STUDIES ON CONSTRUCTION OF VIABLE INVERSE – SKIN TUBE FOR USE AS AN IDEAL OESOPHAGEAL SUBSTITUTE IN CANINES

A THESIS

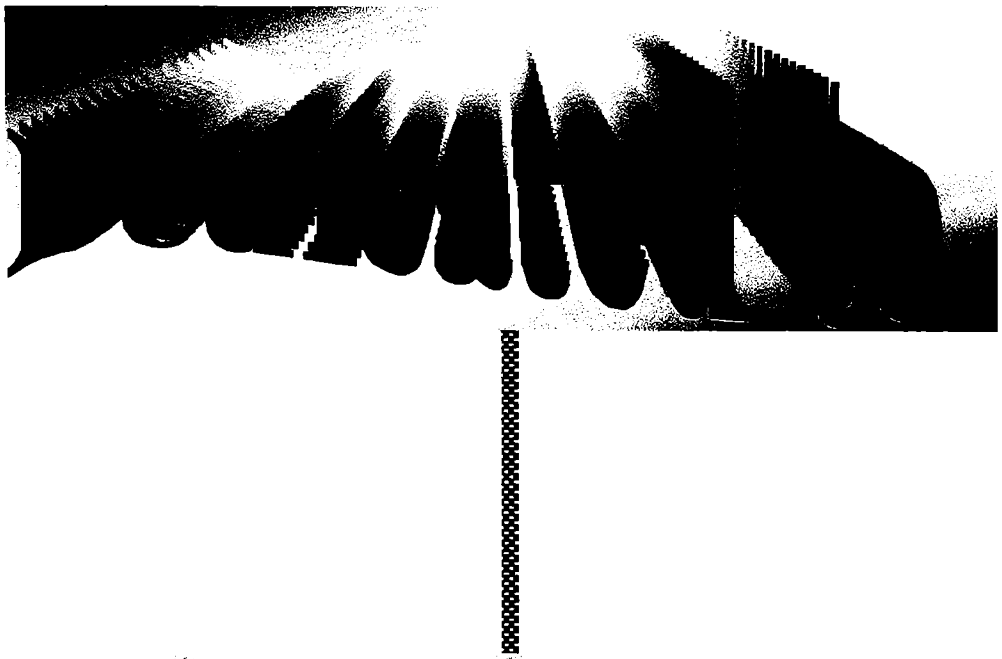
Submitted to the
West Bengal University of Animal and Fishery Sciences
In partial fulfilment of the requirements
for the degree of
Master of Veterinary Science
in

Veterinary Surgery & Radiology

By

Dr. Bhupinder Singh
B.V.Sc & A.H.

DEPARTMENT OF VETERINARY SURGERY & RADIOLOGY
FACULTY OF VETERINARY AND ANIMAL SCIENCES
WEST BENGAL UNIVERSITY OF ANIMAL & FISHERY SCIENCES
37 & 68 , Kshudiram Bose Sarani, Calcutta – 700 037



My ever-inspiring parents who have always showered their blessings on me

West Bengal University of Animal & Fishery Sciences
DEPARTMENT OF VETERINARY SURGERY & RADIOLOGY
FACULTY OF VETERINARY & ANIMALS SCIENCE

HEAD

37 & 68, KSHUDIRAM BOSE SARANI,
CALCUTTA- 700 037
Phone No. 556-9234
Fax No. 91-033-557-1986
Gram - VETUNIV

No...............................

Date. : ....

Dr. T.B. SEN.
M. V. Sc.; Ph D.
HEAD,
Department of Veterinary Surgery & Radiology,
F/O. Veterinary & Animal Science.

CERTIFICATE

This is to certify that the work recorded in the thesis entitled ' **Studies on construction of viable inverse-skin tube for use as an ideal oesophageal substitute in canines** ' *submitted by* Dr. BHUPINDER SINGH *in partial fulfilment of the requirements for the degree of Master of Veterinary Science in Veterinary Surgery and Radiology of the West Bengal University of Animal and Fishery Sciences is the faithfil and bonafide research work carried out under my personal supervision and guidance. The results of the investigations reported in the thesis have not so far been submitted for any other Degree or Diploma. The assistance and help received during the course of investigations have been duly acknowledged.*

TBSen 10/12/95.
Dr.T.B.SEN.
(ADVISOR)

Date :

Place : Calcutta

APPROVAL SHEET

APPROVAL OF EXAMINERS FOR THE AWARD OF THE DEGREE OF MASTER OF VETERINARY SCIENCE

We , the undersigned, having been satisfied with the performance of Dr. Bhupinder Singh, in the viva-voce examination , conducted today, the 14th Jan.,2000 recommend that the thesis be accepted for award of the degree.

	Name	Designation	Signature
1.	Dr. T. B. Sen M.V.Sc.; Ph.D.	Chairman , Advisory committee	14.1.2000
2.		External Examiner	14/1/2000
3.	Prof. (Dr) P. K. Bose M.V.Sc.; Ph.D.	Member , Advisory committee	14/1/2000
4.	Dr. P. K. Samanta M.Sc. (Vet).; Ph.D. (Cal)	Member , Advisory committee	P. K. Samanta
5.	Prof. (Dr) B. Biswas M.S.; M.ch.; DNB.; FIACS.; FASct.	Member , Advisory committee	

ACKNOWLEDGEMENT

A man would do nothing if he thought he would do it so well, that nobody might find a fault with it Keeping this idea in mind , the author embarked on a trial path sometime back and the journey since then has been a long and turbulent one

It is a gratifying moment for the author to convey his deep sense of gratitude , indebtedness and heartfelt thanks to Dr. T. B. Sen , M.V.Sc.; Ph.D., Reader and Head , Department of Veterinary Surgery and Radiology, Faculty of Veterinary and Animal Sciences, West Bengal University of Animal and Fishery Sciences, 68,Kshudiram Bose Sarani, Calcutta 700 037,for his benevolent guidance , constant supervision , valuable suggestions, advices, and wholehearted encouragement through out the entire course of the research work which enabled the author to execute the experiment and preparation of the thesis smoothly.

The author is highly obliged and grateful to Dr. P. K. Samanta.;M.Sc (Vet) , Ph.D.,(Cal), Reader, and Prof. P. K. Bose, M.V.Sc, Ph.D. of Department of Veterinary Surgery and Radiology , for their valuable suggestions , wholehearted encouragement and compassion which enabled the author to execute. the experiment and preparation of this thesis smoothly.

The author feels emmense pleasure in expressing his heartiest thanks to Dr. Dipak Kumar Dey, Reader, M.V.Sc.; Ph.D, Department of Vetrinary Surgery and Radiology, for his valuable suggestions, sincere help and motivation during the long journey.

Neither did the author originally put forth the problem , nor does he claim to have discovered the final solution to it, but the encouragement , sincere cooperation and devoted guidance rendered by Prof. (Dr) Bhabatosh Biswas M.S.; M.ch.; DNB.; FIACS.; FASct.; Professor , Cardiothoracic Surgery, Vivekananda Institute of Medical Sciences and Ramakrishna Mission Seva Prathisthan, Calcutta, made him believe that the author could in his own small way contribute towards finding the final solution. And in doing so he has put the author in a life time debt , a situation the author feels honoured to be in . The author holds him in high regard for his willingness to help and blessings which enabled him to complete the task.

The author also expresses his deep sense of gratitude and acknowledge his gratefulness to Dr. Asim Kumar Bhattacharya Honourable Vice-Chancellor , W.B.U.A.F.S and Dean , U. G. and P. G. studies, Prof. (Dr) D. P. Banerjee , Faculty of Veterinary and Animal Sciences , W.B.U.A.F.S and Dr. D. N. Jana , Directorate of Research W.B.U.A.F.S and other officials of the University and members of the Faculty Council, for the financial assistance and academic facilities extended to the author.

The author expresses his sincere gratitude and feels particularly indebted to Dr. J. Sengupta , M.B.B.S, M.D. (Cal), Ex-Prof. Department of Pathology and Biochemistry, National Medical College, Calcutta, and his Clinical and Research Laboratory – Pathowynd, 29A, Balaram Ghosh Street, Calcutta -700 004 for his valuable suggestions , guidance and all-round help in conducting haematological and biochemical analysis.

A man's true wealth is the good he has done to his fellow men and nobody exemplified this fact more aptly than author's dear friend Dr. Rabindra Mohan Mishra . My failure to express my sincerest gratitude towards him would be truly hypocritical.

When the author looks back his emotions well up to think of his seniors , colleagues and juniors at the Department of Veterinary Surgery and Radiology. The author extends his heartfelt thanks to Dr. Avijit Dutta and Dr. Subrata Sanki and will remain indebted to all till the dooms- day .

The author feels immense pleasure in expressing his heartiest thanks to Dr. Ashutosh Biswas and Mrs.Bhabatosh Biswas and all the members of their family for their sincere help and motivation during this journey. Their friendly ways will make the author remain grateful to them forever.

The author desires to express his heartiest thanks to Dr. Ranjit Dutta , M.B.B.S (Cal), Duncan Gleneagles Clinic , Cal whose valuable suggestions guided the author through his work and culminated in the final touches which one integral to this kind of project.

The assistance and help rendered by the staff members of the Central Library of the University and to all the staff members , Department of Veterinary Surgery and Radiology, W.B.U.A.F.S are fully acknowledged.

The author expresses his sincere gratitude and feels particularly indebted to Dr. S. Bandyopadhyay, Reader , Department of Animal Gynaecology and Obstetrics for his assistance and all-round help throughout the entire period of study.

The author wishes to place on record his deep sense of gratitude and sincere thanks to **Nymph Software Consultancy,** *(Calcutta - 700 048) for composing and printing this manuscript and rendering utmost help during the thick and thin paths of his journey.*

Work, Work, Work till the brain begins to swim and work, work , work till the eyes are heavy and dim. This was taught to the author by his parents. Some debts can never be repaid even in a thousand lives. The author only offers his heartfelt thanks and regards from the deepest corners of his heart to them.

Date
Calcutta

(DR. BHUPINDER SINGH)

CONTENTS

List of Tables

LIST OF FIGURES

ABBREVIATIONS

b.wt.	Body Weight
I/M	Intramuscular
I/V	Intravenous
mg.	Miligram
ml	Millilitre
Nos or #	Number
P.O.D	Post Operative Day
S/C	Subcutaneous
@	At the dose rate of
°F	Degree Fahrenheit
%	Percentage
cmm	Cubic Millimeter
gm	Grams
dl	Decilitre
Hb	Haemoglobulin
WBC	White Blood Cells
RBC	Red Blood Cells
SE	Standard Error
Kg	Kilogram
Cm	Centimeter
Sq.cm.	Square Centimeter
Min.	Minutes
W/V	Weight/Volume
"	Inches
pkt	Packet
G	Gauge
m	Meters
mAS	Milli amperage Second
kvp	Kilovoltage
ffd	Film focal distance
TEC	Total Erythrocyte Count
TLC	Total Leucocyte Count
DLC	Differential Leucocyte Count

CHAPTER I

INTRODUCTION

INTRODUCTION

One of the most striking features in recent years has been the increasing use of experimental surgery for therapeutic triumphs, which although sometimes seeming to arise by chance were only possible on the new background of clinical science.

Possibly there is no greater surgical challenge in the entire digestive tube than resection and replacing a segment of the esophagus. Due to its inelastic character the simple option of resection and end-to-end anastamosis cannot be carried out in the majority and an elaborate strategy must be drafted in individual cases.

Reconstruction of the circumferential defects of the esophagus is a challenging and often frustrating experience due its special anatomical features which needs to be taken into consideration for successful handling and suturing of this organ (Guillamondegui *et al.* 1985).

The fact remains that there is no closely attached serosa that makes suturing more difficult than dealing with rest of the gut. The strong muscular layer largely compensates for this weakness, but it is not helped by the nature of the muscle layer. The later is mainly longitudinal in direction and there is tendency for the fibers to separate and hence, longitudinal stretching and tension is poorly tolerated. Moreover, it lacks an omentum to help localize and seal a leak (Pavletic; 1992).

Another point of importance in considering the esophagus is that, it is a straight tube, which occupies the shortest distance between its upper and lower ends. If a section of the middle course of the esophagus is removed, there is only a limited extent to which the ends can be brought together. In canine esophagus this amount to be 3cm (Parker *et al.* 1949). Only a limited amount of esophagus can therefore, be excised and its continuity re-established by direct suture. Hence, any gap that may occur and the needs for bridging the esophageal gap after complete resection of the particular diseased segment has spurred many workers to develop a variety of substitutes.

Surgical affections of the esophagus of acquired nature are many and varied. Diseases of the esophagus invariably interferes with swallowing, producing the clinical signs called dysphasia. Though the esophagus can distend considerably but it cannot be stretched far longitudinally when resection of a segment of diseased esophagus is inevitable and under no circumstances anastamosis is permissible in that situation, a suitable substitute as prosthesis becomes an imperative necessity for proper functioning of the esophagus and saving the life of the patient.

Management of diseased and damaged segments of the oesophagus, viz; oesophgeal carcinoma, corrosive stricture, atresia etc, may necessitate its removal and reconstruction with a suitable substitute.

While searching out better and better esophageal substitutes, two selection criteria's seem to be considered logically for maximizing the out come. The first consideration certainly relates to mortality and morbidity inherent in every esophageal operation. Mortality and morbidity varies depending on the number of anastamosis required in a particular technique, reliability of the substitute organ's blood supply, operative time, number of incisions and number of body cavities to be explored (abdomen/thorax/neck) for the surgery. However, the most critical determinant of morbidity is the surgeon's proficiency based on his personal experience with the operation. The second consideration relates to the physiological function of the reconstructed digestive tract which is expected to fulfil five assignments; transport, antireflux function, antiaspiration function, provision for venting gas and vomiting.

Though enabling the patient to swallow without aspiration is the primary goal of all procedures; reflux is also a matter of varying concern. No matter which procedure is being adopted, but the operation must promise the best chances for long freedom from the consequences of oesophagitis and stricture. Realistically one may have to settle for less. Infact enabling the patient to swallow without aspiration is the goal and sole determinant of success of a particular type of esophageal replacement surgery.

Past and current techniques of esophageal replacement or repair have involved primary anastamosis, creation of gastric tubes, small or large bowel interposition, use of synthetic materials, use of myocutaneous flaps, and lastly but not the least use of skin tubes.

Stomach is the organ of choice for re-establishing the continuity of the alimentary tract and variable portions of esophagus in humans (Pavletic, 1992). Gastric advancement in to the thoracic cavity (oesophagogastrostomy) has been successfully performed experimentally in the dog, although major complication have been noted, including excessive vomiting, dehiscence, pneumonia and diaphragmatic herniation (Adams *et al.*1938).

Transplanted stomach has three disadvantages; the most serious of which results from the vascular joining of the stomach to the esophagus. Oesophagitis, aspiration and stricture may occur in one-third of the patients. Variety of techniques have been tried to prevent reflux but most surgeons'still rely on Sweets' observation (1945), that the higher the anastamosis the less the reflux. Another disadvantage relates to the stomach's blood supply. Once the left gastric and short gastric vessels are ligated, the fundus survives on microvascular connections that may be wreaked by nominal traction. It is extremely easy to malhandle the stomach. The stomach may need to be removed, straightened out, trimmed back or have tunnel widened for proper anastamotic healing.

The third problem of stomach substitute is the creation of a bulky incarcerated hiatal hernia. Though such occurrences are rare but not less serious. The vulnerable points for compression or twisting are the hiatus and the thoracic inlet that needs to be cared at the time of operation. Despite all shortcomings, the stomach or tubes constructed therefrom remains the overwhelming choice for an esophageal substitute (Akiyama *et al.* 1978).

Pedicled segments of the ileocecum, jejunum and colon have been successfully employed for replacement of major segments of the esophagus in humans but the short vascular arcades of the canine gastrointestinal (GI) tract restrict the mobilization of the small and large intestines in similar fashion (Pavletic, 1992).

The disadvantages connected with reconstruction with the jejunum are several: the vascular arcades are awkward to manage, they are at some distance from the bowel wall so that even after freeing them, the length of the gut available is limited by the vascular connection rather than the gut itself; also unlike the stomach or the esophagus, there is only a very poor amount of vascular connection in the wall of the gut. As a result, unless satisfactory vascular arcades have been left, vascular necrosis will occur. Inevitably there are disadvantages in using the colon too. It is not situated in the immediate operation area so that further exposure is necessary. This adds to the operation time that is further prolonged by extra anastamosis and adjustments necessary in preparing the coloninc tube. Swallowing tends to be delayed through colonic graft (Collis, 1982).

Myocutaneous flaps represent yet another fallback option for repairing fistulae or leaks. Alternatively, the flap may be rolled up into a bulky tube for bridging a short circumferential gap. The major advantage of the musculocutaneous flap is the greater certainty of the blood supply, which is usually provided by the superficial vessels. The cutaneous island receives its entire blood supply through minute perforating vessels arising in the underlying muscles (Demergasso and

Piazra, 1979).

Oesophagogastric anastamosis after mobilization or tube formation is a high-risk procedure. A free transplant of the small or large intestine requires microvascular technique. In addition, to this, there are clinical conditions where replacement of esophagus becomes a problem due to non-availability of the concerned organ or technical problems related to the surgery.

Muriatic acid ingestion in human makes such a unique situation. In many cases the whole length of the esophagus gets badly damaged. Stomach becomes small, thick walled and contracted and hence, unsuitable as a substitute. The upper abdominal contents become densely plastered to each other and parities making jejunum or colon replacement nonfeasible.

In such cases replacement of the esophagus with antesternal inverse-skin tube may prove to be the only option.

Skin tubes have been successfully employed for esophageal reconstruction in humans for many years. They have been designed and used to bridge deficiencies in and even to replace the gullet. Pavletic, (1981) reported the first clinical use of a skin tube for cervical esophageal reconstruction in dogs. The inverse-skin-tube serves as an epithelium lined conduit through which food and liquid may pass into the stomach or into the small bowel directly. The advantages of using skin tube lie in the superficial nature of the operation and the easy access to any breakdown in a suture line. It is also an advantage that other important organs (stomach/jejunum/colon) do not have their function interfered. Ample skin is available in the cervical area of the dog for tube development. The technique requiring neither special instruments, prolonged surgery time, nor special training for microvascular transfer of intestinal segments, could well be used by the veterinary surgeons in ordinary practice.

The present study was therefore under taken with a view to assess the feasibility of using inverse skin tube as an effective substitute for esophageal reconstruction in place of a diseased segment of cervical esophagus. In this study dog has been utilized as the experimental animal as the result of the study may be extrapolated in human patients as well as in other animals.

In addition to its effects on clinical, hematological, radiological features, the degree of stress was also evaluated on some stress indicators.

The present day information has been reviewed in the next chapter under "Review of Literature".

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

In research of studies on construction of viable inverse-skin tube for use as an ideal esophageal substitute in canines, available literature searched for a brief account of highlights have been reviewed with allied references in relation to skin tubes and other esophageal substitutes, skin flaps and clinical review, anaesthetic and surgical stress with reference to its hematological and biochemical studies.

2.1. The Surgical Anatomy and Physiology of the Canine Skin and Oesophagus are described below

2.1.a. Structure of Skin

The skin is the largest organ of the body, and the anatomic and physiological barrier between the animal and environment. It provides protection from physical, chemical, and microbiological injury and its sensory components perceive heat, cold, pain, pruritis, touch and pressure. The skin in addition to preventing desiccation and dehydration informs the central nervous system of its contacts. In addition, the skin is synergistic with internal organ systems and thus reflects pathological process that are either primary elsewhere or are shared with other tissues. The skin act as the site of vitamin D synthesis and the subcutaneous tissue serves as a reservoir for fat, electrolytes, water, carbohydrates and proteins. Secretions of the skin glands not only waterproof and lubricate the skin but also acts as pheromones for recognition.

In terms of structures, the skin is composed of the epidermis and dermis. Structures that compose the skin adenexa, hair follicles, sweat glands, and sebaceous glands are located in the dermis. Besides adenexa, the dermis is composed of fibroblasts, collagen fibers, and various other structures, such as blood vessels, nerves, and fluid.

The subcutaneous tissue is mainly composed of loose connective tissue, including elastic fibers, fat, blood vessels and nerves.

Thin, superficial muscles, collectively called the panniculous muscle, lie within the subcutis in dogs. Examples are the platysma muscle in the neck and the cutaneous trunci muscle in the trunk. Preservation of these muscles is very important principle in the formation of skin flaps for reconstruction.

Blood supply to the skin is through the deep or subdermal plexus. This plexus is the major source of blood supply to the skin and one of the most importances to the surgeon. When creating skin flaps in dogs it is always mandatory to preserve the deep vascular plexus.

In regions where the cutaneous musculature is present, this vascular network is present on the superficial and deep layers of the muscle. Dissection beneath this muscle layer is critical to flap survival.
Direct cutaneous arteries are present in several areas of the body. They arise from the deep vessels that course superficially and run parallel to the skin. These direct cutaneous arteries communicate with deep vascular plexus. Middle and superficial plexus complete the layer of vascular network to the skin.

