosis in the cow. Tierarztliche Hochschule 103 pp. (Vet. Bull. 1981. 51: 4291).

Rattray, Jr. M. J. 1943. Surgery of teat and udder of domestic cattle. J. Am. Vet. Med. Assoc. 103: 205-206.

Renk, W. 1956. Mammary Pathology in cows with 1, 2 or 3 quarters. Zbl. Vet. Med. 3: 131-148. (Vet. Bull 1957. 27: Abst. 873).

Reverdin, M. 1869. Greffesepidermiques; experience faite dans less service de M. le docteur Guyon, a I' hospital Necker. Bull Soc. Imperiale Chir. Paris, Series 2, Vol. 10. (cited by Converse, J. M. 1962. Skin Surgery. Epstein, E. ed. Henry Kimpton, London. 2nd. Ed.)

Rickards, C. E. B. 1969. The management of the gynaecological patient. Pyels Surgical Handicraft. K.M. Verghese Company. Bombay. 19th Ed.

Ross, G. E. J. 1968. Clinical Canine skin grafting. J. Am. Vet. Med. Assoc. 153: 1759.

Sahu, S. and Singh, S. C. 1971. Full thickness grafting in a bullock. Ind. Vet. J. 48: 1070.

Sahu, S. 1974. Ibid 51:295. (cited by Sastry, G. J. S. and Rao, N. R. 1981. Subcarpel tenotomy with skin grafting in a calf for the management of bent knee. Ind. Vet. J. 58:164-165.)

Saunders, J. B. de C. M. 1972. A conceptual history of transplantation. Najarian, J. S. and Simmons, R. L.'S Transplantation. Henry Kimpton Publishers. London.

Sharma, M. N., Maronf, H. M. and Sahu, S. 1968. Vet. Coll. Anual; Univ. Pantnagar. 1:13.(cited by Angelo, S. J. and Dhar, S. 1971. Surgical repair of milk fistula in goat. Ind. Vet. J. 48:419.)

Singh, D. P. and Khan, A. A. 1976. Experimental studies on autogenous skin grafting in bovine (part of the thesis submitted to Rajendra Agri. Univ. Bihar for M.Sc.(Vet.) Surgery by the senior author.) Ind. Vet. J. 52:703-706.

Smith, M. C. and Roguinsky, M. 1971. Mastitis and other diseases of the goat's udder. J. Am. Vet. Med. Assoc. 171:1421-1448.

Stark, R. B. 1962. Plastic Surgery. Baebar Medical Divn. Harper and Row, New York.

Steere, J. M., Moody, K. M. and Nealy, J. 1960. Open teat sinus Surgery Part I. J. Am. Vet. Med. Assoc. 136:75-82.

_____Part. II J. Am. Vet. Med. Assoc. 136:123-126.

Surborg, H. 1980. Local intravenous anaesthesia in the teat surgery of cattle. Deutsche Tierarztliche Woohenschreft. 87:333-335. (Vet. Bull. 1981. 51:Abst. 3660.)

Tadkod, D. M., Mannari, M. N. and Parsania, R. R. 1980. Partial ablation of udder in cows. The Indian Society for Vet. Surgery. Fourth all India Symposium.

Trump, D. E. and Parker, C. F. 1955. Demonstration at the 92nd annual meeting of the Am. Vet. Med. Ass. Minneapolis. (cited by Khan, A. A. 1967. Surgical diseases of the bovine teat. FAO dissertation. Vet. Faculty for FAC fellows and scholars, the Royal Vet. and Agri. Cok. Copenhagan. Denmark.)

Turner, C. W. 1939. The comparative anatomy of the mammary glands. Columbia Cooperative store. Columbia. page 12.

Twaddle, A. A. 1969. Rotation flap skin graft. Newzealand Vet. J. 17:178.

Twaddle, A. A. 1970. Skin grafts in small animal practice. Newzealand Vet. J. 18:121.

Uberreiter, Von O. 1956. Die Hanttransplantation nack Thiersch. Berl. Munch tierarztl. Wchnschr. 69:436-438. (cited by Boyd, C. L. 1967. Equine skin autotransplants for wound healing. J. Am. Vet. Med. Assoc. 151:1618.)

Venzke, C. E. 1940. A histologic study of the teat and gland cistern of the bovine mammary gland. J. Am. Vet. Med. Ass. 96:170-175.

Wallace, A. B., Spreull, J. S. A. and Hamilton, H. A. 1962. The use of autologous free full thickness skin graft in the treatment of a chronic in flammatory skin lesion in a dog. Vet. Rec. 74:286.

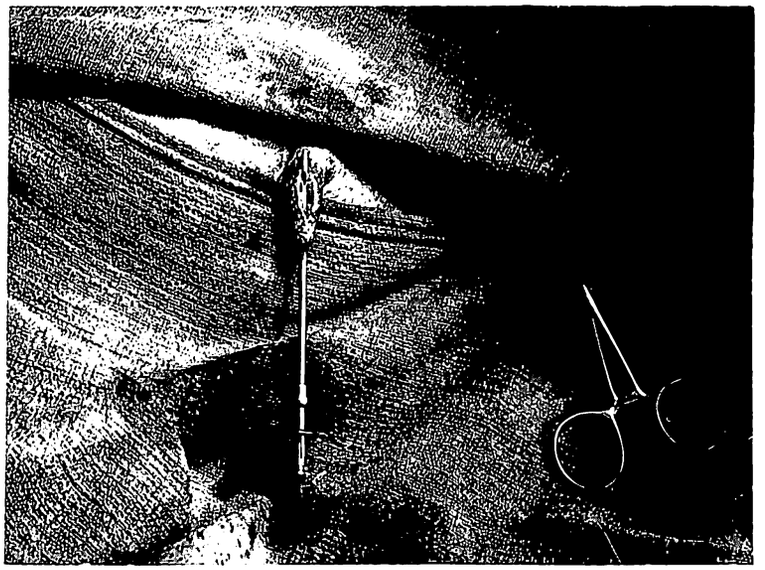
Wilson, F. D. 1952. Dehorning of adult cattle- New technique. Ind. Vet. J. 29:49.

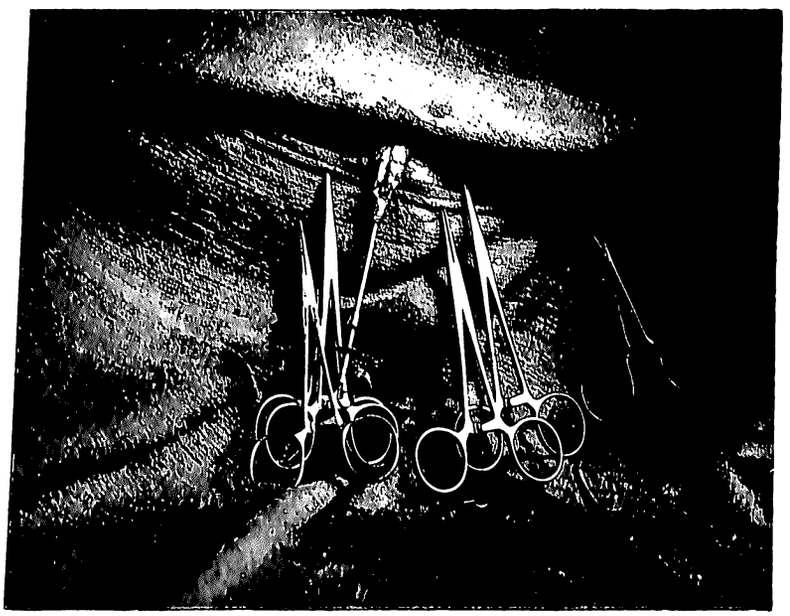
Wolfe, J. R. 1875. A new method for performing plastic operation- Brit. Med. J. 2:360. (cited by Brenizer, A. G. 1940. Skin and fascia grafting. Am. J. Surg. 47:265.)

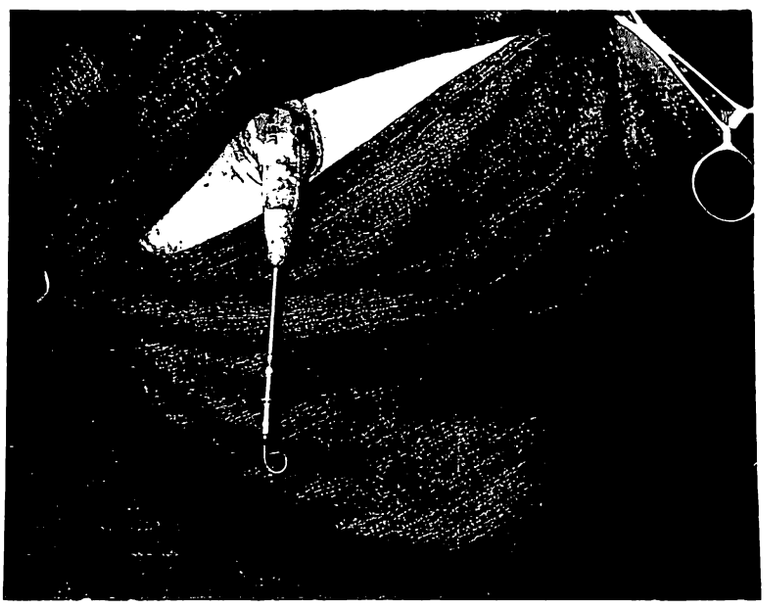
Wooldridge, G. H. 1923. Encylopaedia of Vet. Med., Surgery and obst. Vol. II. Ist. Ed. Henry Frowde and Hodder and Stoughton, London.