2.1.b. Macroscopic anatomy of the canine oesophagus

The oesophagus is a prosaic organ. It is a muscular tube that begins at the pharynx, passes through the neck and thorax and enters the abdomen to end at the gastroesophageal junction. It starts as the continuation of the pharynx. It is related ventrally to the dorsal aspect of the trachea and dorsally to the longus coli muscle. At the level of the third cervical vertebra the oesophagus descends to the left surface of the trachea and maintains this relation up to the sixth vertebra. Then it goes little upwards and enters the thorax through the dorso-lateral aspect of the thoracic inlet. At the level of the 3rd to 4th cervical vertebra it is related superiorly to the left longus coli muscle, laterally to the vagosympathetic trunck, common carotid artery and internal jugular vein. In the thorax it gains the dorsal surface of the trachea and continues with this relation upto the right of the median plane. It goes upward and backward in the posterior mediastinal space inclines again to the left of the median line and enters the abdominal cavity through the oesophageal hiatus along with dorsal and ventral continuations of the vagus nerves. At the base of the heart it is related to the aortic arch at the left side. In the posterior mediastinum it is related to the mediastinal lymph nodes and corresponding lungs on either side (Ghosh, 1995).The oesophagus is fixed cranially by the attachment of fascia muscle to the cricoid cartilage of the larynx and vertebral fascia of the neck. It is movable where it passes through the neck and thorax, and is covered by deep cervical fascia, and mediastinal fascia and adventetia of other organs. It is fixed caudally by the phrenico-oesophageal membrane and stomach.

2.1.c.. Microscopic anatomy of the canine esophagus

The esophagus consists of four layers: mucosa, submucosa, muscularis, and adventetia. The mucosal layer of the collapsed esophagus lies in longitudinal folds and consists of cornified, stratified squamous epithelium. The oesophageal epithelium has ducts openings from the submucosal mucus secreting glands. Cardiac glands occur in the distal esophagus in all species. The submucosal layer contains many elastic fibers and allows the mucosa to lie in longitudinal folds when the oesophagus is empty. Submucosal glands are present throughout the entire length of the canine oesophagus. The third layer of the oesophagus is the muscularis. It contains two layers of muscles usually described as inner circular (spiral) and outer longitudinal (oblique). In the dog the muscle layer is striated through out the length except for a small area of smooth muscle in the inner circular layer near the cardia The fourth layer of the oesophagus is the adventitia. It is made up of deep cervical fascia, adventitia of contiguous structures, pleura, and in those species with an abdominal component, peritoneum.

Cranial oesophageal sphincter is mainly composed of the crico-pharyngeous muscle, which blends imperceptibly with the caudal fibers of the thyro-pharyngeous muscle. The caudal aspect of the cricopharyngeous muscle is well developed and can be recognized radiographically in both survey and contrast radiographic studies.

The existence of the caudal oesophageal sphincter is well recognized in all species that have been studied carefully .The surgeon recognizes the area by seeing the external landmark, the cardiac incisura, and insertion of the phrenico-oesophageal ligament (Anderson, 1980).

Blood supply: to the cervical part is supplied by the cranial and caudal thyroid arteries and common carotid artery and the thoracic part receives it vascular supply from the esophageal branches of the dorsal intercoastal aorta and the left gastric artery.

Nerve supply: The main motor nerve supply to the esophagus is from the vagus. Cervical and the remainder of the esophagus receive fibers from the vagal truncks. In dogs myentric plexus (Auerbach plexus) is absent and instead of this ganglion cells are present between the muscle layers. Motor end plates connected to efferent fibers constitute the main nervous plexus of the canine esophagus.

2.1.d. Surgical physiology of the canine esophagus

Peristaltic activity in the dog is similar to that of man (Gaynor *et al.* 1980). The movement of the oesophagus associated with swallowing is a peristaltic wave that travels from the upper oesphageal sphincter to the lower oesophageal sphincter. Peristaltic contraction of the oesophagus elicited only by swallowing movement is termed as primary peristalsis. Local oesophageal stimulation by the introduction of a bolus or foreign body into the oesophageal lumen will, however, elicit a peristaltic movement known as secondary peristalsis. Thus, primary and secondary peristaltic waves differ only in the location of the organ. A bolus is necessary for the propagation of these waves in the cervical portion of the canine esophagus and greatly facilitates progress in the thoracic portion. When the wave approaches the gastroesophageal junction, the lower oesophageal sphincter relaxes prior to arrival of the wave permitting the bolus to pass, and then contracts after the bolus enters the stomach.

2.2 Review of literature on esophageal reconstruction techniques

Billworth (1872) first described resection of the cervical esophagus since then many ingenious methods have been devised to replace it.

Mikulicz (1886) resected the cervical oesophagus for carcinoma and four months later closed the fistula resulting from this operation and reconstructed the oesophagus with two skin flaps, one from each side of the neck, which he united to form a tube. The skin lateral to the flaps was drawn together over the tube with silver wire sutures. The wound healed well and ten days after the operation the patient was able to swallow solid food, but death occurred from recurrence of the tumor 16 months later.

VonHacker (1891), after experimenting in dogs, attempted a similar procedure for oesophageal reconstruction using skin flaps from the neck region.

Bircher (1894) attempted to short-circuit a carcinoma of the esophagus by means of a buried skin tube. At the initial operation he made two vertical incisions about 3 inches apart on the front of the chest just to the left of the midline, undercut the edges of the strip of skin thus isolated without disturbing the attachment of its central part and united them to form a tube. He then mobilized the skin on each side of the defect and sutured the margins together so as to bury the tube. At a second operation he united the lower end of the tube to the stomach via gastrostomy. He planned to unite the upper end of the tube to the oesophagus in the neck, but the patient died before this was done. These cases were not reported at the time but were published in 1907 by E.Bircher.

Depage (1903) was the first to use gastric tubes for reconstruction of the oesophagus.

Beck and Carrel (1905), in America showed in dogs that a tube constructed from the greater curvature of the stomach and nourished by the left gastric artery could be brought up subcutaneously (antethoracic) in front of the chest far enough to be anastamosed to the cervical oesophagus.

Roux (1907) reconstructed the full length of the thoracic esophagus using skin tube in addition to jejunum. The main disadvantage of this type of jejunuo-dermato-oesophagoplasty was that the operation required multiple staged procedures using one or more than one body tissue particularly free skin grafts.

Lane (1911) introduced a new technique in which he used a single skin flap with its base lying on the left of the neck. After resecting the tumor with a margin of healthy esophagus he rolled up the flaps to form a tube in the long axis of the esophagus and joined it to the pharynx above and the esophagus below. At a second stage he divided the base of the flap and closed the lateral aperture remaining in the tube.

Lexer and his junior colleagues Frangengeim in (1911) instead of trying to bridge the whole gap between the cervical oesophagus and the stomach with jejunum, used a combination of antethoracic skin tube above and jejunum below.

Kelling and Vulliet (1911) used colon in a subcutaneous route in continuity with skin tube to perform oesophageal replacement.

Jianu (1912) used antethoracic transplantation of a gastric tube in front of the chest to be anastamosed to the cervical esophagus. Jianu had hoped to obtain a tube from the stomach sufficiently long to be anastamosed directly to the oesophagus in the neck, but in most cases an intervening skin tube was used.

Torrek in 1913 and later again in 1925 achieved brilliant success in reconstructing the oesophagus with the help of skin tube fashioned antesternally in front of the chest. He created an oesophageal fistula above and a gastric fistula below and joined them with the help of a skin tube.

Von Fink (1913) used stomach as an antesternal oesophagus in a patient with carcinoma of the oesophagus. He completed the procedure by connecting the mobilized stomach to the cervical esophagus by means of a skin tube.

Payer (1917) was the first to have successfully completed cutaneous oesophagoplasty using the antethoracic skin tube technique described by Bircher (1894).

Esser (1917c) modified the Bircher's method of constructing an antethoracic skin tube to replace the thoracic part of the oesophagus. He formed a skin tube by burying split skin grafts, wrapped raw surface outwards around a cylindrical mould, in a subcutaneous tunnel.

Hedbloom (1922) used the technique described by Franz with brilliant success in reconstructing the esophagus with skin tubes.

Galpern (1925) tried without much success to use omentum to provide a serous covering for the lower end of the skin tube constructed by Bircher's method.

Ochsner and Owens (1934) found 16 cases reported in the literature in which antethoracic transplantation of the stomach as a whole used for reconstruction of the oesophagus, but 10 of them died, and good function was obtained in only four.

Ohsawa (1936) reported the first clinical use of successful intrathoracic oesophagogastrostomy in which the stomach as a whole was transplanted.

Wookey (1942) described a technique by which the skin of the neck was infolded to form a tube to bridge a defect involving the cervical area only.

Davis and Stafford (1942) reported a single case of Lexer type oesophagoplasty in which they modified the technique by using flaps from a distance instead of local flaps to close the defect resulting from the construction of the antethoracic skin tube. To overcome the difficulty of burying the substitute esophagus with local skin flaps they used a tubed pedicled flap from the lateral thoraco-abdominal region.

Yudin (1944) reported several cases of antethoracic oesophagoplasty in which jejunal segment was used. Instead of isolating a segment of the jejunum and attaching the lower end to the stomach, however, he used a Y- loop, that is he divided the jejunum in one place only and restored the continuity by end-to-end anastamosis. In 21 cases the jejunum reached to the neck and was anastamosed directly to the esophagus or the pharynx, in 1 it failed to do so and a skin tube was used in addition.

Reinhoff (1944) reported what appears to be the first instance in which a jejunal loop was brought up in the thorax in man. He used an Y-loop to short-circuit a lye stricture of the esophagus. He made a tunnel behind the sternum by working from the abdomen below and the neck above without opening the pleura, passed the loop upwards in this tunnel, and brought the end of the loop to the surface in the 2nd intercoastal space. Subsequently he joined the jejunum to the esophagus, first by means of a skin tube and latter by direct anastamosis.

Longmire and Ravitch (1946) selected the jejunum as that portion of the alimentary tract to be ultimately completely isolated from its mesenteric blood supply, implanted in a skin tube and transferred to the chest to serve as an artificial esophagus. This was first recorded attempt at transfer of a segment of bowel deprived of its blood supply to a heterotopic position.

Ladd and Swenson (1947) used a Lexer type of oesophagoplasty in children with congenital atresia of the esophagus. Instead of trying to bury the skin tube with local skin flaps they used a tubed pedicle graft from the right axilla.

Hanrahan (1947) in a patient in whom a jejunal loop brought up to cervical oesophagostomy had partially broken down, found that the skin between the esophageal and jejunal openings was too scarred to be used to form a tube. He therefore raised a long tubed pedicle graft and used part of this to replace the scarred skin. Next he used the transplanted skin to form a substitute esophagus, and finally he buried this with the remainder of the tubed pedicle graft.

Wookey (1948) had stated that for reconstructing the defects left after pharyngolaryngectomy local flaps, lateral cervical flaps, and staged chest pedicles may all be used, the choice depending upon the condition of the cervical skin. In many patients the skin will not survive mobilization and coverage of the reconstructed pharynx must be obtained by the use of the chest skin carried by a tubed pedicle. Split-thickness skin grafts were abandoned in favor of cervical full-thickness flaps. Although technically simple, local flaps were limited by their size and required multiple stage operations.

Bricker *et al.* (1949) made attempts to repair defects in the thoracic esophagus with skin flaps applied as patches and to replace a segment of the esophagus with the skin tube transplanted to the mediastinum and joined to the esophagus above and below by end-to-end anastamosis. There procedure of using intrathoracic skin tubes were however, difficult and hazardous, and in patients who survive there is a high incidence of postoperative stricture, confirmed radiographically by doing contrast study of the neo-esophagus with barium meal.

Bricker *et al.* (1949) described a modified Wookey's method that incorporates a chest flap also. Thus a cervico-thoracic flap is fashioned in stages and passed into the chest after a tube is made to reconstruct that segment of the esophagus from the level of the aortic arch to the post-cricoid region.

Orsoni and Toupet (1950) used the descending colon and the left half of the transversing colon to construct an antethoracic short-circuit between the cervical oesophagus and the stomach inpatients with inoperable carcinoma of the oesophagus or the cardia. The mortality was high and there was moreover a high incidence of fistula formation in the survivors.

Mipton *et al.* (1952) successfully applied free slit thickness skin grafts to replace the oesophagus and pharyngeal segments in 4 human beings.

Petrov (1954) reported successful resection of a malignant tumor developed in an artificial oesophagus constructed more than 30 years ago. The original reconstruction was performed to alliviate stenosis secondary to a caustic burn, and was skin tube for the upper half and a small intestinal segment for lower half of new prethoracic oesophagus. The cell type of the cancer is not reported; however; the lesion was located in the lower portion of the skin tube at its anastamosis with the small intestinal segment.

Richard *et al.* (1956) successfully replaced the cervical oesophagus by free autogenous dermal grafts in dogs.

Jayes (1957) reported a case of 30 year old women, who developed squamous cell carcinoma in a reconstructed esophagus performed 23 years ago for stenosis secondary to ingestion of hydrochloric acid. The original reconstruction involved an oesophago-dermato-jejuno-gastrostomy. The papilliferous tumor appeared at the upper esophageal skin tube for 8cm. Local skin tube and rotation flaps made successful secondary reconstruction following excision of the tumor.

Ong and Lee (1960) suggested visceral interposition is the only method that solves the problem created by total oesophagectomy, which is always indicated for esophageal tumors.

Fogh-Anderson (1961) reported a squamous cell carcinoma in a 42 year old man. This cancer developed 34 years ago subsequently to a corrosive esophageal stricture, reconstructed primarily with a prethoracic skin tube. The poly-poid tumor arose at the upper esophageal skin tube anastamosis and extended down the skin tube

1cm. Using skin tube covered by local flaps performed secondary reconstruction.

Iskeceli (1962) used non-vascularised free intestinal segment and found that the subject survived but late stricture was invariable.

Lillehei *et al.* (1963a) showed that free revascularised intestinal graft functioned perfectly without nerve or lymphatic connections.

Harrison (1964) critically evaluated the defects followed by pharyngeal reconstruction, using local or pedicled skin these defects are now well known and include local recurrence in at least 50 percent of the cases, stricture at the skin -esophageal junction and inadequate resection due to the necessity of leaving an accessible esophageal stump.

Ranger and Shaw (1964) found that multiple stage reconstruction using skin flaps might take upto months to complete and carry mortality rate of between 3 to 20 %.

Bakamjian (1965) noted that split- thickness skin dressed over a tubular or conical stent of one kind or another have the merits of simplicity and immediate re -establishment of the pharyngeal continuity. With the natural tendency for considerable contracture to occur in split-thickness grafts, however, and the inordinately high incidence of poor "takes" in a critically mobile and contaminated region such as the pharynx, the goals of a primary, single stage reconstruction are frequently defeated by the development of the fistulas, severe strictures and occasionally a fulminating infection underneath the neck flaps. The Bakamjian method is a two-stage method in which a medially based chest flap is being used. The tissue used is the chest wall skin. It is an interpolated flap based on the perorating vessels of the internal mammary artery, thus it is an axial pattern flap and may well be a fasciocutaneous flap as well. It can be raised in one stage and its importance is that its length easily permits reconstruction of the mouth, pharynx and cervical esophagus.

Brain (1967) reported 11% mortality in his human patients for resection and replacement of esophagus with jejunum and colon.

Malcolm (1968) reported that both operations of oeosphageal replacement with jejunum and colon have considerable morbidity and may be followed by late complications, such as peptic ulcers in the transplant.

Bromberg *et al.* (1968) reported carcinoma in a reconstructed esophagus. The carcinoma was located at the mid portion of the skin tube that was used for replacement of the diseased segment of the esophagus.

Vidne and Levy (1970) described the use of pericardium to replace and repair a congenital esophageal stenosis in a young child.

Singh and Tyagi (1972) reported the suitable techniques of auto and homo esophageal transplants in buffalo calves. Transplantation was tried with autofascia lata, part of ileum and polyethylene tube.

Their study also comprised observations in the tissue reactions by different suture materials. It was concluded that autofascia lata seems to be quite satisfactory tissue for reconstruction of esophageal wounds and non-absorbable suture materials provide better healing than catgut.

Arnold and Coran (1973) performed pericardioesophagoplasty for partial resection and replacement in adult dogs. To minimize or prevent fibrosis and stricture formation a pericardial pedicle graft rather than a free graft was used. 11 dogs underwent these procedures and 9 animals survived that maintained their weight or have gained weight during the postoperative follow up period. Although this technique is inadvertent for total esophageal replacement, it is quite effective in replacing portions of the mid-esophagus. In addition, by employing the pericardial graft, the thoraco-abdominal approach and the multiple intestinal anastamosis, involved in bowel interpositions or gastric tube procedures can be limited.

Lortat-Jacob (1973) reported that in exceptionally rare cases it is impossible to reestablish the continuity of the upper digestive tract without interposition of a cutaneous tube. The results of the procedure are usually good when the length of the skin tube is not long.

Howard *et al.* (1975) described the use of sternothyroideous muscle for esophageal reinforcement in dogs. The technique involves the use of sternothyroideus muscle as a patch to repair the cervical esophageal injuries.

Soloman *et al.* (1977) described a method for segmental replacement of esophagus in dogs, with one of the three-tissue substitutes viz., pericardium, fascia lata, aortic homograft. The experiments involving the thoracic esophagus failed owing to the development of acute mediastiniitis and sepsis. The most promising results were obtained in animals in which aortic homograft was used to replace the cervical segment of the esophagus. 8 of the 12 animals with aortic homograft survived and gained weight until killed 1 to 6 months after operation. The overall results suggests that aortic homograft may have a potential clinical application in cases in which oesophageal replacement is necessary.

Ariyan (1979) developed the pectoralis major myocutaneous flap which supplanted the Bakamjian's flap for esophageal reconstruction.

Demergaso *et al.* (1979) and Guillamondegui (1981) both have preferred trapezious myocutaneous flap because it forms a tube more readily than the bulky PCMF.

Edwards *et al.* (1979) showed that musculocutaneous flaps appear to have improved vascularised provide bulk and may be raised without a delay. The deltopectoral flap occasionally shows poor vascularity and minor wound complications are frequent. PMCF has great potential over the deltopectoral flap with respect to greater flap length, improved vascularity, bulk and one stage reconstruction of oropharyngeal and cervical esophageal defects. A major advantage of the PMCF is that all donor sites are closed primarily, and hence, there is no additional need of skin grafts to cover the donor area.

Francisco and Mario (1979) developed the trapezious myocutaneous flap for successful reconstruction of the hypopharynx and cervicaloesophagus. The TMCF is a vscularised, composite pedicle formed by the upper and medial portions of the trapezious muscle and an island of the overlying skin of the shoulder. The superficial transverse cervical vessels usually provide the blood supply to this pedicle. The coetaneous island receives its entire blood supply through minute perforating vessels arising in the underlying trapezious muscle. The hypopharynx can be completely reconstructed by shaping the coetaneous island into a coned skin tube with ends of different diameters, which are then sutured to the oropharynx and base of the tongue and to the cervical esophagus.

Ryan *et al.* (1981) used the pectoralis major myocutaneous flap (PMCF) for replacement of cervical esophagus.

Pavletic (1981) has described the use of omocervical flap for esophageal replacement in dogs. The omocervical island arterial flap, based on the superficial branch of omocervical artery, could be fashioned into an epithelium-lined skin tube and sutured to the pharyngostomy and oesophagostomy in one stage with considerable save in time and money.

Miyamoto *et al.* (1984) successfully reconstructed an ante thoracic esophagus in a human patient fashioning a skin tube from a skin flap supplied by perforators from the internal mammary vessels. This neo-esophagus was covered with a trapezious myocutaneous flap in a one-stage operation.

Jurkiewicz and Atlanta (1984) described that free heterotopic transplantation of segments of the distal alimentary tact revascularised in the neck provide a very satisfactory forward method of reconstruction of the cervical esophagus. At present pharyngo-esophageal reconstruction's are of 4 main types: (1), free skin grafts,(2) local or regional skin flaps,(3) subcutaneous or intrathoracic interposition or migration on a vascular pedicle of more distal positions of the alimentary tract- stomach or colon; and (4) lastly a free graft of jejunum or colon.

Miyamoto *et al.* (1984) performed antethoracic reconstruction of the thoracic esophagus by fashioning a skin tube from a skin flap in one stage operation in a 46-year-old Japanese man. The cervical esophageal coetaneous fistula and the jejunostomy opening were linked together using a skin tube. One week after the operation minors leak appeared in the cervical region. A barium sulfate swallow confirmed a small leak at the junction of the lower end of the cervical esophagus and the skin tube. However, the passage of barium was smooth and no stenosis was seen. Inspite of minor leakage, oral feeding was started 21 days after operation and all this leakage ceased spontaneously on the 75^{th} day.

Guillamondegui *et al.* (1985) performed complete resection of the hypopharynx (in 54 patients having hypopharyngeal tumors) and cervical esophagus (in 24 patients). Circumferential resection was followed by cutaneous flap or graft surgery in 44 cases, colon bypass in 16, lateral trapezious musculocutaneous flap surgery in 9, and pectoralis major musculocutaneous flap surgery in 6. 10 of 41 deltopectoral flaps were delayed. An average of 4 procedures were required to close the fistula, and in 15 cases it was never closed. Complications were frequent and stenosis sometimes resulted. Survival was 28 % at 3 years. Musculocutaneous flap reconstruction usually involved only one procedure. Survival was 35% at 2 years. About half of the colonic interposition's were complicated. Survival was 57% at 2years. Thus it was concluded that the choice of reconstructive surgery after circumferential resection of the hypopharynx or cervical esophagus should be based on the quality and length of survival offered.

Raymond *et al.*(1986) have made a meticulous use of a tubed pectoralis major myocutaneous flap for salvage of a failed colonic bypass of the esophagus. According to him vascular impairment and sloughs of the proximal portion of the colon with esophageal fistula is a perplexing complication of the colonic bypass of the esophagus. If the fistula fails to heal, several operative alternatives are available. These include simple operative closure, replacement of colonic bypass by gastric mobilization or formation of gastric tube and oesophago-gastric anastamosis in the neck , transplantation of a segment of a small intestine as an oesophago-colonic interposition, tubed axial cutaneous flap interposition and tubed MCF interposition. Oesophagogastric anstamosis after mobilization or tube formation of the stomach is an extensive and high risk intraabdominal operation. The presence of a previous cologastrostomy presents another obstacle to gastric mobilization or tube formation. A free transfer of the small intestine requires microvascular technique and an intraabdominal operation. Thus, the safest and simplest solution appears to be a choice between a tubed deltopectoral Bakamjian flap (BF) and PMCF .

Mutoc (1986) reconstructed the cervical esophagus by free transfer of a jejunal loop and they observed radiographically using barium sulfate suspension in their study that fistulisation was the most frequent problem in short-term survivors and inanition due to a functional rather than anastomtic stenosis and dysmotility was observed in the long-term survivors.

Daleck *et al.* (1987) performed cervical oesophagoplasty in dogs with autologous or homologous peritoneum preserved in glycerine. 24 adult dogs were divided in 2 groups, on one of which received an implant on the ventral pat of the cervical esophagus of a homologous peritoneum graft in the form of a plaque, preserved in glycerin, while the second group received a similar but autologous graft consisting of fresh peritoneum. 2 representative of each group were killed on postoperative day 7,15,30,60,90 and 120. After both grafting techniques there was an initial acute inflammatory reaction followed by connective tissue proliferation by the 15th day, epithelium was already covering a major part of the lesions. It was concluded that both techniques are equally suitable.

Straw *et al.* (1987) evaluated a technique for reconstruction of the thoracic esophagus with the help of skeletal muscle graft. A 9 x 10 cm section of transverse abdominal muscle was harvested, fashioned into a tubular graft, and vascularised via the omentum. The vascularised tube was advanced into the caudal thorax through the diaphragm at a second operation 22-44 days after harvesting the section of transverse abdominal muscle. A 5cm of the thoracic oesophagus was replaced with the vascular tube graft.

Kakegawa *et al.* (1987) presented a new procedure for esophageal reconstruction using the skin flap combined with the overlying muscle flap in a situation in which preceding cervical oesophagostomy and antesternal colostomy have been performed. The skin canal which is the most important part of this reconstruction, is created using the skin of the anterior chest wall without transferring coetaneous tissues from other places. Therefore, the operative procedure becomes simpler and the blood supply to the skin canal is more assured. While blood of the wall of the canal is supposed to be supplied initially from internal mammary and intercostal arteries, the muscle flap over the canal may subsequently provide more blood supply to the skin canal. In addition to sufficient blood supply, the length of the suture line for creating the skin canal is minimal and thereby, the possibility of postoperative leakage can be diminished. Because both oesophagostoma and colostoma are not damaged in the second stage of the operation, strictures at these sites are not likely to occur. Further more, the muscle flap serves as a physical protector for the canal, and presents a suitable bed for the split thickness graft. This two stage operation using combined skin and muscle flaps after antesternal colostomy is a safe, simple and assured technique for the compromised colonic segment at primary esophageal reconstruction. This procedure is also applicable to the patient in whom use of a stomach tube for esophageal replacement is attempted but primary cervical oesophagogastrostomy is not possible.

Shima *et al.* (1988) studied the segmental replacement of esophagus with gluteraldehyde treated tracheal grafts.

Firedman *et al.* (1988) made a judicious use of sternocleidomastoid myoperiosteal flap for esophageal and pharyngeal replacements and repair of fistula, both in human and animal patients. These flaps were too bulky and difficult to repair esophageal and pharyngeal reconstruction's. An ideal flap would be local, well vascularised, compact and capable of being sutured into a tension free, water tight seal.

Ike *et al.* (1989) fabricated an artificial oesophagus from a collagen-coated silicon tube 5cm long, with an inner diameter of 2.5 cm and a wall thickness of 1mm. The outer surface was coated with dry collagen to 5mm thickness. The bilayered prosthesis was anastamosed to the cervical esophagus of adult mongrel dogs that were fed. with intravenous hyperalimentation with 80cal/kg/day and 60ml water/kg/day for 3 weeks after the operation. Once the dogs began to feed orally, the artificial esophagus dropped spontaneously into the stomach and formation of neo-oeosphagus was complete. Macroscopically the neo-esophagus showed no evidence of leakage or inflammation and had a smooth inner surface, but it developed a slight segmental narrowing. Microscopically, layers of stratified squamous epithelium covered the neo-esophagus with in 3-4 weeks. The most characteristic feature of the artificial esophagus was that the replacement prosthesis did not remain in the esophagus after healing. Esophageal epithelialization extended into the collagen layer coating the silicon tube and a new esophageal lumen was developed , thereby decreasing the chances of infection and leakage. However, neo-esophageal stricture and stenosis was observed when the silicon tube was removed.

Holmberg *et al.* (1991) made an attempt to completely replace the thoracic oeosophagus in dogs with the help of free bowel transfer by using orthotopic colon graft in their experiment. A segment of cervical esophagus was replaced in 3 dogs, and the entire esophagus was by-passed in 6 dogs. The orthotopic graft worked well and the surviving dogs had normal feces with in 24 hours of surgery. The cervical grafts remained viable and the dogs were able to drink normally and swallow gruel from elevated bowel. Chronic regurgitation of solid food remained an unsolved problem. All thoracic grafts failed because of mechanical kinking of the vascular pedicles and leakage.

Natsume *et al.* (1993) studied a new artificial esophagus with a bilayered structure made of porous collagen sponge and silicon. 5cm of cervical esophagus was replaced with this prosthetic device in 19 adult mongrel dogs. Two weeks after implantation the collagen sponge was replaced by autologous tissue and regeneration of the neo-esophagus was observed in all the animals. The inner surface of the neo-oesophagus was covered with matured mucosal epithelium similar to the intact esophagus 4-5 weeks after implantation. The replacement site was not complicated with infection, anastamotic leakage, or exuberant granulation tissue development on the luminal surface.

Freud *et al.* (1993) investigated the use of a prosthetic biologic material-lyophilized dura matter (Lyodura) in patching the esophageal defects in dog having in view its use in bridging long gap congenital esophageal atresia. A segment of the esophagus was excised and replaced by 3cm in length and 2cm in diameter, Lyodura tubes. The study revealed that the area of prosthetic tube replacement was characterized by a narrowing of the esophageal wall and histopathological studies showed that the epithelization process was complete in about 2 months and muscle reconstruction did not take place at the patched areas. It was concluded that Lyodura could be considered as a successful alternative for bridging esophageal defects.

Yamataka and Miyano (1994) developed a technique for reconstruction of thoracic esophageal replacement with a tubed latissimus dorsi musculocutaneous flap in dogs.

Yamataka *et al.* (1994) replaced a portion of the thoracic oesophagus in 14 puppies. A tubed latissimus dorsi musculocutaneous flap (TLDMF) was introduced into the thoracic cavity through a right thoracotomy. The coetaneous layer was rolled into a tube and interposed in the space of the esophagus. The muscle layer was wrapped around the anastamosis. 3 puppies died of postoperative complications, such as minor anastamotic leakage and postoperative bleeding. 1 puppy died due to some unknown reason. The rest 10 puppies had an unevent full recovery. Thus it could be conclude that this technique could be used as an alternative method to bridge a long gap in patients with esophageal atresia or severe stricture.

Amarpal *et al.* (1995) performed experimental oesophagoplasty with free gastric seromuscular graft in 12 dogs. The animals were destroyed after 7,15,30, and 60 days latter. Breaking strength, tensile strength, extensibility, and energy absorption of the anastamotic sites increased upto day 60. Histopthologic and histochemical studies revealed early infiltration of PMNC and lymphocytes followed by gradual increase in collagen fibers. Epithelization of graft site was complete by day 30. On day 60 stratified epithelium was observed at the anastamotic sites but esophageal glands were not evident at the region. It could be concluded that seromuscular graft induced good healing of cervical oesophageal wall defects.

Liapis (1996) replaced a part of he esophageal wall by a strip of skin in dog.

Hobor *et al.* (1997) reported that if there is no other possibility of whole esophagus, the antethoracal neo-esophagus from musculocutaneous flaps gives the best result compared with the skin tube reconstruction.

Chauhan *et al.* (1998) successfully used avascular intestinal segment to replace esophageal defect in dogs.

2.3. Review of literature on skin flaps and clinical review

Skin flaps from the forehead and cheeks were used by Indian surgeons more than 2000 years ago, principally in the operation of rhinoplasty and the operation described in the Susruta and Sanhita (Kaviraj Kunjalial Bhisragratna, 1907-1916; Withington, 1894, Garrison, 1929; and Kosh, 1941).

Halstead (1896) first reported the staged transfer of flaps and described the process as "waltzing of flaps".

Filatow (1917) was the first human surgeon who made the first tubes pedicle graft and used it to reconstruct a lower eyelid.

Perthes (1917) and Blair (1921) reported that the risk of necrosis was diminished if a flap was "delayed" that is fashioned in two or more staged operations.

Celsus (Spencer, 1925) also described the use of flaps formed from tissues in the vicinity of the defect for repairing lesions of the ears, nose and lips.

Davis and Kitllowski (1931) stated that the degree of contraction is uniform in all directions and is independent of the site of the donor area and the age of the patient. They further quoted that the existence of static lesion in the skin is shown also by the fact that flaps contract, when they are freed from the pull of the surrounding skin and from attachments to deep structures.

Wallace and Learmouth (1946) succeeded in improving the circulation in flaps by heating the whole body and stated that it results in reflux dilatation of flap vessels, ultimately improving the circulation in flaps and hence, its viability.

Conway, Stark and Docktor (1949) reported hairgrowth to be an associated sign of circulatory adequacy in the elevated flap. They further reported good hair growth by day 12 in tube rabbits flaps, but stated that rate of hair growth was of little use when assessing flap survival in the early postoperative periods.

Hynes (1950) stated that the color of the flap may be altered by changes in posture, blue and white flaps are both due to arterial insufficiency. He further described that impaired circulation results in tissue anoxia, and may be followed by edema, intravascular clotting and necrosis.

Brown, Fryer and McDowell (1951a,b) has suggested the use of local flaps as a permanent pedicle blood supplying flap to augment the blood supply to viscera's.

Climo (1951) suggested that when a flap is being raised it is possible to judge accurately whether it can safely be transferred without delay by observing the color of the blood escaping from several dermal vessels. Constant red dermal bleeding from the edges of the flap is good evidence of an adequate circulation. He further stated that blue dermal bleeding, is evidence of a deficient venous return, and is an indication to stop raising the flap and return.

Wong (1951) reported good results by injecting heparin into the flap near its distal end to revascularise its overall circulation.

VonDeilen (1951) defined local flaps as those formed from tissues in immediate vicinity of the defect.

Moran (1952a,b) used an thoraco-abdominal pedicle skin flap to augment the blood supply of the heart in coronary disease in dogs.

Billiangham and Medawar (1955) stated that contraction process of natural repair of wound of skin notably plays a very important part in the healing of skin of the neck region.

Billiangham and Medawar (1955) showed in rabbits that the healing of full-thickness defects upto a certain size, is brought about by two distinct process: circulation a forced tissue movement that results in closure of the wound by the opposition of its original edges, and intussuception growth, a true increase in area of the skin brought about by the formation of new tissues upon or within the framework provided by preexisting tissues.

Gillman *et al.* (1955) stated that in healing of incised wound, epithelium is the first tissue to regenerate and bridge the gap. According to him. The epithelium becomes hyperplastic and invasive and only then 3-5 days after injury is there evidence of fibroblastic proliferation. Blood and tissue fluid in the wound seem to play no role rather than. A protective one and the transected dermis also contribute little or nothing to the process of repair.

Conway and Griffith (1957) investigated the possibility of using skin flaps to provide an alternative blood supply to kidneys in dogs.

Woodruff (1960) had defined skin flap or pedicle flap as a portion of skin or subcutaneous fat which has been raised from the underlying tissues, but which remains connected at some part of its periphery to the donor site by a pedicle containing vessels. He further defined local skin flaps as a flap that is derived from the tissues in immediate vicinity of the defect.

Woodruff (1960) has elaborated the general principles governing the use of flaps: he stated that in reconstructive operations in which flaps are used there are five principles of paramount importance, which must be observed, viz.,

Firstly, the flap must fit into the defect accurately without undue tension, secondly, the flap must at all times have an adequate blood supply, thirdly, infection must be kept to a minimum, fourthly, the part must be effectively immobilized and fifthly, any secondary defect created in the donor area must be repaired.

He has further elaborated the main indications for using flap, which are as follows:

1. when it is necessary to transplant subcutaneous fat as well as skin for e.g., to cover tendons.
2. when there is defect of both mucous membrane and skin e.g., lined flaps used in coetaneous oesophagoplasty.
3. when skin replacement is to be followed by operation on bones, tendons or nerves.
4. for repairing weight bearing areas, notably the sole of the foot.
5. When it is impossible to prepare a bed capable of providing quickly for the nutrition of a free graft.

Meyes (1964) observed excessive wound tension to be one cause of flap necrosis. He stated that this necrosis occurs as a result to circulatory compromise and that wound tension retards wound healing. It was also observed that skin wounds, under marked tension in dogs often separated, although no sloughing occurred if the circulation was maintained.

Myers and Cherry (1968) stated that complete arterial or venous compromise to a flap causes necrosis. Pure arterial obstruction caused pale flaps in rabbits without obvious signs of necrosis for over 3 days. Pure venous obstruction resulted in venous engorgement, ecchymosis and cyanosis within 24 hours with variable degree of necrosis.

Grabb and Smith (1973) used pedicle grafts to cover defects with poor vascularity areas difficult to immobilize, holes overlying cavities, and area where padding and durability are essential.

Cohen (1974) found ischemia to be an important factor in revascularisation of skin flaps. He further noted greatest functional changes in the ischemic areas.

Cawley and Archibald (1974) observed that loose, elastic skin over the head, neck and trunk of the dog permitted its mobilization for easy wound closure.

Reinisch (1974) stated that flap survival is also influenced by the integrity of non-adrenergic control over flap microcirculaton.

Sympathetic denervation during flap construction may cause arteriovenous anastamosis to open, shunting blood away from the distal end of the flap. He further stated that careful surgical dissection minimizes vascular trauma, and helps to optimize perfusion to the distal end of the skin flap.

Grabb and Meyer (1975) observed flaps properly developed survive because of their intact circulation. They further stated that flaps necrosis results from infection, toxic agents an inadequate blood supply.

Converse (1977) has defined a pedicle graft (skin flap) as a portion of skin and subcutaneous tissue with a vascular attachment moved from one area of body to another. According to him the word flap denotes a tongue of tissue whereas the term pedicle denotes its base or stem.

McKeever and Braden (1978) stated that the stabilisation of skingraft and skin flaps is very important for the survival. During the first few hours after transplantation, stabilisation is provided by a fibrin network that serves the graft or the flap to the recipient bed. Revascularisation charecterised by invasion of endothelial buds into the graft proceeds if the graft or flap becomes bound to the recipient bed. They stated that stabilisation of the skin graft and flap is commonly disturbed due to graft or flap movement, due to inadequate fixation or bandaging, infection or haematoma formation. Haematoma formation is the most common complication.

Braden (1979) stated that when the wound is too large to close with tension sutures with stints, but not large enough to warrant a rotation or sliding flap, extensive undermining can often mobilise sufficient skin to relieve the tension. As a general rule the distance of undermining on each side of the wound should equal the wound opening. If the skin edges still cannot be approximated and closed, the undermining distance can be extended by another 50 percent.

Finseth, Zimmerman and Liggins (1979) reported that increasing the width of the pedicle flap doesn't increase its total survival length. They further stated that flaps created under the same conditions of blood supply survive to the same length regardless of flap width. It was found that increasing the width of the pedicle flap only permits the chance of including direct coetaneous vessels in the flap.

Mulliken and Healey (1979) observed underlying haematoma as a cause of flap necrosis from pressure generated beneath the flap. Evacuation of the haematoma within 12 hours of its formation improved flap survival in rats.

Tsur, Daniller and Strauch (1980) found that revascularisation is sufficient to maintain the skin flap by 6 or 7 days in rats and 4 to 5 days in pigs. They further stated that revascularisation from the wound bed was of greater importance than the wound edges was found that beds with a high vascular density vascularise a flap more rapidly. Especially ischemic areas of the flap.

Young (1980) studied revascularisation of pedicle skin flaps in pigs and found that the inherent vascular supply immediately after the procedure of flap elevation was insufficient to maintain flap viability. He noted vascular growth in ischemic areas of swine flaps 3-4 days after surgery and found that the whole flap had a collateral blood supply in 7-10 days.

Swaim (1980) stated that careful planning and meticulous, atraumatic surgical techniques are necessary to prevent excessive tension, kinking, pressure, haematoma, circulatory compromise and infection of the flap. He further emphasised the use of polygalactin, polypropylene and polymerised caprolactum sutures in closing contaminated and infected wounds in small animals. He stated that the breakdown product of these sutures may have some bacteriostatic properties.

Pavletic (1980) stated that flap survival was dependent on the deep subdermal plexus entering the base of the flap. He further quoted that the subdermal plexus in the dog was fed by terminal branches of direct coetaneous arteries, both of which are associated with the panniculous muscle layers.

Swaim (1980) classified local skin flaps into rotational, transposition single pedicle advancement, bipedicle advancement and subcutaneous pedicle flap. He further stated that a short wide flap has a good blood supply but limited motility. But a long, narrow flap has good motility.

Swaim (1980) and Pavletic (1983) stated that single pedicle advancement flap (sliding flap) is probably the most common flap used in veterinary practice because of its simple design and doesn't create a secondary defect requiring closure. They further stated that paired single pedicle advancement flaps could be employed to Close Square or rectangular defects, resulting in an H-closure.

Sasaki and Pang (1981) stated that the release of prostaglandin's from traumatized cells can cause vasoconstriction and thrombus formation which effect the viability of the skin flap.

Pavletic (1981) and Pavletic *et al.* (1982) stated that subjective assessment of the flap viability could be noted by observing the color of the skin. Hey further stated that portions of flaps with severe circulatory compromise pass through changes in color: from red (inflammation), to lavender, to deep purple and finally to black after 1 to 6 days.

Pavletic (1981) stated that canine flap necrosis was not visually apparent for 5-6 days and found that a minimum of 1 week was required to determine whether all portions of a flap survived.

Kerrigen and Daniel (1983) stated that digital pressure and blanching of the skin with color returning within 4 seconds use as a primitive test to evaluate flap circulation in man couldn't be practically applied for the skin of dog as the later doesn't readily blanch.

Pavletic and Peyton (1983) stated that infection was more likely to occur in tissues with poor circulation resulting to flap necrosis and non-viability.

Kerrigen and Danial (1983) had observed acidosis, increased glucose consumption, changes in cellular enzymes of inter-medially metabolism, and a shift to anaerobic metabolism in ischemic skin flaps.

Cohen, Harmon and Phizackerley (1983) stated that the fate of a skin flap is determined by the ability of its circulation to meet the metabolic needs of the tissues.

Pavletic (1983) reported that local flaps were the most practical method of closing defects, which could not be approximated by simple undermining and suturing. He also stated that the effective use of the local flaps is dependent on forming a flap in a neighboring area where loose, elastic skin prevails. Local flaps are both simple, economical and are more able to maintain a similar pattern of hair growth and color than distant flaps.

Kerrigen and Daniel (1983) stated that temperature measurements of skin flaps are necessary to accurately assess the flap circulation. They further stated that bleeding along the skin margins was considered a desirable intraoperative clinical sign of adequate flap circulation but it did not gave any information about the venous return.

Pavletic (1983) recommended the use of flaps with base wider than the width of the flap body to avoid inadvertent narrowing of pedicle. He further emphasized on avoiding tension over to recipient bed.

Kerrigen and Daniel (1983) stated that color; warmth, pain sensation and bleeding are used to assess the viability of damaged skin.

Pavletic (1985) stated that the multiple factors that contribute to poor circulation of flap underscore the importance of atraumatic surgical technique, asepsis, haemostasis and careful planning of the flap transfer. Surgical trauma and unnecessary division of the coetaneous vascular formation, infection and improper postoperative bandaging techniques all have a cumulative negative effect on flap survivability.

Pang *et al.* (1986) reported that the tissue ischemia and necrosis in the distal portion of the skin flaps resulted from arteriolar vasoconstriction mediated by neurohormonal substance released from raising the skin flaps.

Kostolisch and Pavletic (1987) stated that distal flap necrosis associated with axial flap use in canines can be minimized by decreasing the flap length.