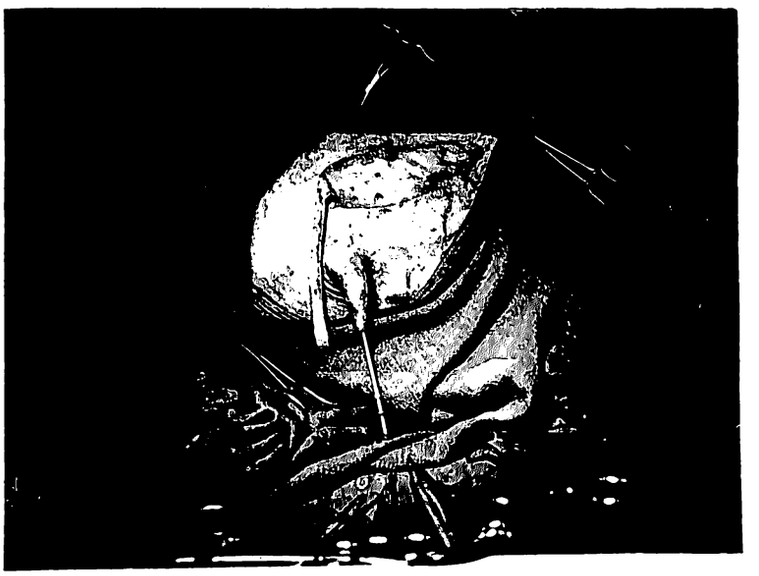
Woolsey, J. H. Jr. and Schaffer, M. H. 1952. Treatment of granulating wounds in horses by means of skin grafting. J. Am. Vet. Med. Assoc. 121:173.

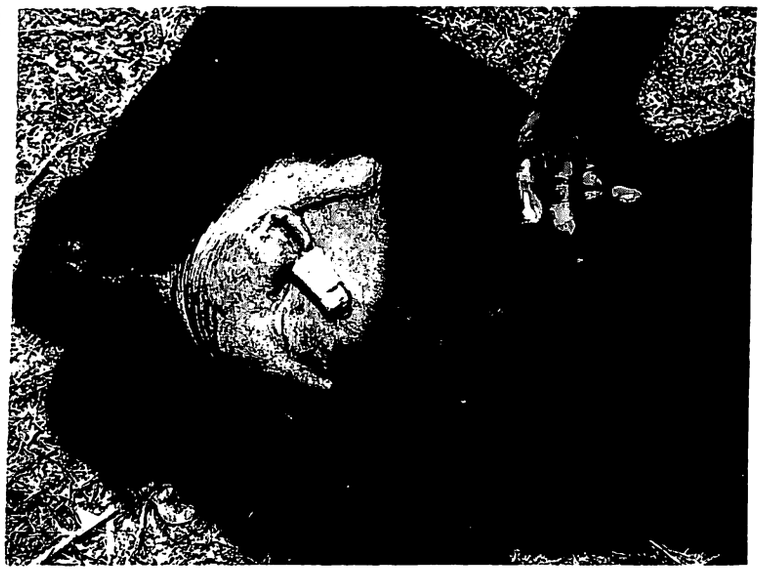
Wright and Hall, 1961. (Cited by Khan, A. A. 1967. Surgical diseases of the bovine teat. FAO dissertation. Vet. Faculty for FAO fellows and scholars, the Royal Vet. and Agri. College, Copenhagen, Denmark.)

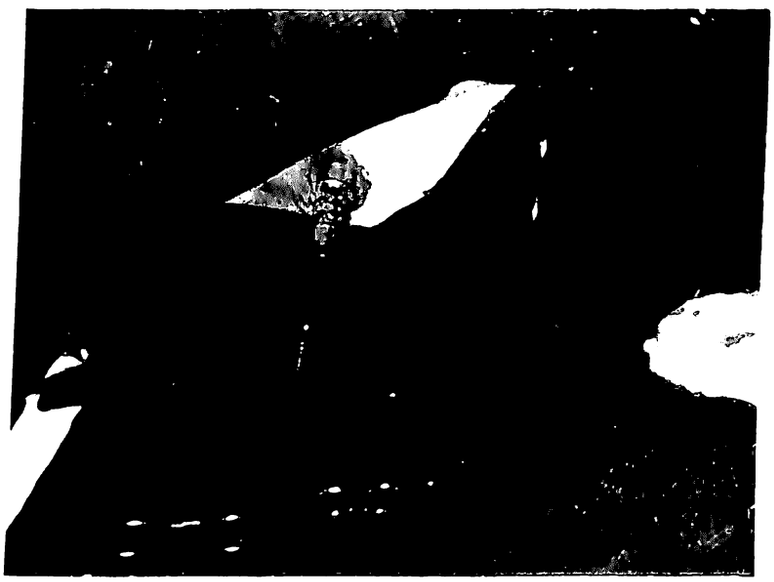












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