Trevor *et al.* (1992) reported the clinical use of axial pattern flaps in dogs and cats. 19 axial pattern flaps were used in 16 dogs and cats to provide skin for repair of extensive coetaneous defects. They found post-operative drainage was the most common complication (n=15), followed by partial dehiscence of the sutured flap (n=7), distal flap necrosis (n=6), infection (n=3), edema (n=3), and seroma formation (n=2). They stated that judicious placement of Penrose drains aided in prevention of seroma formation. Edema related to compromise venous and lymphatic drainage in skin flap was managed conservatively with warm compress and local hydrotherapy. Partial dehiscence of sutured flaps was attributed to excessive tension on the incisional lines. They further showed that wound dehiscence could be managed by the additional placement of the sutures and found that the dehiscence involved small area of the sutured incisions and healed by contraction and epithelization with no apparent effect on flap survival. They also observed that distal flap necrosis was another frequent problem related to inadequate blood supply. Mild to moderate serosanguinous or purulent drainage for 3-8 days following surgery was observed. Seroma formation was also observed in only 2 flaps, lasting 3-7 days. Edema resolved in 6-8 days. In each case, the dehiscence involved only a small portion of the total incisional length. Conservative treatment with topical wound cleansing resulted in healing by second intention in all wounds. The surviving skin was full thickness, with normal or near normal hair growth.

Hinchkliff *et al.* (1992) studied the relationship between the pedicle width and viable length in ponies. Four dorsally based pedicle type skin flaps of 20cm length and 3,6,9,12 cm in width were created in a random sequence on one flank in each of 10 ponies. Skin texture and appearance, depletion of hair and wound healing at 14 days after surgery, assessed flap survival length. There was considerable variation between animals in the viable length of flaps of the same width; however a significant difference in the viable length of flaps of different widths was detected. The viable length of the 3cm flaps was significantly different from that of the 12cm flaps. There was positive correlation between flap width and viable length. It was concluded that there is a significant relationship between flap width and viable length.

2.4. Review of literature on anaesthetic and surgical stress

Charles (1963) sited Hoch-Ligeti (1953), that a study was conducted on the changes occurring in the plasma protein and blood sugar levels of humans after various surgical operations. In 45 patients, one-third showed a decrease in albumin levels and an increase in the blood sugar and globulin concentrations during the first 24 hours after surgery. Similar changes were present in 80% of all surgical cases during the following 4 post-operative days. After the 5^{th} post-operative day the levels of the serum protein and blood sugar levels tended to return to the pre-operative levels and no significant variations were observed.

Charles (1963) stated that the serum glycoproteins have been found to change under conditions of injury and stress. He further cited the findings of Pariera *et al.* (1960) that decreases in the serum total protein levels were evident in rats and dogs due to hemorrhage.

Doxey (1966) presented the normal average hematological values and range of variation in normal healthy adult dogs. He further stated that a regenerative lift shift or increase in immature neutrophils occur mainly during infection and inflammatory conditions.

Hume (1969) reported that the plasma protein levels decline after injury and this is primarily reflected in albumin fraction.

Clarke (1970) reported that the hyperglycemia response to surgery was related to its duration and the extent of its stress.

Maclaren and Pallet (1970) observed that the protein energy malnutrition resulted lowered blood glucose concentration.

Gupta (1973) studied with progressive alteration in some blood biochemical parameters in chronic protein malnutrition.

Choles (1974) and Sastry (1989) stated that leukocytosis due to neutrophilia occurs in conditions where there is corticosteroids release in states of stress, pain, anesthesia, trauma, and surgical manipulation.

Schalm *et al.* (1975) stated that the stress in several forms alters the total plasma protein concentrations. Hemorrhage leads to loss of plasma proteins and reduced blood volume. Local vascular changes responsible for the signs of inflammation leads to loss of protein into tissue fluids in tissue injury. Albumin is the most abundant of the plasma proteins. It is the protein to be lost from the blood during tissue injury.

Stephenson *et al.* (1978) anaesthetized 17 dogs (4-7) years with a mixture of xylazine (2mg/kg IM) and ketamine (5.5mg/kg IM) given 15 minutes after atropine sulfate (0.24mg/kg IM) on 52 occasions. The study revealed that the dogs reached the required plane of anesthesia after 10 minutes and remained sedated for a further 30 minutes. Recovery was complete within 1-2 hours.

Anthony *et al.* (1979) studied that there is a specific protein sparing effect of insulin in catabolic patients that is independent of the nature of the energy sources.

Panwar and Kathuria (1979) showed the normal biochemical value of blood of healthy dogs.

Woolfsen *et al.* (1979) reported that the rise of blood glucose level due to traumatic and anaesthetic stress effecting hormonal imbalance.

Moreina *et al.* (1980) used a solution of xylazine hydrochloride in two groups of 20 clinically healthy mongrel dogs. Group1 received 4mg/kg.b.wt.IM route. Groupe2 received 2mg/kg.b.wt.IV route followed after 10 minutes by 4mg/kg.b.wt.IM. There was no excitation although 7 in group1 and 2 in group 2 vomited. Rectal temperature, pulse rate and respiratory rate fell but there was slight reduction in palpebral, corneal, photophobia, laryngotracheal, anal, and interdigital refluxes.

Tvedten (1981) stated that stress- steroid patterns are one of the most common hematological findings in canine patients. The expected pattern is leukocytosis, neutrophilia, lymphopenia, and monocytosis.

Majumdar and Ghosh (1983) observed that the depression of blood glucose, in case of vitamin A deficiency.

Dass *et al.* (1983) performed laparotomy in buffalo calves and observed a gradual fall in serum total protein upto 96 hours.

Sharma *et al.* (1983) concluded that IM administration of xylazine at 0.15mg/kg.b.wt in atropine (0.02mg/kg) premedication and thiopentone sodium induced anesthesia in dogs caused a slight decrease in heart and respiratory rate, mean arterial blood pressure and body temperature, hematological changes included decrease in TLC and TEC, Hb% and PCV. Neutrophilia with corresponding lymphocytopenia was observed at maximum depth of anesthesia.

Benson *et al.* (1984) stated that the relaxation of all body muscles during anesthesia might also lower the utilization of glucose at tissue level leading to hyperglycemia.

Lele and Bhokre (1985) concluded that xylazine anesthesia alone and in combination with the preanaesthetic procedures significant depression of respiratory rate and heart rate with inconsistent effect on blood pressure. The rectal temperature slightly elevated in the beginning followed by a slight decrease. No significant influence on BUN and blood glucose level was observed.

Gopalan *et al.* (1985) analyzed blood samples of groups of 6 dogs given xylazine IV, IM or SC and compared with blood of saline injected controls. Xylazine caused a reduction in PCV, which was greatest when given SC. Blood glucose levels increased with all routes of injection, and the eosinophil count was higher with IV and SC injections.

Agarwal and Kumar (1985) reported that in a healthy subject, the biochemical constituents are usually maintained without normal limits. Changes in these limits as a response to trauma are feasible.

Singh and Kumar (1992) reported about surgical stress, showed higher increase in urea nitrogen, glucose, serum creatinine, cholesterol, serum potassium, globulin and decrease in total protein, albumin, serum sodium and chloride levels in buffaloes at various intervals after operation.

Varshney *et al.* (1992) observed a fall in total protein after caesarian section in cow upto 5th to 7th postoperative day. They suggested that the fall in serum protein level might be due to negative nitrogen balance produced after surgery.

Saxena and Madan (1997) stated the pathological stress could be due to a various reasons like surgical stress, vaccination stress, stress of hospitalization and stress due to systemic diseases.

CHAPTER III

MATERIALS & METHODS

MATERIALS and METHODS

3.1. MATERIALS

3.1.1. SELECTION AND GROUPING OF ANIMALS

In the present experimental model a total number of nine clinically healthy adult mongrel dogs of either sex, weighing about 12 to 15 kg each were utilised. These dogs were obtained from local procurement facilities and were maintained in the (Surgery & Radiology) Department of the university.

Before launching the experiments, these experimental animals were housed in the animal house for 3 weeks, with a view to acclimatise them in the environment and pre-experimental check-up of their health including routine physical examinations done regularly. Scheduled deworming were also done.

Necessary routine clinical as well as laboratory examination of the blood, stool, etc. was done and minor defects detected in them were rectified.

Among all these animals, 6 apparently healthy mongrel dogs of either sex were placed in Group-A and were randomly subdivided into subgroups i.e., AI and AII consisting of three females and three males in each sub-group. The animals in the first sub-group i.e., sub-group AI were numbered 1, 2, 3 and the animals in the second sub-group AII were numbered 4, 5, and 6. The animals of Group-A served the purpose of experiment. The rest of the animals belonging to the second group i.e., Group-B were numbered 7, 8, and 9 and were used as Sham-operated control.

Similar methodology was followed in all the animals of Group-A and Group-B for clinical, haematological, biochemical studies. Radiological studies were done only for the animals of the Group-A.

3.1.2. Drugs and Appliances

3.1.2.1. Pre anaesthetic and anaesthetic agents

1. Injection Atropine Sulphate-1ml ampoule containing Atropine Sulphate equivalent to 0.65mg atropine per ml [Bengal Immunity].
2. Injection Xylazine- 2ml vials containing xylazine hydrochloride 23.32mg/ml [Indian Immunologicals].
3. Injection Xylocaine 2%-30ml vial containing 2% lignocaine hydrochloride - [Astra IDL- Banglore].
4. Xylocaine jelly 2%-30gm Jelly [Astra-IDL, Banglore].

3.1.2. 2. Medicaments

1. Injection Conflox 5%- 30ml vial
2. Injection Avil-10ml vials containing Pheniramine maleate equivalent to 22.7mg/ml [Biomedica].
3. Injection Zobid-30ml vials containing Diclofenac sodium equivalent to25mg/ml [Sarabhai].
4. Injection Decdan-2ml vials containing Dexamethasone sodium phosphate 4mg/ml [Merind].

5. Injection Corapram-5ml vials containing Doxapram equivalent to 20mg/5ml. [Kandelwal Lab. LTD; Mumbai].
6. Injection Deriphylin-2ml ampoule containing Etophylin, 169.4mg, Theophylin 50.6mg per 2ml of each [German Remedies].
7. Injection Adrenalin-1ml ampoule containing Adrenaline bitarterate 1.8mg, sod.metabisulphate 0.1mgv/v, sod.chloride 8mg,per ml [P&Blab].
8. Injection Polybion-2ml ampoule containing all B-complex vitamins per 2ml [E. Merck].
9. Injection Livogen-10ml vials containing B-complex vitamins [Glaxo].
10. Injection Ringer's Lactate-540ml bottles [Albert David].
11. Injection Dextrose saline-5%; 10%-500ml bottle [Albert David].
12. Injection Normal saline-500ml bottles [Albert David].
13. Betadine liquid 5%-100ml bottle [Wockhardt].
14. Cetrimide solution 20%w/v-75ml bottle [ICI].
15. Liquid Dettol-100ml bottle [Reckitts].
16. Spirit of Ether.
17. Nebasulf powder-10g powders [Pfizer Ind Ltd].
18. Soframycin skin cream-20gm cream [HMR].
19. Ca-EDTA.

3.1.2 3. Suture Materials

1. 3-0 Coated Vicryl violet braided, Ethicon.
2. 2-0 Ethibond green braided, (polyester suture),Ethicon.
3. 3-0 Ethilon monofilament, Ethicon.

3.1.2.4. Accessories

Routine Surgical Instruments:- During operation the following sets of instruments and surgical sundries, all previously sterilised, were kept ready for usage:-

1. Bard Parker operating knife # 3 & # 4 with corresponding blade sizes 10,15 and 20 22 respectively.
2. Backhaus towel clamps- 12Nos
3. Allies tissue forceps (6")- 8Nos
4. Thumb forceps with teethes 4:3 (6")- 2Nos
5. Dissecting forceps (6")- 2Nos
6. Lahey haemostat forceps (a) straight (6")- 8Nos
   (b) Curved (6")- 8Nos
7. Halsted mosquito forceps (a) straight (4")- 6Nos
   (b) Curved (4")- 6Nos
9. Foerster straight sponge forceps (10")- 1Nos
10. Mayo-Hegar needle holder (6")- 2Nos
11. Stitch cutting scissors (4")- 2Nos
12. Metzenbaum scissors (a) straight- 1Nos
    (b) Curved- 1Nos
14. Operating scissors (a) with both ends pointed (i) straight- 1Nos
15. Lister bandage scissors- 1Nos
16. Kidney trays- 3Nos
17. Suturing needles (a) Traumatic (straight and curved)- 2Nos
    (b) Atraumatic (curved)- 2Nos
18. Sterile rubber and polyethylene tubes
19. Sterile drapes, window clothes, large hand towels
20. Sterile operating gowns

Fig.No: 1.0.Displaying routine surgical set of instruments with necessary medicaments and appliances.

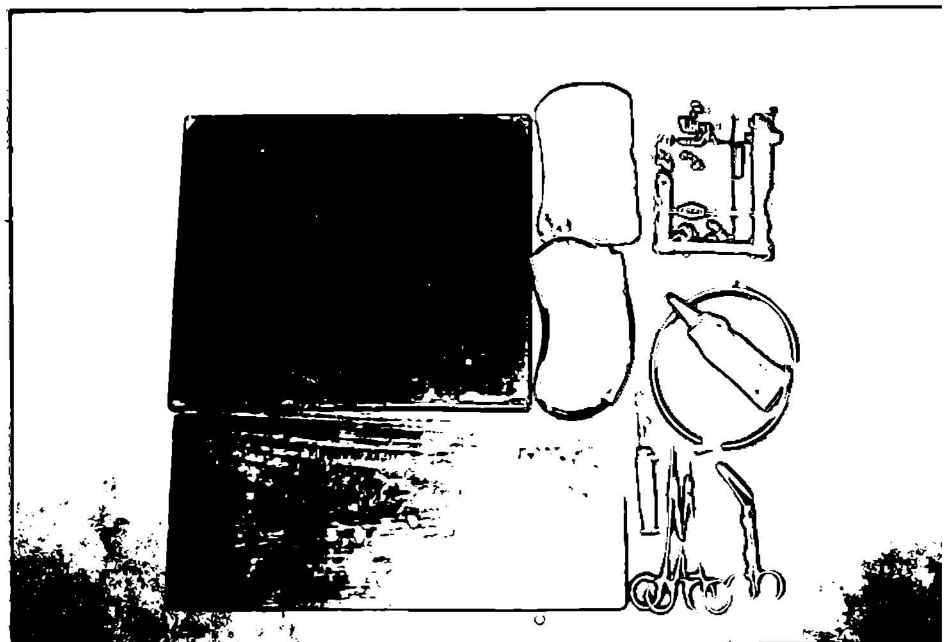


Fig.No.1.1Displaying materials used in contrast radiographic study.

21. Sterile hand gloves 6½ and 7½
22. Sterile gauges
23. Rolled bandages 5cm, 7.5cm, 10cm etc
24. Absorbant cotton-1 role
25. Sofratulle-1pkt
26. Surgipad (10cmx10cm)-1pkt
27. Disposable syringes-1ml, 2ml, 5ml, 20ml, 50ml etc
28. Sterile hypodermic needles 16G, 18G, 20G, 22Getc
29. Leucoplast adhesive tape-(10cmx5m)
30. Hair clippers and shaving blades
31. Saline sets and scalpvein sets (22G, 24G)
32. Blood collection vials and serum vials.

3.2. Methods

3.2.1. Standardisation of the technique

No earlier reference of any work of the type undertaken in present study was available from the literature in this field excepting the work done by Bircher (1894), Mickulicz(1886), and Miyamoto *et al.* (1984) in humans and Pavletic (1992), in canines. These however, differed materially from the present work. As such author was obliged to depend in certain areas of his work on arbitrary decisions based on the published work in the close proximity. The technique developed and followed, had therefore, to be practised on two adult mongrel dogs with a view to attaining proficiency in the application of the technique on actual experimental animals to avoid error.

3.2.2. Design of the experiment

Each experimental animal of the first group i.e., Group-A served as a complete unit of study in respect of construction of antecervical skin tube. In all the experimental animals of Group-A inverse skin tube was constructed on the ventral cervical area using local autologous skin flaps without transferring cutaneous tissues from other places.

The animals of the Sham-operated control group i.e., Group-B were subjected to minor surgical intervention by making a single longitudinal incision on the ventral aspect of the neck region for comparing the healing status with that of the experimental group.

Routine post-operative care, management and observations were followed, as per schedule in all the animals. After the operation each individual animal was closely observed for clinical, haematological, biochemical and radiological studies upto the period of 90 days postoperative. Radiological studies were done only for animals of Group-A (Experimental group) to assess the process of complete healing, patency and occurrence of stricture or stenosis, if any in each animal.

3.3. Construction of antecervical skin tube

The construction of the inverse-skin tube is the most important part of this study. The skin tube was constructed keeping the idea in mind, that food and liquid shall be by-passed directly from the pharynx or proximal oesophagus and enter into the stomach or the small bowel via the skin tube. Thus, the skin tube would act as a neo-oesophagus.

3.3.1. Preoperative considerations

Routine preoperative preparation of all the experimental animals were carried out prior to the day of operation and just before the operation.

3.3.2. Prior to the day of operation

Besides routine clinical check up and consultation of the laboratory reports in the pre-surgery phase of each experimental animal, routine skin preparation of the ventral cervical (neck) area was conducted on the previous day of surgery. Besides skin preparation, food and water were with held for 24 hours and 12 hours respectively before each surgical procedure in each animal.

3.3.3. Preparation of the animal just before the operation

The area of the radial vein was cleanly shaved to facilitate the collection of blood samples for examination and administration of necessary drugs.

The ventral cervical neck area was once again prepared aseptically and covered with drapes in all animals.

The animal was carefully restrained and then placed in dorsal recumbence (supine position) on the operation table with the neck in an extended position for non-distorted development of the local skin flap. The forelimbs were extended posteriorly towards the trunck of the animal, tied and fixed with the operation table. The site of operation was finally prepared for the surgical procedure with 70% alcohol and betadine solution.

Before administration of drugs, related physical parameters, viz., (temperature, pulse rate, and respiratory rate) were recorded and blood samples were taken after placing the animal in lateral recumbence for haematological and biochemical studies.

3.3.4. Pre-anaesthetic medication

This was done by subcutaneous injection of atropine sulphate @ 0.06mg/kg.b.wt in all the animals.

3.3.5. Anaesthetic procedure

After 10 minutes of administration of preanaesthetic injection xylazine hydrochloride @ 1mg/kg.b.wt was administered by intramuscular route.

The animal was placed on its back (supine position) and the neck secured to the operation table in an extended position and simultaneously 10 ml of lignocaine hydrochloride @ 1ml/2cm area, was infiltrated subcutaneously by linear infiltration in the proposed line of incision at the ventral cervical neck region.

The entire animal was wrapped with a drape and finally another drape was fixed at the operation site prior to necessary surgical intervention. The drapes were fixed in position with Backhaus towel clamps. Final cleaning of the operative area was done and it was painted with betadine solution and allowed to dry.

3.3.6. Operative procedure

The operative procedure was followed as described by Bircher (1894) in partial modifications. The operation was started 10 minutes after the administration of anaesthetic drug combination. A lined flap, one which had epithelium on its deeper surface as well as on its superficial surface was constructed by folding part of the autologous skin flap on itself.

The skin canal, which was the most important part of this construction, was created using the local skin of the cervical region without transferring cutaneous tissues from other places.

Two parallel, longitudinal incisions about 3 to 5 cm apart were made on the mid-ventral neck region and extended just to the left of the mid-line while moving posteriorly towards the pectoral region, keeping the incisions in a straight line. A ratio of 2:1 was kept fixed between the base of the flap remaining attached with the dermal bed for maintenance of effective circulation and the edges of the flap which were elevated and folded back to form the skin tube. The incisions were linked at the proximal and distal ends by horizontal incisions; so as to form a rectangular skin flap. The edges of the skin flap were thus isolated without disturbing the attachment of its central part, as because the blood supply to the skin canal was mainly supplied through the subdermal perforating vessels of the central part. The skin canal was thus created by approximating the skin edges of the flap with one layer of inverted simple interrupted sutures of 3-0 coated vicryl (polyglactin 910). The skin lateral to the flaps on each side was mobilised with out much undermining and their margins were sutured together by vertical mattress sutures so as to cover the raw surface and to bury the tube. Before covering the raw dermal surface of the so formed inverted skin tube with the lateral flaps, some 3 to 4 anchoring sutures of vertical mattress type were preplaced between the raw dermal layer of the inverted skin tube wall and the overlying lateral skin flaps and finally tied externally over the wall of the lateral flaps on either sides. This technique was developed and adopted by the author that helped to obliterate the dead space formed between the inverted skin tube walls and the overlying lateral skin flaps. It also helped to completely immobilise the lateral flaps from the recipient bed and succeeded in 100% "take" of the flaps. Inorder, to maintain the patency of the skin tube, a rubber tube was introduced into the skin canal and kept *in situ* by fixing its upper and lower ends with the respective ends of the skin tube wall by plain interrupted sutures in all the animals of the Group-A.

A single longitudinal incision was made in a similar fashion on the ventral aspect of the neck region and the wound edges were sutured in a routine manner for animals of Sham-operated control group (Group-B).

Intraoperative studies with respect to the length of incisions, length and breadth of the skin flap, biometry of the skin tube with respect to its length, and diameter, area of the skin flap, duration of operation, extent of haemorrhage, were considered and recorded in all the animals of Group-A

Plate No: 1.2 to 2.6 shows different steps of operative procedure.

3.3.7. Post operative care, management and treatment

After the operation animals were transferred to the observation room. A protective dressing was applied over the wound area and all the four paws of all the animals were well padded so as to avoid self-inflicted injury to the operative site. The animals were muzzled and kept under strict observation.

The animals were treated with Conflox injection @ 5mg/kg.b.wt. Intramuscularly once daily for 5 consecutive days. Diclofenac sodium was injected deep intramuscularly @ 1mg/kg.b.wt/day/animal for 3 consecutive days.

Routine post-operative dressing of the wound of all the animals were followed on the 3^{rd}, 5^{th}, and 7^{th} postoperative days, considering '0' day as the day of operation. The skin sutures were removed on the 10^{th} to 12^{th} postoperative day.

All the animals undergoing the operative procedure were observed for a period of 90 post-operative days and were kept in natural

Fig.No.1.2 Local infiltration of the operative site.

Fig.No.1.3Two parallel longitudinal incisions at the ventral neck region with measurements of the skin flap length.

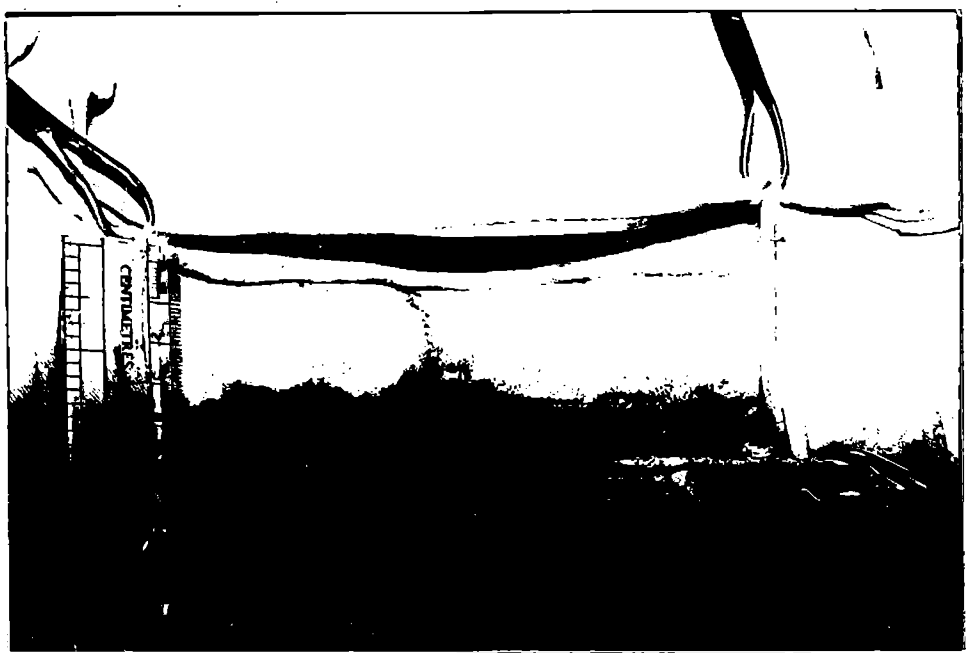


Fig.No.1.4 (a&b) Measurement of the width of the skin flap.

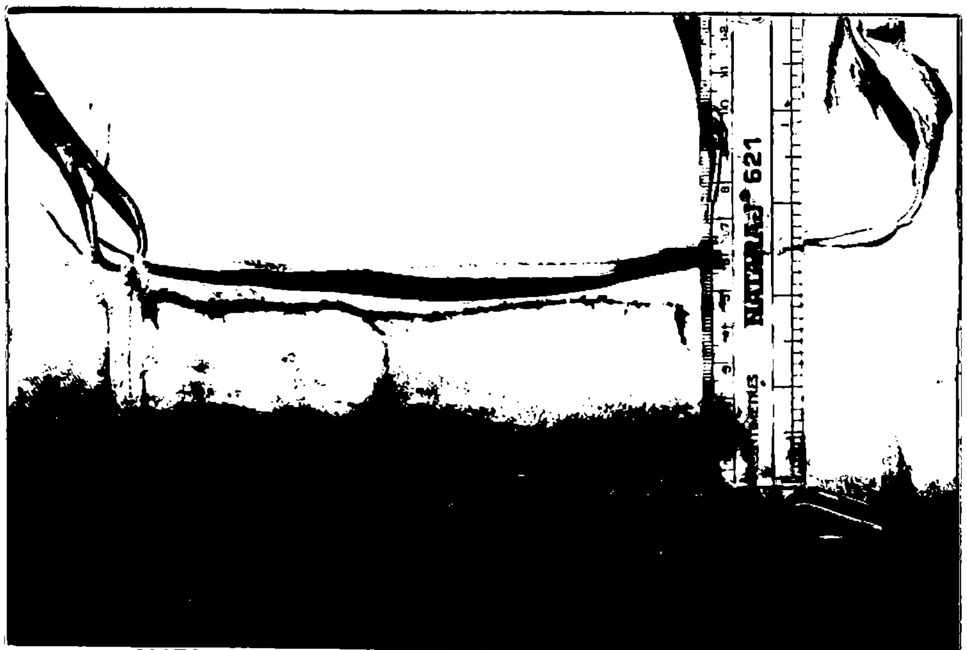


Fig.No.1.4 (a&b) Measurement of the width of the skin flap.

Fig.No1.5 Rectangular skin flap used for construction of inverse-skin tube with slight cut at the four corners.

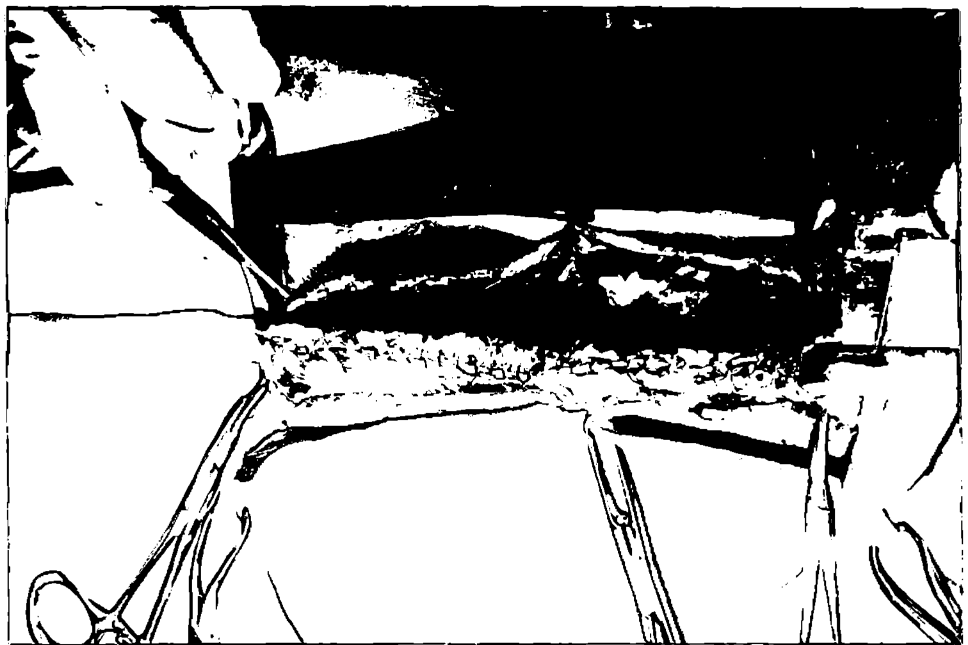


Fig.No.1.6.Skin tube constructed after rolling the two cut edges of the rectangular skin flap.

Fig.No.1.7Measumment of the length of the skin tube with polyethylene tube placed *in situ*.

Fig.No.1.8 (a&b) Measuring the diameter of the skin tube.

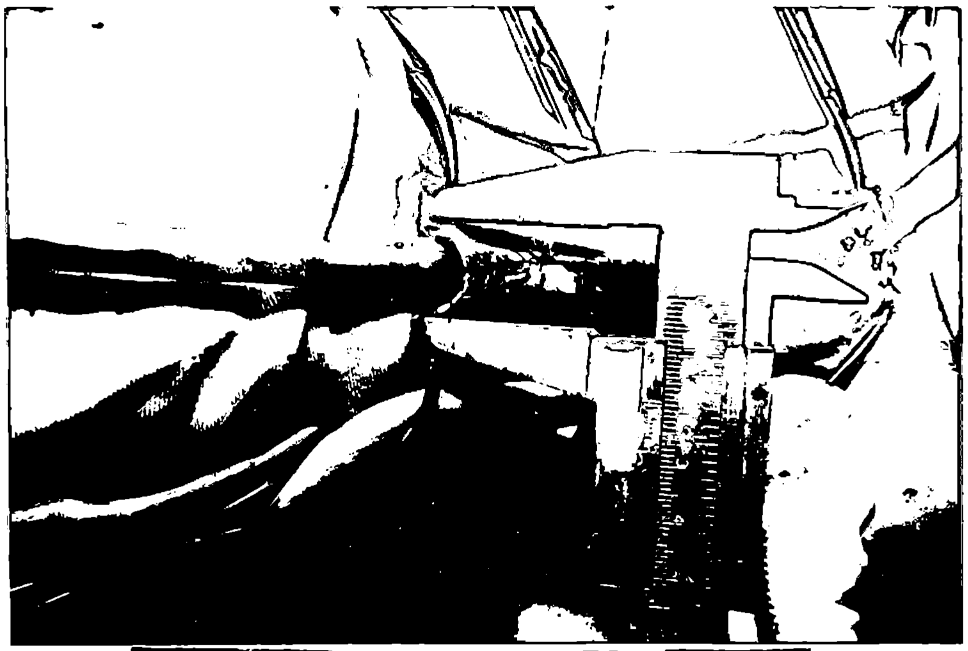


Fig.No.1.8 (a&b) Measuring the diameter of the skin tube.

Fig.No.1.9 (a&b) Starting placement of anchoring sutures of vertical mattress type.

Fig.No.1.9 (a&b) Starting placement of anchoring sutures of vertical mattress type.

Fig.No.2.0.Tying anchoring sutures outside the lateral skin flap.

Fig.No.2.1.Completion of anchoring sutures at right side of the lateral skin flap with left side in progress.

Fig.No.2.2.Completion of anchoring sutures of both sides of lateral skin flaps.

Fig.No.2.3. (a&b) Stage of burying and covering the skin tube.

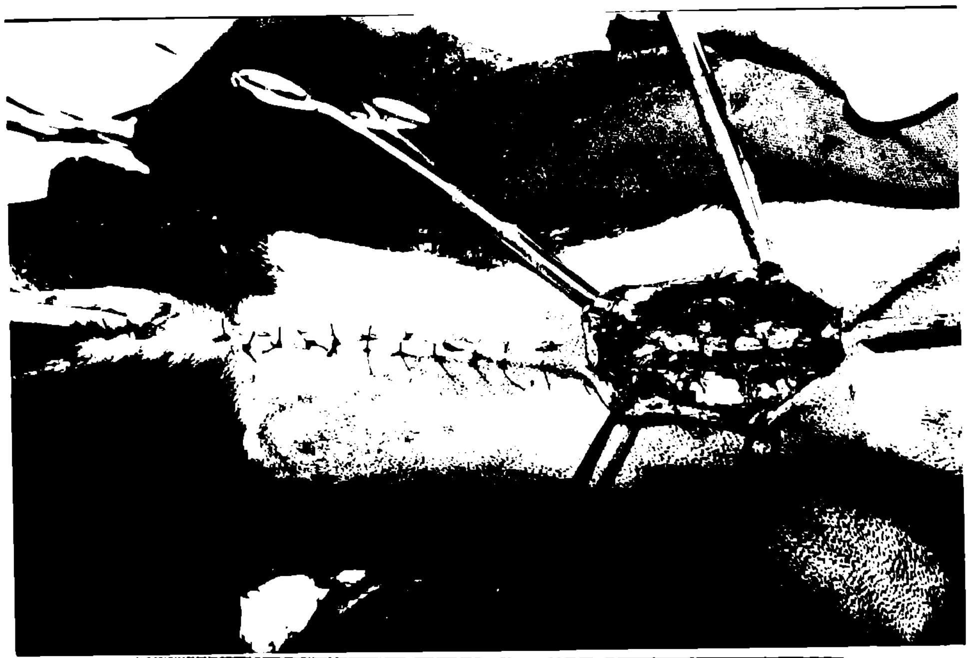


Fig No.2.3. (a&b) Stage of burying and covering the skin tube.

Fig.No.2.4.Underlying skin tube covered with lateral skin flaps with rubber catheter *in situ*.

Fig.No.2.5. Underlying skin tube covered with lateral skin flaps with polyethylene tube *in situ*

Fig.No.2.6. Measuring the length of constructed skin tube.

Fig.No.2.7.Measuring the length of the healed skin tube on the 10th postoperative day.

conditions with uniform standard diet and ample supply of drinking water.

For analysis of the selected parameters the following features were observed and evaluated in all the animals, which are outlined as below:

3.3.8. Clinical Examinations

3.3.8.1. Physical examination of the animals

This was done by recording the physiological parameters, which included rectal temperature (degree Fahrenheit), respiratory rate (per minute), pulse rate (per minute), upto a period of 90 days after operation at 0 day, 1st , 3rd, 5th, 7th, 10,th 20th, 30th, 60th, and 90th days interval. Physical status of health was also assured by supporting aids accordingly.

3.3.8.2. Local inflammatory reaction and healing of the wound

Swelling, seroma formation, haematoma, edema and associated signs of local inflammatory reactions were observed in all the animals from the day of operation, '0' day upto 90 days post-operation. The charges were evaluated by visual and manual examination. Patency of the healed skin tube, biometry of the healed skin tube, type of wound healing and complications of wound healing viz., wound dehiscence, exudation etc., were also noted, for all animals.

3.3.8.3. Haematological Examinations

3ml of blood were collected from radial vein in a test tube with anticoagulant [EDTA-0.1mg/ml] on each occasion and from each animal preoperatively and on days 0,1,3,5,7,10,20,30,60 and 90 postoperatively. Total erythrocyte count [TEC-10^6/cmm], total leukocyte count [TLC-10^3/cmm], differential leukocyte count [DLC-%], haemoglobin [Hb- gm%] were done prior to and after surgical operation. Estimation of TEC and TLC was done by using Neubauer Haemocytometer as described by Schalm *et al.* (1975). DLC were done by the method described by Schalm *et al.* (1975). Hb gm % was determined by using Sahli's haemoglobinometer as per acid haematin method of Schalm *et al.* (1975).

3.3.8.4. Biochemical Examinations

In each case, the following biochemical observations were made after collecting blood samples from all the animals 24 hours before surgery (preoperative day), 0 (day of operation), 24 hours after the end of surgery (1st posto perative day), and thereafter on the 3rd, 5th, 7th, 10th, 20th, 30th, 60th, and 90th post-operative days.

Biochemical evaluation was estimated by the method as follows: -

(a) serum total protein was estimated by Kjeldhal Nesslerization method as described by Varley (1988).
(b) serum total albumin was estimated by Kjeldhal Nesselerization method as described by Varley (1988).
(c) blood sugar level was estimated by Nelson Somogyl method as described by Oser (1965).

3.3.8.5. Radiological examinations

Contrast radiographic evaluation of the antecervical inverse skin tubes constructed in all the animals of Group-A was done with the help of 30% w/v Barium sulphate powder on 15^{th}, 30^{th}, 60^{th}, and 90^{th} postoperative days to access the process of wound healing, stenosis or stricture formation if any and in addition to also access the patency of the healed skin tubes. 15 to 20ml of barium sulphate suspension was prepared by mixing required quantity of barium sulphate powder mixed with water. Required quantity of the contrast media was then infused into the inverse-skin tube with the help of a rubber tube or catheter attached to a 20ml disposable syringe. Before introducing the contrast media into the skin canal one end of the skin tube was effectively plugged with cotton and after filling the skin tube with the contrast media, the other end was also plugged in a similar manner. Radiographs were taken in lateral positions.

The radiographic features were used as follows: 6mAS/60kvp/36"ffd.

3.3.8.6. Statistical analysis

The values of rectal temperature, pulse rate, respiration rate, TEC, TLC, DLC, Hb%, serum total protein, serum albumin, and blood sugar level were statistically analysed as described by (Snedecor and Cochran, 1967).

CHAPTER IV

OBSERVATIONS & RESULTS

OBSERVATIONS AND RESULTS

Results and observations of all the selected parameters as outlined in this study were presented in this chapter and detailed in their respective heads accordingly.

The selected parameters of study of animals in experimental group (Group-A) and Sham-operated control group (Group-B) with regard to clinical, hematological, biochemical findings was observed on individual cases. Radiological findings were done only for animals of group-A and not for the Sham-operated control group. The findings are recorded and presented in respective Tables No: from 1.0 to Table No: 1.7.

4.1. ANAESTHETIC STUDY

Injection of atropine sulfate at the dose rate of 0.06mg/kg.b.wt subcutaneously, 10 minutes before anesthesia acted as a pre-medication to anesthesia.

4.1.1. PHYSICAL CHARACTERITICS

After about 10 ±2 minutes of intramuscular injection of xylazine hydrochloride all the animals gradually developed sedation and became calm and quite. No excitation or other untoward effect was seen in any animal. But in animal no : 4 and 8 vomiting were seen. Linear infiltration of local anaesthetic solution (2% Lignocaine hydrochloride) on the proposed lines of incisions developed analgesia after 10±2 minutes of its administration. There was no sensation at the operative site and no pain feeling throughout the operative procedure was noticed. Profound sedation was observed for 10 to 45± minutes and it was found to be sufficient enough for constructing the cervical skin canal in all animals of group-A. All the animals remained calm and quite upto 55± minutes and after that they raised their head and recovered from anaesthetic stage.

The results are tabulated in Table No : 1.0

Table No: 1.0 Results of Anaesthetic Study.

Type of Anesthesia	Onset of Action (minutes)	Recovery Time (minutes)	Duration of action (minutes)	Complications
Atropine Sulfate @0.06mg/kg SC + Xylazine hydrochloride @/mg/kg.IM	10±2	55±5	45±5	Vomiting occurred in 2 cases Animal no: 4 and 8.

4.2. INTRA-OPERATIVE OBSERVATIONS

During the performance of operation in all the animals of the respective groups' necessary observations in respect to length of incisions, duration of operation, extent of hemorrhage, post-operative complications and healing pattern of the wound revealed some important features. In addition, to the above features special intraoperative observations were made in respect to the length and breadth of the skin flap, area of the skin flap (length x breadth), biometry of the skin tube (both length and diameter of the skin tube) in all the experimental animals of group-A.

The average length of incision was 16.9 cm in animals of group-A and 14.0 cm in animals of the group-B. The average length and breadth of the skin flap were 16.9cm and 4.25cm in the experimental animals belonging to group-A respectively. Biometry of the skin tube constructed in the group-A animals revealed that the average length of the skin tube was 15.00cm and its average diameter was 2.50cm respectively. The average area of the skin flap was found to be 71.82 sq.cm. In animals of the experimental group i.e., Group-A there was no difficulty in keeping the two incisions parallel to each other and in a straight line over the ventral cervical area. The skin flaps could be very easily elevated without much undermining. In all the animals of group-A, the inverse skin tube was constructed without any difficulty. No major hemorrhage was observed in any case. Average duration of operation was 30± minutes in all the animals of experimental group (Group-A). The operative results are tabulated in Table No : 1.1 .

Table No: 1.1 Results of Intra-operative Observations:

INTRA-OPERATIVE OBSERVATIONS	GROUP-A No: of animals: 6 Experimental	GROUP-B NO: of animals: 3 Control
1. Average length of incisions (cm)	16.9	14.0
2. Average length of skin flap (cm)	16.9	
3. Average breadth of skin flap (cm)	4.25	

4. Average area of the skin flap (sq.cm)	16.9x4.25 = 71.82	
5. Biometry of the skin tube (a) Average length of the skin tube (cm) (b) Average diameter of the skin tube(cm)	 15.11 2.56	
6. Extent of Haemorrhage	++	+
7. Average duration of operation (min)	30±5	15±5
8. Post-operative complications	Partial dehiscence of sutured flap in animal no:3.	None
9. Healing pattern	In all cases healing took place by 1st intention except in animal 3 where partial dehiscenc of sutured skin flap occurred at distal end.	Healing took place by first intention in all the cases.
10. Biometry of healed skin tube (cm) (a) Average Length of the healed skin tube (b) Average diameter of the healed skin tube	 15.00 2.5	

4.3. CLINICAL OBSERVATIONS DURING POST-OPERATIVE PERIOD

Eight out of nine experimental animals did not show any post-operative complications. No marked local inflammatory reactions were observed in both the experimental and control group of animal's upto 90 days post-operative. A little swelling was only visible at the operative site that reached maximum on the 5th post-operative day and thereafter, it subsided gradually and resolution took place within the 10th post-operative day. No marked haematoma, edema or seroma were observed on the operative site during the post-operative period. All the experimental animals of group-A tolerated well the construction of the inverse-skin tube satisfactorily. Excepting one case (animal no: 3), healing took place uneventfully by first intention in all cases and sutures were removed on the 10th post-operative day. In only animal no:3, partial dehiscence of the sutured skin flap occurred at the distal end and secondary closure was required. The precise post-operative treatment regimen obtained favorable results. The skin tubes healed up uneventfully and the patency was well maintained in all cases with 100 percent success upto the 90th post-operative day.

The animals of the control group did not elicit any pathological clinical finding. The physiological status of these animals did not varied beyond its normal physiological limit.

It was observed that the rectal temperature, pulse rate, and respiration rate in the pre- and post-operative stages of all the animals did not show any marked changes. The trend of lowering and elevation of the above parameters, in each instance did not affected much more than the normal range. (Table No: 1.2 and Table No: 1.3).

4.4. HAEMATOLOGICAL OBSERVATIONS

All the hematological parameters were observed prior to operation and upto 90th post-operative day in all the animals. The hematological picture (Table No: 1.4 and 1.5) in general did not show any marked difference in the total count of R.B.C., and W.B.C., differential leukocyte counts, and hemoglobin percentage from the corresponding pre-operative values in all the experimental animals. However, a slight increase in the total leukocyte count and neutrophil percentage was observed from the very first postoperative day and it remained slightly high from the normal value upto the 10th postoperative day. Maximum increased TLC and neutrophil percentage was observed on the 5th

TABLE NO. 1.2

Mean with SE of Temperature (oF), pulse rate (per minute), and respiration rate (per minute) of Experimental animals. Animal No: 1 to 6. GROUP – A

Parameters	Preoperative day	Post operative days									
		0 (on the day of operation)	1	3	5	7	10	20	30	60	90
Temperature (^{0}F)	101.3+/-0.91	101.3+/-0.17	101.8+/-0.60	102.2+/-0.64	101.3+/-0.31	101.9+/-023	101.4+/-0.24	101.2+/-0.11	101.3+/-0.07	101.3+/-0.07	101.3+/-0.08
Pulse Rate (per minute)	79.5+/-1.70	71.5+/-5.31	91.66+/-6.52	101.0+/-6.52	90.33+/-3.24	86.83+/-2.63	83.66+/-2.40	82.66+/-2:23	81.0+/-2.23	79.66+/-1.49	78.66+/-1.90
Respiration Rate (per minute)	19.33+/-0.66	17.16+/-0.90	37.16+/-9.23	38.83+/-6.95	30.66+/-5.46	24.33+/-1.89	21.00+/-1.03	20.5+/-0.80	21.5+/-0.34	21.66+/-0.33	20.33+/-0.33

TABLE NO. 1.3

Mean with SE of Temperature (oF), pulse rate (per minute), and respiration rate (per minute) of Control animals.
Animal No: 7, 8, 9. GROUP – B

Parameters	Preoperative day	Post operative days									
		0 (on the day of operation)	1	3	5	7	10	20	30	60	90
Temperature (^{0}F)	102.0+/-0.0333	102.0+/-0.33	101.1+/-0.05	100.7+/-0.35	101.6+/-0.30	101.7+/-0.35	101.3+/-0.14	101.3+/-0.20	101.3+/-0.15	101.33+/-0.03	101.6+/-0.11
Pulse Rate (per minute)	78.0+/-3.055	78.0+/-3.055	76.0+/-2.40	78.66+/-2.40	80.0+/-2.00	79.33+/-0.66	83.33+/-3.52	79.33+/-0.66	78.0+/-2.00	77.33+/-2.40	75.33+/-2.40
Respiration Rate (per minute)	21.0+/-0.577	20.33+/-0.33	21.33+/-0.66	23.33+/1.20	22.66+/-0.33	21.33+/-0.33	21.66+/-1.20	21.66+/-0.33	20.66+/-0.66	21.66+/-0.33	21.33+/-0.66

TABLE NO. 1.4

Mean with 'SE' of Haematological examination of experimental group of animals. Group –A (Animals No. 1 to 6)

Days	Neutrophils (%)	Lymphocytes (%)	Monocytes (%)	Eosinophils (%)	Hb (gm%)	W.B.C (x 10^3/cmm)	R.B.C (x 10^6/cmm)
Preoperative day	63.66 ±0.760	32.16 ±1.16	0.50 ±0.223	2.88 ±0.36	14.33 ±0.33	10.10 ±0.06	5.21 ±0.06
1st POD	66.5 ±1.20	29.83 ±0.54	1.00 ±0.36	2.66 ±0.42	14.00 ±0.45	10.14 ±0.055	5.05 ±0.05
3rd POD	68.33 ±1.05	28.66 ±0.61	0.5 ±0.22	2.55 ±0.5	13.76 ±0.42	10.30 ±0.054	5.03 ±0.07
5th POD	69.00 ±0.68	28.16 ±0.54	0.5 ±0.22	2.55 ±0.22	13.5 ±0.48	10.58 ±0.083	5.05 ±0.05
7th POD	68.33 ±1.30	28.5 ±0.95	0.86 ±0.33	2.55 ±0.22	13.9 ±0.43	10.44 ±0.049	5.15 ±0.07
10th POD	66.5 ±1.08	30.00 ±1.06	0.83 ±0.40	2.83 ±0.30	14.2 ±0.40	10.40 ±0.054	5.15 ±0.06
20th POD	64.83 ±1.32	31.5 ±0.92	0.66 ±0.21	2.66 ±0.42	14.21 ±0.42	10.20 ±0.05	5.15 ±0.06
30th POD	63.66 ±0.918	32.68 ±0.5163	0.50 ±0.233	2.68 ±0.25	14.28 ±0.41	10.15 ±0.055	5.15 ±0.04
60th POD	62.00 ±0.516	32.83 ±0.4013	0.60 ±0.21	2.98 ±0.34	14.6 ±0.22	10.11 ±0.045	5.21 ±0.03
90th POD	63.33 ±1.11	33.00 ±1.03	0.83 ±0.30	2.66 ±0.40	14.6 ±0.21	10.00 ±0.2026	5.18 ±0.04

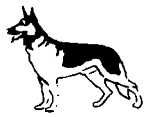


TABLE NO. 1.5

Mean with 'SE' of Haematological examination of Control group of animals. Group –B (Animals No. 7, 8, 9)

Days	Neutrophils (%)	Lymphocytes (%)	Monocytes (%)	Eosinophils (%)	Hb (gm%)	W.B.C (x 10^3/cmm)	R.B.C (x 10^6/cmm)
Preoperative day	67.66 ±0.33	28.33 ±0.88	0.66 ±0.33	3.33 ±0.66	13.66 ±0.33	10.76 ±0.66	5.3 ±0.057
1st POD	69.66 ±0.33	28.66 ±0.66	0.00 ±0.00	1.66 ±0.33	12.66 ±0.33	10.60 ±0.05	5.2 ±0.057
3rd POD	70.33 ±1.20	27.00 ±0.57	1.00 ±0.57	1.66 ±0.33	12.55 ±0.28	10.48 ±0.15	5.06 ±0.03
5th POD	69.33 ±0.33	28.33 ±0.33	0.33 ±0.33	2.00 ±0.00	12.55 ±0.28	10.58 ±0.28	5.23 ±0.03
7th POD	76.66 ±0.33	28.00 ±0.57	1.00 ±0.00	3.33 ±0.33	13.50 ±0.28	10.7 ±0.15	5.16 ±0.120
10th POD	66.66 ±0.88	29.33 ±0.66	1.00 ±0.57	3.33 ±0.57	13.5 ±0.28	10.7 ±0.05	5.26 ±0.120
20th POD	67.00 ±0.57	29.66 ±0.33	1.33 ±0.66	2.00 ±0.00	14.0 ±0.28	10.75 ±0.05	5.1 ±0.057
30th POD	66.66 ±0.33	29.00 ±1.52	1.00 ±0.57	3.33 ±0.33	14.3 ±0.16	10.778 ±0.07	5.1 ±0.057
60th POD	66.66 ±0.33	29.33 ±1.73	0.66 ±0.66	3.00 ±0.57	13.5 ±0.34	10.63 ±0.06	5.36 ±0.03
90th POD	67.00 ±0.57	28.33 ±0.33	1.33 ±0.33	3.33 ±0.66	13.6 ±0.33	10.9 ±0.000	5.36 ±0.03

postoperative day and it gradually declined thereafter and reached near its normal value by the 20^{th} postoperative day in all the experimental animals of group-A. The trend of lowering or elevation of the above parameters, in each instance did not affected much more than the normal range. (Table No:1.4 and 1.5).

4.5. BIOCHEMICAL OBSERVATIONS

In the present experiment the mean value of serum total protein, serum albumin, and blood sugar levels have been shown in both the experimental and control groups of animals from 0-day upto 90^{th} post-operative day including the pre-operative day in Table No : 1.6 and Table No: 1.7.

There was no significant difference in the levels of serum total protein, serum albumin and blood sugar levels during the pre-operative and post-operative period of control groups of animals' i.e., Group-B animals. (Table No: 1.7).

However, the serum total protein level among the experimental group i.e., Group-A was found to be 4.81±0.1922 gm/dl. 24 hours before the operation. 24 hours after the operation the level decreased significantly to 3.70±0.1460 gm/dl. Thereafter, a gradual fall in the serum total protein level was seen and it declined to reach its minimum value on the 5^{th} post-operative day. Thereafter, it started increasing gradually to reach near its base value on the 20^{th} post-operative day.

TABLE NO.1.6

Mean with SE of Serum total protein , Serum albumin , and blood sugar levels of Experimental animals. Animal No: 1 to 6. GROUP – A

Parameters	Preoperative day (24 hours before surgery)	0 (On the day of operation)	Post operative days									
			1 (24 hours after surgery)	3	5	7	10	20	30	60	90
Serum total protein (gm/dl)	4.81+/-0.19	4.86+/-0.20	3.70+/-0.14	3.53+/-0.13	3.11+/-0.12	3.33+/-0.14	0.70+/-0.09	4.70+/-0.15	4.93+/-0.09	4.91+/-0.08	4.95+/-0.08
Serum albumin (gm/dl)	4.03+/-0.06	3.95+/-0.06	2.95+/-0.12	2.55+/-0.07	2.43+/-0.02	2.51+/-0.03	3.01+/-0.03	3.90+/-0.03	4.15+/-0.05	4.25+/-0.08	4.31+/-0.04
Blood sugar level (mg/dl)	87.16+/-0.83	84.16+/-1.16	120.66+/-0.8	126.0+/-1.12	130.16+/-0.57	128.0+/-0.60	100.66+/-2.10	88.50+/-0.88	83.83+/-0.90	83.66+/-1.22	80.16+/-0.79

TABLE NO. 1.7

Mean with SE of Serum total protein , Serum albumin , and blood sugar levels of Control animals. Animal No: 7, 8 and 9. GROUP – B

Parameters	Preoperative day (24 hours before surgery)	0 (On the day of operation)	Post operative days								
			1 (24hours after surgery)	3	5	7	10	20	30	60	90
Serum total protein (gm/dl)	4.60+/-0.62	4.53+/-0.65	4.26+/-037	4.13+/-0.50	4.06+/-0.52	4.33+/-0.35	4.40+/-0.87	4.56+/-0.82	4.70+/-0.63	4.73+/-0.89	4.76+/-0.04
Serum albumin (gm/dl)	3.73+/-0.50	3.80+/-0.52	3.40+/-0.50	3.23+/-0.38	3.20+/-0.80	3.46+/-0.448	3.73+/-0.63	3.76+/-0.49	3.86+/-0.61	3.90+/-0.52	3.96+/-0.53
Blood sugar level (mg/dl)	85.33+/-6.66	83.33+/-6.76	92.60+/-9.82	101.6+/-8.56	110.6+/-8.56	109.3+/-7.05	95.33+/-4.66	88.66+/-2.66	88.33+/-6.38	84.33+/-4.72	81.33+/-4.17

On the other hand, serum albumin level among the animals of the experimental group (Group-A) was estimated to be 4.03±0.066 gm/dl 24 hours before the surgery. 24 hours after the surgery the serum albumin level declined significantly to 2.95±0.1231 gm/dl. It reached its minimum value by the 5^{th} post-operative day and thereafter, it started rising gradually so as to reach to its pre-operative value by 20^{th} post-operative day.

Estimation of the blood sugar level among the experimental group of animals was found to be 87.16+/-0.833 mg/dl 24 hours prior to operation.24 hours after the surgical intervention, the blood sugar level increased significantly to 120.66+/-0.88 mg/dl. Maximum rise of blood sugar level was noticed on the 5^{th} post-operative day. Thereafter, a gradual fall in the blood sugar level was observed and by the 20^{th} post-operative day the blood sugar level came near to its base line value.

4.6. RADIOLOGICAL OBSERVATIONS

Radiography of the viable ante cervical inverse- skin tube on 15^{th}, 30^{th}, 60^{th} and 90^{th} post-operative day with barium sulfate suspension, (30% w/v) revealed neither stenosis, nor stricture formation in any of the experimental animals belonging to group-A. Patency was well maintained in all the animals of the above group. Radiological findings have been presented in Plate.No : 3.2, 3.3, 3.4 and 3.5 respectively.

Fig.No.2.8.Showing excellent maintenance of patency of skin tube on the 30th postoperative day with polyethylene tube placed within skin canal.

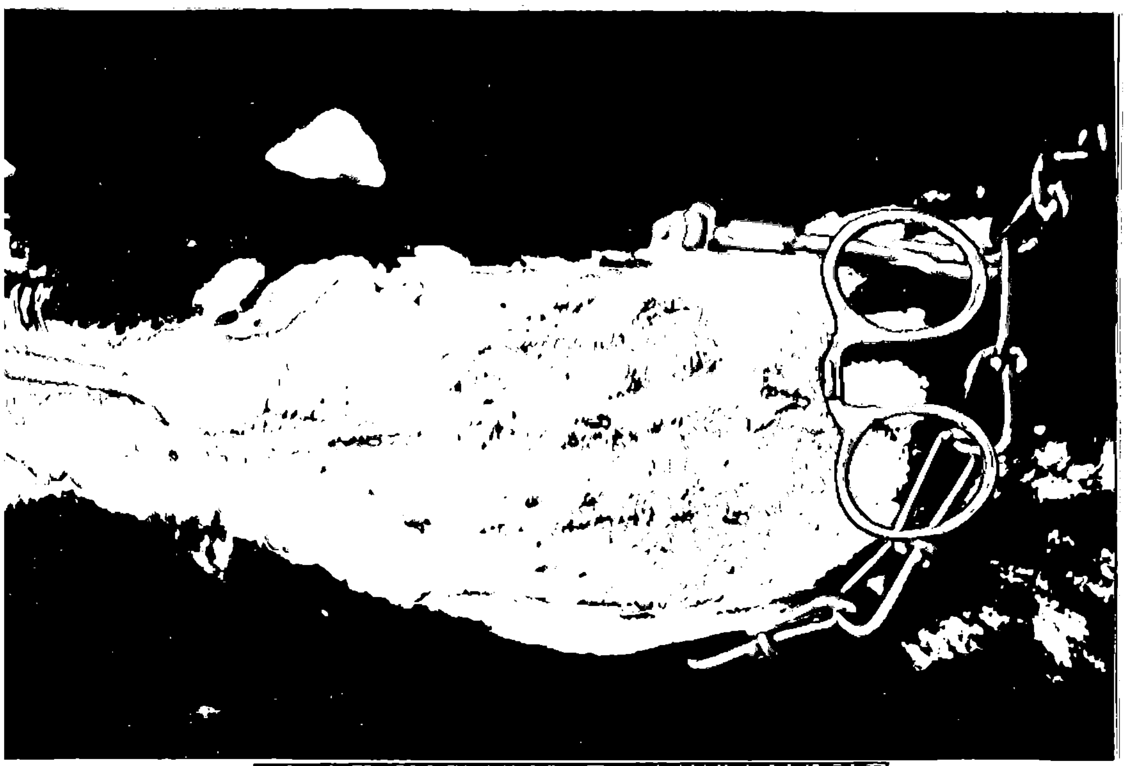


Fig.No.2.9. Shows excellent maintenance of patency of skin tube on the 90th postoperative day.

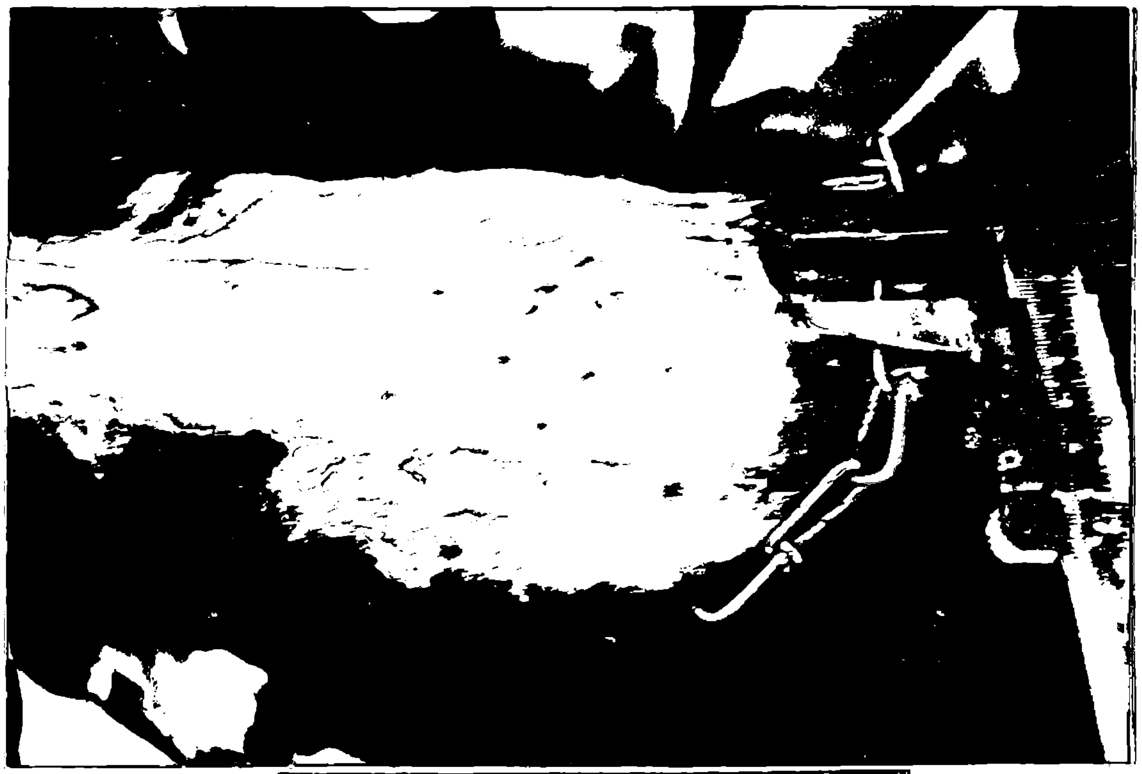


Fig.No.3.0. Showing diameter of the healed skin tube.

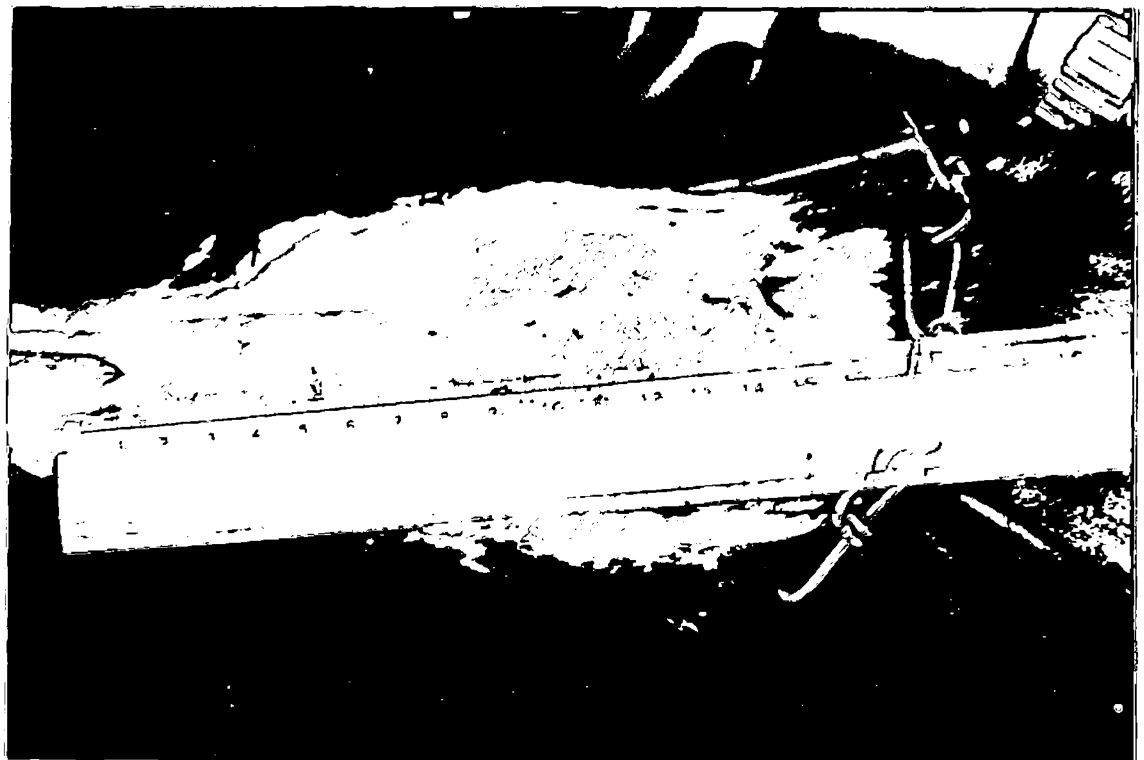


Fig.No.3.1. Showing length of the healed skin tube.

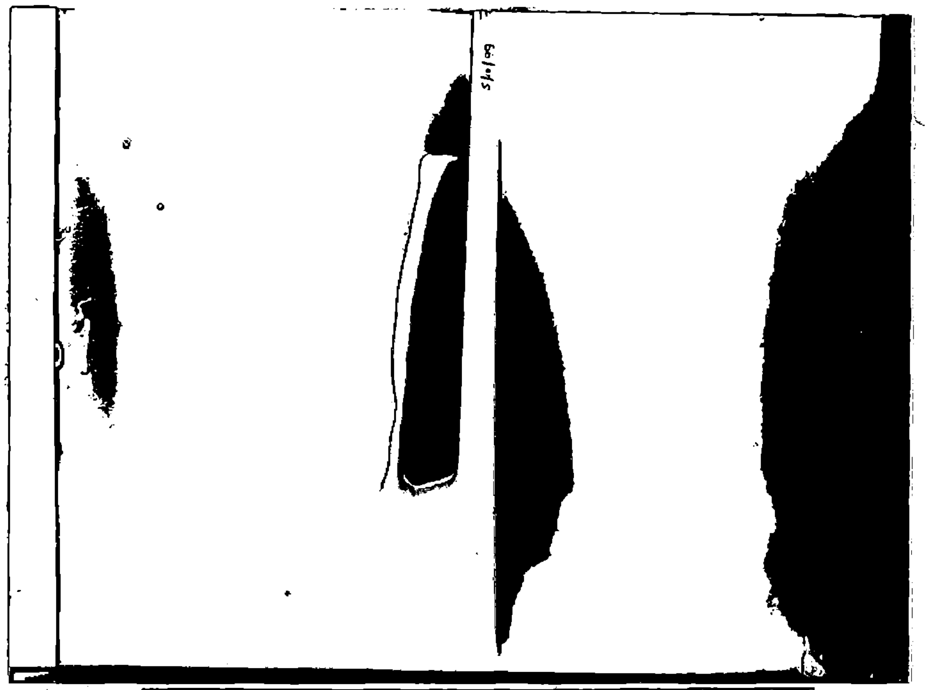


Fig.No.3.2.Contrast radiograph on 15th POD with contrast media inside the skin tube showing excellent patency of skin tube.

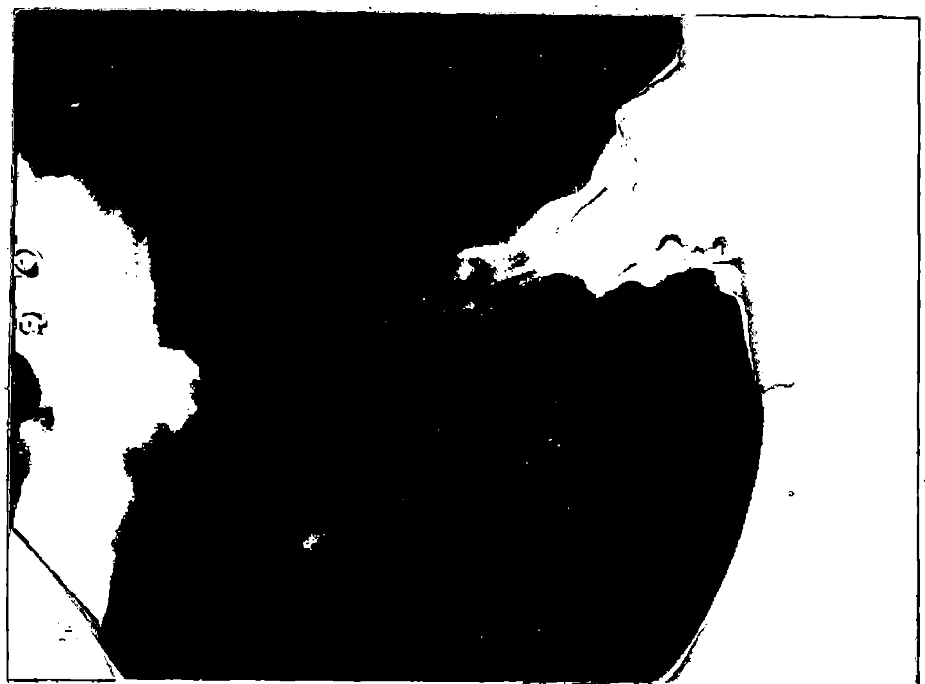


Fig.No.3.3.Contrast radiograph on 30th POD with contrast media inside the skin canal.

Fig.No.3.4.Contrast radiograph on 60[th] POD with contrast media within the skin tube.

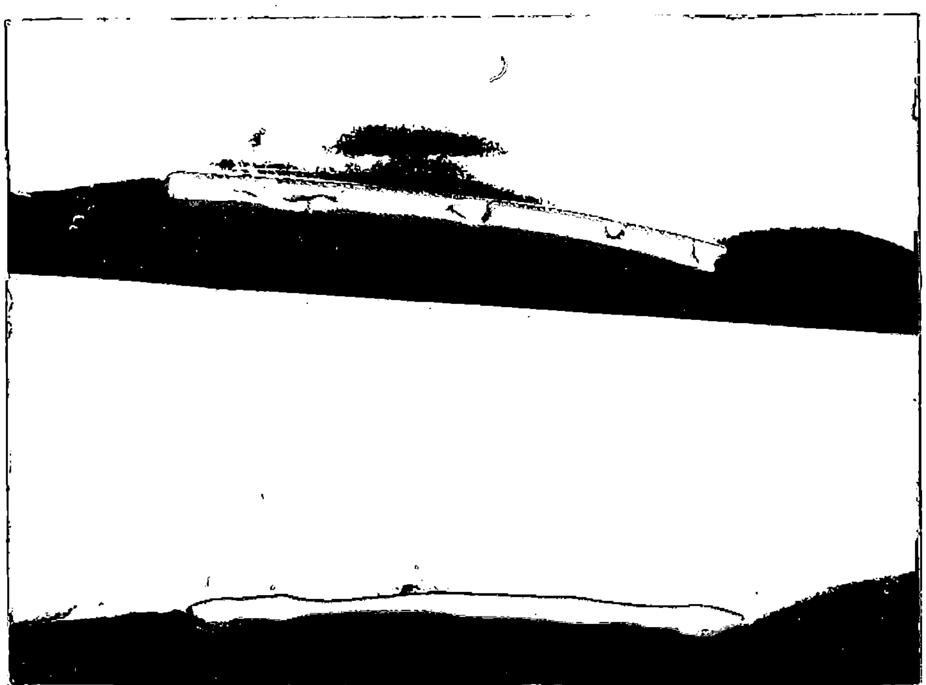


Fig.No.3.5.Contrast radiograph on 90[th] POD with contrast media inside skin tube.

CHAPTER V

DISCUSSION

DISCUSSION

Whenever important structures are congenitally absent, or are irreparably damaged by injury or disease, the problem of replacement arises. In many instances no solution can be found, for the surgery of replacement, though of ancient lineage, has developed very slowly in comparison with the surgery of ablation, but important advances have been made in recent years.

Since man first became involved with the science of medicine the increasing use of replacement and reconstructive surgery has been a subject of major controversy. Oesophageal replacement has exercised the mind and technical skill of Surgeons' for hundred of years. For many years, efforts have been directed towards the outcome of a suitable substitute as prosthesis for proper functioning of the oesophagus and saving the life of the patient.

Management of the diseased and damaged segments of the oesophagus like oesophageal carcinoma, corrosive strictures, atresia etc., require its removal and reconstruction with a suitable autologous substitute.

One of the earliest discoveries in oesophageal reconstructive surgery was the use of cervical skin flaps to reconstruct a portion of the cervical oesophagus as described by Mikulicz (1886) and Bircher (1894).

The necessity of achieving the proper functional capacity of the oesophagus and thus saving the life of the subject by various techniques namely, primary anastamosis, creation of gastric tubes, small or large bowel interposition, use of synthetic materials and composite skin flaps etc, have been felt by the surgeons. But their applications, however, remain restricted because of limitations in non-availability of the concerned organ as well as technical problems related to the surgery.

Obviously these volumetric and technical concerns with the pedicle transplantation and anastamosis of hollow viscera's, to restore the continuity of the oesophagus after resection have stimulated interest about the potentiality for the use of inverse-skin tube as an acceptable alternative substitute for oesophageal reconstruction.

Skin tubes have been successfully employed for oesophageal reconstruction and replacement in humans for many years. They have been designed and used to bridge deficiencies in and even to replace the gullet either alone or in combination with pedicled transplantation of hollow viscera's to restore the continuity of the alimentary tract.

Pavletic (1981) reported the first clinical use of skin tubes for cervical oesophageal reconstruction in dogs. The inverse - skin tube serves as an epithelium - lined conduit through which food and liquid may pass into the stomach or into the small bowel directly.

The advantages of using skin tube lie in the superficial nature of the operation manoeuvre and the easy access to any breakdown in a suture line. It is also an advantage that other important organs like stomach, jejunum, and colon don't have their function interfered. Ample loose, elastic skin is available in the neck region of the dog which permits its easy mobilisation and wound closure as reported by Cawley and Archibald (1974). The local skin flaps over the neck region can be easily utilised for inverse-skin tube development. This technique which doesn't require special instruments, prolonged surgery time, or the training required for microvascular transfer of intestinal segments for small intestinal substitution of the cervical oesophagus, could be used by the veterinary surgeons' in ordinary practice.

In the present study, construction of the viable inverse-skin tube on six clinically healthy, adult mongrel dogs using local skin flaps of cervical region were evaluated by clinical, haematological, and radiological studies. In addition, the degree of stress was also evaluated on some stress indicators namely, serum total protein, serum albumin, and blood sugar level by biochemical studies.

Unfortunately scarcity of earlier records of comparable works has made it almost impossible to compare the observations and findings of the present study with those of other workers. Moreover, the parameter of the present study obliged the author to formulate and standardise his own technique in light of few related references available in the literature.

5.1. ANAESTHETIC OBSERVATIONS

As per the plan of work, satisfactory anaesthesia was achieved in all cases by using a combination of atropine sulphate and xylazine hydrochloride along with local infiltration of 2% lignocaine hydrochloride at the proposed site of incision. At no level there was any excitation or other untoward effect seen in any animal. Only in two cases there was vomiting a few minutes after administration of xylazine. These observations corroborate the findings of Hall (1978), Moreira *et al.* (1979) and Lele and Bhokre (1985).

5.2. INTRAOPERATIVE OBSERVATIONS

Local skin flaps of the cervical area were used in the construction of the viable inverse-skin tube in all the experimental animals of group-A. The skin canal, which is the most important part of this construction, was created using the local skin of the cervical region without transferring cutaneous from other places. The effective use of the local skin flaps is dependent on forming a flap in a neighbouring area where loose, elastic skin prevails like the skin of the neck region of the dog which permits its mobilisation and effective wound closure as viewed by Cawley and Archibald (1974). Further, these local skin flaps are both simple and economical and the most practical method of closing defects, which could not be approximated by simple undermining and suturing as stated by Pavletic (1983).

The operative technique for construction of the inverse-skin tube was tolerated well by all the experimental animals and healing was uneventful in all the cases except in experimental animal No: 3 in which the distal terminal portion of the skin tube showed signs of wound dehiscence on the 4th postoperative day, which was due to excessive tension on the incisional lines. This event of wound dehiscence was also reported by Trevor *et al.* (1992). However, in the present study the wound dehiscence was managed by secondary closure by placing few additional sutures.

Careful planning and meticulous atraumatic surgical techniques as described by Swaim (1980), helped in successful elevation of the cervical skin flaps without much undermining and with minimal surgical trauma for construction of the inverse-skin tubes in all the experimental animals of group-A.

Complete immobilisation of the lateral skin flaps overlying the so-formed inverse-skin tube was achieved by placing 3 to 4 anchoring sutures of vertical mattress type between the raw dermal layer of the inverted skin tube wall and the lateral skin flaps. This technique was developed and adopted by the author that helped to obliterate the dead space formed between the inverted skin tube walls and the overlying lateral skin flaps. It also helped to completely immobilise the lateral flaps from the recipient bed and succeeded in 100 percent "take" and survivability of the flaps. This corroborates the findings of Woodruff (1960) that effective immobilisation of the part is of paramount importance for effective take up of the skin flaps.

Bleeding along the skin margins was a positive intraoperative clinical sign of adequate flap circulation in all the animals. These findings were in complete agreement with those of Kerrigen and Daniel (1983). Constant red dermal bleeding from the edges of the skin flap was a good evidence of adequate circulation and so it was possible to judge accurately the successful transfer and "take" of the skin flaps in animal undergoing inverse-skin tube construction. These findings corroborated well with those of Climo (1951).

Excellent survivability of the skin flaps in all the experimental animals of group-A used for the construction of the inverse-skin tube could be attributed mainly to adequate maintenance of the deep subdermal plexus entering the base of the flap and without disturbing the terminal branches of the cutaneous arteries which feed the subdermal plexus. The same findings corroborate with the recommendations of Pavletic (1980), Grabb and Meyer (1925), Cohen, Harmon and Phizackerley (1983) and Woodruff (1960).

Adequate fixation and immobilisation of the lateral pedicle skin flaps achieved by the modified technique of placing anchoring sutures as developed and adopted by the author helped in 100 percent stabilisation of the skin flaps. Adequate positive results were further achieved by following proper and precise postoperative treatment regimen in all the experimental animals. This finding of the present work corroborates the recommendations of McKeever and Braden (1978) and Woodruff (1960).

The extent of Haemorrhage was kept to minimum by adopting meticulous atraumatic surgical technique. However, saline soaked sterile surgical gauge served adequate for effective control of haemorrhage from the wound bed. This helped in minimising the postoperative complication of haematoma formation in all cases. This was judged to be another important factor for successful "take" of the flaps and subsequent healing of the skin canal. This findings of the present study indirectly agrees with the recommendations of Pavletic (1985), and McKeever and Braden (1978) and partly with the observations of Mulliken and Healey (1979) who observed underlying haematoma as a cause of flap necrosis from pressure beneath the flap.

5.3. POSTOPERATIVE OBSERVATIONS

5.3.1.CLINICAL OBSERVATIONS

Surgically created inverse-skin tubes were well tolerated and accepted by all the experimental animals of group-A causing no ill-effects, and no serious inflammation in the surrounding tissues. Clinically, healing was uncomplicated in all the animals and there was no evidence of any untoward reaction in any case except in experimental animal No: 3, where partial dehiscence of the sutured skin flap occurred at the distal terminal end of the skin tube, which however, was successfully managed by secondary closure. From the result of physical evaluation it was evident that there was no relative difference in inflammatory response both in control and experimental group of animals. Chronic inflammatory response was also not observed in any case.

The positive response of the ante cervical inverse-skin tube produced gradually when surgically constructed at the neck region of all the experimental animals was quite apparent in the present study. The physiological status of all these animals did not varied beyond its normal physiological limit. Only a transient inflammatory response was observed in both control and experimental group of animals that were said to be atleast partially associated with the surgical trauma.

The clinical findings of the present study exhibited no ill effects. This may be further substantiated on haematological, biochemical and radiological studies.

The clinical relevance of this study supports to build up the concept that such type of morphological and biocompatible inverse-skin tube prosthesis may duplicate the success of oesophageal reconstruction in place of a diseased segment. The potential for similar findings in clinical practice is suggested by morphological comparison between this model and its clinical applications.

5.3.2. HAEMATOLOGICAL OBSERVATIONS

Due to non-availability of any earlier records regarding the changes in the blood picture in a systematic manner and at regular intervals, following construction of ante cervical inverse-skin tube, no comparison could be made.

As regards changes in the blood picture estimation following surgery slightly increased total leukocyte count (T.L.C) and neutrophil percentage was observed from the very first postoperative day and remained elevated upto the 10^{th} postoperative day in all animals of group-A and thereafter it returned towards normal indicating resolution of inflammation and surgical stress. This slight increase in T.L.C due to an increase in neutrophil percentage in conditions where there is corticosteroid release in states of stress, pain, anaesthesia, trauma, surgical manipulation was also reported by Choles, (1974) and Sastry, (1989).

However, from the present study it appears that there was no marked change in the blood picture of the experimental animals between the preoperative and postoperative values. The trend of lowering and elevation of the above parameters, in each instance did not affected much more than the normal range and was a normal physiological response of the body to injury and trauma.

5.3.3. BIOCHEMICAL OBSERVATIONS

In the present study, the mean value of serum total protein level among the experimental group of animal's i.e., group-A was found to be 4.81±0.1922 gm/dl 24 hours before the operation. 24 hours after the operation i.e., on the 1st postoperative day the level decreased significantly to 3.70±0.146gm/dl. The trend in decline of the serum total protein was observed upto the 5th postoperative day. After the 5th postoperative day the levels of serum total protein tended to return to the preoperative levels. This corroborates the findings of Hoch-Ligeti (1953). The hyporpoteinemia might be due to negative nitrogen balance produced after surgery to increase catabolism, also supported by in animals, Singh and Kumar (1992), Varschney *et al.* (1992), and Dass *et al.* (1983).

Serum albumin level also exhibited a significant fall 24 after surgery and was estimated to be 2.95±0.123 gm/dl. 24 hours before the operation the serum albumin level in animals of group-A was 4.03±0.066gm/dl. It reached its minimum value by the 5th postoperative day and thereafter, it started rising gradually and tended to reach its normal preoperative value. Hoch-Ligeti (1953) also reported a similar fall in the serum albumin level during the first 24 hours after surgery. He further stated that the fall in serum albumin level continues upto the 5th postoperative day and thereafter the levels tend to reach its preoperative value. The finding of the present work corroborates the findings of the above named worker. The fall in serum albumin level may be partly due to passage of albumin into extravascular compartment on account of tissue injury that is supported by Singh and Kumar (1992).

In the present study, estimation of blood sugar among the experimental group of animals was found to be 87.16±0.233 mg/dl, 24 hours before surgery. 24 hours after the surgical intervention, the blood sugar levels were elevated to 120.66±0.88mg/dl. Maximum rise of blood sugar level was noticed on the 5th postoperative day. After the 5th postoperative day the blood sugar levels tended to return to the normal preoperative values. The changes in the blood sugar level during different postoperative days as observed in the present study corroborated with the findings of Hoch-Ligeti (1953) cited by Charles (1963). This rise of blood glucose level may be explained as increased glycogenolysis triggered principally by the release of catecholamines and glucocorticoids and impaired insulin activity as a result of greater intensity of stress. Therefore, when surgical operations are carried out on the body, the operative procedure induces a principal biochemical alteration- rise of blood sugar level Clerke (1970), Singh and Kumar (1992), Varschney *et al.* (1992), due to traumatic stress effecting hormonal imbalance Wolfson *et al.* (1979).

So it is evident from the present work that though there was a greater extent of rise of blood sugar level (showing greater affection of carbohydrate metabolism) and lower extent of fall of serum total protein level (showing increased body protein utilisation), and lower extent of fall of serum albumin level (showing passage of albumin into extravascular compartment on account of injury) during surgery among the animals of the experimental group in which ante cervical skin tubes were constructed indicating the extent of stress of surgery to be a normal metabolic response of the body to injury or trauma. The amount of stress exhibited by the experimental animals was with in the physiological limits and no adverse effect from stress of surgery was noticed in any of the subjects.

5.3.4. RADIOLOGICAL OBSERVATIONS

Due to non-availability of any earlier record regarding examination of patency of the so constructed viable antecervical inverse-skin tube in dogs by contrast radiography at regular intervals no comparison could be made, however, from the present study it appears that there was neither any stricture nor stenosis in the constructed inverse- skin tubes in any of the experimental animals through out the entire postoperative period. This corroborates the findings of Miyamoto *et al.* (1984).

So from the present work the feasibility of using ante cervical inverse-skin tube as an effective substitute for oesophageal reconstruction in place of a diseased segment of cervical oesophagus can be successfully assessed. It may lend a new line of treatment procedure in human and veterinary oesophageal reconstructive practice. Thus, the role of inverse-skin tube may prove to be the surgery of choice for the advent of surgical applications.

CHAPTER VI

SUMMARY

SUMMARY

Management of diseased and damaged segments of esophagus like esophageal carcinoma, corrosive strictures, atresia etc requires its extensive removal and reconstruction with a suitable autologous substitute.

The study was therefore undertaken with a view to assess and evaluate the feasibility of using antecervical inverse-skin tube as an effective substitute for esophageal reconstruction in place of a diseased segment of cervical esophagus.

Nine clinically, healthy adult mongrel dogs of either sex were randomly divided into two groups during the course of study. Six apparently healthy dogs of either sex were randomly placed into group-A with a male to female ratio of 1:1. Rest three animals were placed into group-B. Animals of group-A served the purpose of experiment and were subjected to surgical intervention for construction of ante cervical inverse-skin tubes. Whereas, the animals of group-B served the purpose of control. Ante cervical inverse-skin tubes with an average length and diameter of 15.00cm and 2.50cm were surgically constructed in group-A animals by utilizing the local skin flaps over the neck region without transferring coetaneous tissues from other distant places.

All the animals were maintained for observation upto 90^{th} day postoperative day. The effect of the modified technique for construction of ante cervical inverse-skin tube on healing was evaluated

on the basis of intra-operative, clinical, hematological, biochemical and radiological observations.

In the present study, ante cervical inverse-skin tubes were constructed in all the experimental animals without much difficulty. Loose. Elastic skin over the neck region of dog permitted easy elevation and mobilization of the lateral pedicle skin flaps over the skin tube and thus provided effective wound closure. Soft tissue manipulation and hemorrhage during the operation was also very less.

The operative technique as developed and adopted by the author for adequate fixation and mobilization of the lateral pedicle skin flap to cover the raw dermal surface of the inverse-skin tube helped not only in excellent stabilization of the skin flaps but also in uneventful healing of the inverse-skin tubes in all the experimental animals.

No marked local inflammatory reactions were observed in any of the experimental animals through out the entire period of the study. A little swelling was only visible at the operative site that reached maximum on the 5^{th} postoperative day and thereafter, it subsided gradually and resolution took place within the 10^{th} postoperative day. No marked haematoma, seroma, or edema was observed on the operative site during the postoperative period. It was observed that the rectal temperature, pulse rate, and respiration rate in the pre-operative and postoperative stages of all the animals did not show any marked changes. The physiological status of the animals did not varied much beyond its normal physiological limits.

In the present study there was no marked change in the blood picture of all the animals of the two groups between the pre-operative and post-operative days. The trend of lowering or elevation of the above parameters in each instance did not affected much more than the normal range.

Serums total protein and serum albumin decreased significantly 24 hours after the surgery and tended to fall gradually thereafter upto the 5^{th} postoperative day in all the experimental animals. After the 5^{th} postoperative day the levels of the above parameters tended to reach its normal preoperative values and remained slightly higher till the end of observation period.

Blood sugar level increased significantly in all the experimental animals, 24 hours after surgery. Maximum rise was noticed on the 5^{th} postoperative day. Thereafter, it tended to decline and remained slightly lower throughout the observation period.

In the present study radiographs of the inverse-skin tubes taken at regular intervals revealed excellent maintenance of patency with no untoward consequences of stricture or stenosis in any of the experimental animals of group-A.

Surgically created inverse-skin tubes were well tolerated and accepted by the experimental animals causing no ill-effects and no serious inflammatory reactions in the surrounding tissues. Healing of the skin tubes was uncomplicated in all the cases and there was no evidence of any untoward reaction. A precise post-operative treatment regimen obtained favorable results.

After three months postoperatively no significant change was observed in any case clinically and radiologically. The present study illustrates that ante cervical inverse-skin tube can act as an ideal esophageal substitute in place of a diseased segment of cervical esophagus and it is likely to lend a direct helping hand in shaping the esophageal reconstructive surgery in near future and saving the life of the patient.

CHAPTER VII

CONCLUSION

CONCLUSION

1. The present study was done with the object to assess the feasibility of using ante cervical inverse-skin tube as an effective substitute for oesophageal reconstruction both in animals and human beings in place of a diseased segment of cervical oesophagus after necessary experimentation on dogs. There are many factors which must be considered in determining whether it is feasible to replace a part or full length of the oesophagus by skin tubes.

2. The ante cervical inverse-skin tubes as constructed on the animals in the present study exhibited no adverse biological response. Infact, the positive response of the ante cervical inverse-skin tube produced gradually when surgically constructed at the neck region of all experimental animals was quite apparent in the present study. The skin tubes were tolerated well by all the animals with uneventful healing.

3. The clinical, haematological, biochemical, and radiological assessment on dog indicate the suitability of ante cervical inverse-skin tubes for effective management of diseased and damaged segments of oesophagus which require extensive removal and reconstruction with a suitable autologous substitutes and the results of the present study may be extrapolated to human patients.

4. It is clear that the ante cervical inverse-skin tubes far out weigh their limitations and it is likely to lend a helping hand in shaping the future of oesophageal reconstructive surgery.

5. With these findings in mind we are inclined to view that a considerable amount of experimental research work is needed to fulfil the hope of discovering substitutes of this nature which would, on simple application to the patient significantly hasten the rate of healing of oesophageal defects. Therefore, to conduct more extensive research work in this field is an imperative necessity.

CHAPTER VIII

Future scope of research

FUTURE SCOPE OF RESEARCH

This work is a step towards reconstruction and replacement of entire length of esophagus (cervical, thoracic and abdominal) for clinical conditions when the whole length of esophagus needs to be removed due to some irreversible disease process such as chemical injury or malignant neoplasm's. Though different parts of the GI tract including stomach, jejunum, ileum or colon has been in use for esophageal replacement in various pathological conditions, there are situations when neither of them appear to be suitable or available. In such conditions either the skin tube or a combination of skin tube and GI tract parts may be used as substitute. This work though in a small series has established that the construction of an ante sternal skin tube is a viable option.

We propose to standardize the technique to establish communication between the ends of this skin tube with the esophagus or pharynx at one end and the stomach or jejunum at the other end to facilitate propagation of food from pharynx to stomach or beyond that.

In addition, to this objective several other goals listed below may also be reached by utilizing the knowledge of developing ante sternal skin tube. These are: -

1. Construction of ante thoracic inverse-skin tube in continuation to the preformed ante cervical skin tube and thus establishing a direct communication between the pharynx or esophagus above and stomach below through gastrostomy.

2. In a similar manner other parts of the GI tract beyond stomach viz., duodenum, jejunum etc may be brought up ante sternally through a subcutaneous tunnel beneath the skin at a suitable site and their stomal openings subsequently anastamosed with the distal end of the skin tube.

3. Construction of variable lengths and diameters of inverse-skin tubes by varying the flap lengths and widths.

4. Construction of inverse-skin tubes using a split-thickness skin flap with only the epidermis serving as an epithelium lined conduit of the skin tube.

5. Comparative study between the inverse-skin tube reconstruction procedure for esophageal reconstruction and other conventional surgical methods of esophageal replacement.

6. Studies on potential use of canine axial pattern flaps, island arterial flaps and myocutaneous flaps for one-stage reconstruction of the esophagus in canines.

7. Research should be directed to study the use of intravenous fluorescein dye in the dog to access its efficacy for predicting flap survival and assessing circulation of the skin tube.

8. Research should be directed at changes occurring in the flap microcirculation and methods to prevent necrosis once circulatory compromise to the skin is evident.

BIBLIOGRAPHY

BIBLIOGRAPHY

Adams,W.E.;Escudero,L.;Aronsohn,H.G. and Shaw,M.M (1938).: Resection of the thoracic oesophagus. A clinical and experimental study. *J.Thoracic. Surg*, 7:605.

Agarwal,K.B.P.; and Kumar,S (1985).: Observation of change in electrolyte level in serum of laparotomised dogs. *Ind.Vet.J.* **62** :567-568.

Akiyama,H.; Miyazomo,H.; and Tsurumaree,M (1978).: Use of stomach as an oesophageal substitute. *Ann.Surg*, **188**:606.

Amarpal.; Singh,B.; and Kumar,A (1995).: Gastric seromuscular autogenous graft for oesophagoplasty in dogs: mechanical and histolomorphological study. *Ind.J.Vet.Surg*, **16**(1):35-38.

Anderson,Neil.V (1980).: **Veterinary Gastroenterology.** *Lea & Febiger*, Philadelphia.pp: 372-373.

Anthony,M.J.; Woolfson,M.B.; Richard,V.H.; and Simon,P.A (1979).: Insulin to inhibit protein catabolism after injury. *New.Eng.J.Med*, **300**(1).

Ariyan.S(1979).: The pectoralis major musculocutaneous flap: a versatile flap for reconstruction in the head and neck. *Plast.Reconstr.Surg*, **63**:73-79.

Arnold,G.C (1973).: Pericardio-oesophagoplasty—A new operation for partial oesophageal replacement. *The Am. J.Surg*,125(3):294-299.

Bakamjian,V.Y (1965).: A two stage method for pharyngo-oesophageal reconstruction with a primary pectoral skin flap. *Plast.Reconstr.Surg*, 36:173.

Balegno,H.F.; and Neuhans,O.W (1959).: *Proc.Soc.Exptl.Biol.Med*. 97: 234.

Beck,C.; and Carrel,A (1905).: Demonstration of specimens illustrating method of formation of a prethoracic oesophagus. *Illinois.Med.J*, 7:463.

Benson,G.J (1984).: Effects of xylazine hydrochloride upon plasma glucose and serum insulin concentration in adult dogs. *Vet.Bull*, 55(1):1985L58.

Bhisragnatra,K.K(1916).: **The Sushurata Sanhita**, An English Translation based on the original *Sanskrit Text*, Calcutta, Bose.

Billingham,R.E.; and Medawar,P(1955).: Contracture and intussusceptive growth in the healing of extensive wounds in mammalian skin. *J.Anat.Lond*, 89:114.

Billworth,T.H(1872).: *Longenbecks Arch. Klin. Chir*, 13: 65.

Bircher,E (1907).: Ein Beitrag Zur plastischen Bildung eines neuen oesophagus. *Zbl.Chir*, 34: 1479.

Blair,V.P(1921).: The delayed transfer of long pedicle flaps in plastic surgery. *Surg.Gynaecol.Obstetr.* 33:261.

Braden,T.D (1979.: Plastic and Reconstructive Surgery of the Canine Torso. *Vet.Clini. North.Amer: Small Animal Practice*, 9(2) :285-309.

Brain,R.H.F (1967).: The place for jejunal transplantation in the treatment of simple stricture of the oesophagus. *Ann.R.Coll.Surg.Engl*, 40: 100.

Bricker,E.M.; Burford,T.H.; and Eiseman,B (1949).: The use of tubed pedicle graft in cancer of the oesophagus. *J.Thorac.Surg*,18:304.

Bromberg,B.E.; Song,I.C.; Mishrick,A.; and Collins,R (1968).: Carcinoma in a reconstructed oesophagus. *Ann.Surg*, 168(2): 269-273.

Brown,J.B.; Fryer,M.P.; and McDowell,F(1951a).: Permanent pedicle blood carrying flaps for repairing defects in avascular areas. *Ann.Surg.* 134:486.

Brown,J.B.; Fryer,M.P.; and McDowell,F(1951b).: Application of permanent pedicle blood carrying flaps. *Plast.Reconstr.Surg.* 8:335.

Cawley,A.J.; and Archibald,J(1974).: Plastic Surgery in Archibald,J 2nd ed: **Canine Surgery**. *American Veterinary Publications Inc.* Santa Barbara.

Charles,E.C.; and Kaneko,J.J (1963).: *in* **Clinical Biochemistry of Domestic Animals**. *Academic Press*, New York. pp:158-160.

Chauhan,K.K.; Mirakhur,K.K.; Roy,K.S.; and Mohindra,V (1998).: Avascular intestinal segmental interpositioning in smaller cervical oesophageal defects in dogs. *Ind.J.Vet.Surg*,19(2): 107-108.

Choles,E.H (1974).: **Leukocytes in Veterinary Clinical Pathology**,2nd ed. *W.B. Saunders & Comp.*, Philadelphia.pp:40-98.

Clarke,R.S.J (1970).: The hypoglycaemic response to different types of surgery and anaesthesia. *Brit.J.Anaes.* 42:45-51.

Climo,S(1951).: Dermal bleeding and the delay operation. *Plast.Reconstr.Surg*.8:59.

Cohen,B.E(1974).: Beneficial effects of staged division of pedicle in experimental axial pattern flaps. *Plast.Reconstr.Surg*, 63:336.

Cohen,B.Z.; Harmon,C.S.; and Phizackerley,B.M(1983).: Glucose metabolism in experimental skin flaps. *Plast.Reconstr.Surg*, 71:79.

Collis,L.J (1982).: Reconstructing the oesophagus *in* **Reconstructive Procedures In Surgery**. Edited by, Bevan,P.G. *Blackwell Scientific Publications*, 1st Ed, Bostan. pp:86-104.

Converse,J.M(1977).: **Reconstructive plastic surgery**.Vol-I. *W.B.Saunders*, Philadelphia.

Conway,H.; and Griffith,B.H(1957).: Revascularisation of the kidney by tubed pedicle flap.*Transpl.Bull*, 4:61.

Conway,H.; Stark,R.B.; and Docktor,J.P(1949).: Vascularisation of tubed pedicles. *Plast.Reconstr.Surg*, 4:133.

Dalek,C.R.; Gandolfi,W.; Dalek,C.L.M.; and Alessei,A.C (1987).: Cervical oesophagoplasty in the dog, with autologous peritoneum preserved in glycerine. Experimental study. *Ars Veterinaria*, 3(2): 195-202.

Dass,L.L.; Sahay,P.N.; Khan,A.A (1983).: Studies on effect of laparotomy on certain blood constituents in buffalo calves. *Ind.J.Anim.Health*, June, 1983.:47-49.

Davis,J.S.; and Kitlwoski,E.A(1931).: Immediate contraction of cutaneous grafts and its causes. *Arch.Surg.Chicago*,23:954.

Davis,J.S.; and Stafford,E.S (1942).: Successful reconstruction of the oesophagus. *Johns Hopk.Hosp.Bull*, 71:191.

Demergasso,F.; and Piazza,M (1979).: Trapezious myocutaneous flap in reconstructive surgery for head and neck cancer. An original technique. *Am.J.Surg*, 138:533-536.

Depage,A (1903).: Nouvelle methode de gastrostomie. *Presse Med.* (Abstr.), 19:755.

Doxey,D.L (1966).: Cellular changes in the blood as an aid to diagnosis.

Edward,H.W.; Franklin,J.D.; Madden,J.J.; and Lynch,J.B (1979).: Pectoralis major myocutaneous flap: A new flap in head and neck reconstruction. *Am.J.Surg*,**138**(10):537-543.

Esser,J.F.S (1917c).: Sogenannte totale oesophagoplastik aus Hauntlappen nach Thiersch ohne Verwendung von Darmschlinge. *Dtsch.Z.Chir*, **142**:403.

Filatow,W.B(1917).: Plastic a tig ronde. *Vestn Oftalmol*.No:**4**&5.

Finseth,F.; Zimmerman,J.; and Liggins,D(1979).: Prevention of muscle necrosis in an experimental neurovascular island skin flap by a vasodilator drug isoxsuprine.*Plast.Reconstr.Surg*,**63**:774.

Fogh-Anderson,P (1961).: Reconstruction after cancer in an antethoracic skin tube oesophagus. *Acta.Chir.Scand.Suppl*, **283**:298.

Francisco,D.; and Mario,V.P (1979).: Trapezious myocutaneous flap in reconstructive surgery. For head and neck cancer: an original technique. *Am.J.Surg*,**138**(10):533-536.

Frangenheim,P (1911).: Zur Frageder Oeopagoplastik. *Arch.Klin.Chir*, **95**,684.

Freud,E.; Grief,M.; Rozner,M.; Finally,R.; Gfrati,I.; Kidron,D.; Odes,M.; and Mares,A.J (1993).: Bridging of oesophageal defects with lyophilised dura matter: an experimental study. *J.Pediatr.Surg*, **28**(8): 986-989.

Friedman,M.; Toriumi,D.M.; Strorigl,T.; Chilis,T.; and Skolinik,E (1988).: The sternocleidomastoid myoperiosteal flap for oesophagopharyngeal reconstruction and fistula repair: clinical and experimental study. *Laryngoscope*, 98(10):1084-1091.

Galpern,E.J. (1925).: Eine neve methode der oesophagoplastik. *Zbl.Chir*, 52: 182.

Garrison,F.H(1929).: **An Introduction To The History of Medicine**, 4^{th} Ed. *W.B.Saunders Com.*, Philadelphia.

Gaynor,F.; Hoffer,R.E.; Nichols,M.F.; Rosser,E.; Moraff,H.; Hahn,A.W.; and Germain,M.; and Arsac,M (1980).: Current resources of microsurgery for the replacement of the cervical oesophagus and the hypopharynx. *Ann. Otolaryngol Chir Cervicofac*, 97(3):189-199.

Ghosh,R.K (1995).: **Primary Veterinary Anatomy**, 1^{st} ed. *Current Books International, Bombay*,pp: 123.

Gillman,T.; Penn,J.; Bronks,D.; and Roux,M(1955).: A re-examination of certain aspects of the histogenesis of the healing of cutaneous wounds- a preliminary report. *Brit.J.Surg*, 43:141.

Gopalan,S.; Sammana,H.C.; and Ramaswamy,V.M (1980).: Certain haematological changes of xylazine in dogs. *Cherion*, TamilNadu.9(1):49-54.

Grabb,W.C.; and Meyers,M.B(1975).: **Skin flaps**. *Little Brown & Comp.*, Boston.

Grabb,W.C.; and Smith,J.W(1973).: **Plastic Surgery**. *Little Brown & Comp.*, Boston.

Guillamondegui,O.M.; and Larson,D.L (1985).: The lateral trapezious myocutaneous flap :Its use In head and neck reconstruction. *Plast. Reconstr.Surg*, 67:143-150.

Guillamondegui,O.M.; Geoffray,B.; and McKenna,R.J (1985).: Total reconstruction of the hypopharynx and cervical oesophagus. *Am.J.Surg*, 150(10): 422-426.

Gupta,P.P (1973).: Biochemical alterations in blood in progressive protein malnutrition of Indian pigs. *J.Anim.Health*. June'73.

Halsted,W.S(1896).: Three cases of plastic surgery-1, Extensive burns of neck. *Johns.Hopk.Hosp.Bull*,:25.

Hanrahan,E.M. (1947).: The use of migrated skin flap for both lining and covering of an artificial antethoracic oesophagus. *Plast.Reconstr.Surg*, 2 : 474.

Harrison,D.F.N.(1964).: *Ann.Otol.Rhinol.Zar*, 73:1026.

Hedbloom,C.A. (1922).: Combined transplueral and transperitoneal resection of the thoracic oesophagus and the cardia for carcinoma. *Surg.Gynecol.Obstet*, 35:284.

Hinchkliff,K.W.; MacDonald,D.R.; Lindsay,W.A(1992).: Pedicle skin flaps in ponies:viable lengths are related to the flap width. *Equine.Vet.J.* 24(1):26-29.

Hobor,B.; Borbely,L.; Halmos,l.; and Horvath,O.P.(1997).: The replacement of the oesophagus by musculo-cutaneous flaps. *Acta. Chir.Hurg,* **36** (1-4): 132-133.

Hoch-Ligeti,C.; Irvine,K.; and Sprinkle,E.P (1953).: *Proc.Soc.Exptl.Bio.Med.* **84** :707.

Holmberg,D.L.;Kuzuma,A.B.; Miller,C.W. (1991).: Free bowel transfer for oesophageal reconstruction in the dog. *Microsurgery,*12(2):140-141.

Howard,D.R.; Lammerding,J.J.; and Dewevre,B. (1975).: Oesophageal reinforcement with sternothyroideus muscle in the dog. *Canine Practice,* 2(4): 30-35.

Hume,D.H (1969).: Endocrine and metabolic response to injury *in* **"Principles of Surgery"** by Schwartz,S.I. *McGraw Hill Book Co.* New York.

Hynes,W(1950).: The blood vessels in skin tubes and flaps. *Brit.J.Plast.Surg,* 3:165.

Ike,O.; Shimuzu,Y.; Okada,T.; Natsume,T.; Watanahe,S.; Ikada,Y.; and Hitori,S. (1989).: Experimental studies on artificial oesophagus for the purpose of oesophagus epithelization using collagen-coated silicon tube. *ASAIO-Trans,* 35(3):226-228.

Iskeceli,O.K. (1962).: *Surg*, 51: 496.

Jayes,P.H.(1957).: Carcinoma in a reconstructed oesophagus. *Brit.J.Plast.Surg*,**10**(222):1957-1958.

Jianu,A. (1912).: Gastrostomie und Oesophagoplastik. *Dtsch.Z.Chir*, **118**: 383.

Jurkiewicz, M.J. (1984).: Reconstructive surgery of he cervical oesophagus. *J.Thorac. Cardiovasc.Surg*, 88:893-897.

Kakegawa,T.; machi,J.; Yamana,H.; Fujita,H.; and Tai,Y.(1987).: A new technique for oesophageal reconstruction by combined skin and muscle flaps after tissue failure in primary colonic interposition. *Surg.Gynecol.Obstet*, **164**(6):576-578.

Kelling,G. (1911).: Oesophagoplastik mit milfe des querkolon. *Zentralbl. Chir*, **38**:1209.

Kerigan,C.L.;and Daniel,R.K(1983).: Monitoring acute skin flap failure. *Plast.Reconstr.Surg*, **71**:519.

Koch,S.L(1941).:The transplantation of skin and subcutaneous tissues to the hand. *Surg.Gynaecol.Obstetr.* **72**:1.

Kostolioch,M.; and Pavletic,M.M(1987).: Axial pattern flap based on the genicular branch of the spahenous artery in the dog. *Vet.Surg.* **16**:217-227.

Ladd,W.E.; and Swenson,O (1947).: Oesophageal atresia and tracheo-oesophageal fistula. *Ann.Surg.,* 125: 23.

Lane,W.A (1911).: Excision of the cancerous segment of the oesophagus: restoration of the oesophagus by means of skin flap. *Brit.Med.J.,* 1:16.

Learmouth,J.R(1946).: Reflux vasodilatation in surgery *in* **Edinburg Postgraduate Lectures in Medicine**, Edinburg,*Oliver&Boyd,* vol3 pp:301.

Lele,C.M.; and Bhokre,A.P (1985).: Evaluation of xylazine as an anaesthetic agent in combination with certain preanaesthetic drug in dogs -I. Respiratory rate, blood pressure, heart rate and temperature. *Ind.Vet.J.* **62**:675-682.

Lele,C.M.; and Bhokre,A.P (1985).: Evaluation of xylazine as an anaesthetic agent in combination with certain preanaesthetic drug in dogs-II. Electrocardigraphic and biochemical study. *Ind.Vet.J* **62**:863-868.

Lexer,E (1908).: Oesophagoplastik Duetsche. *Medizinische.Wochenschrift.,* **34**:574.

Liapis,I.C (1996).: Replacement of a part of the oesophageal wall by a strip of skin in a dog. *Point-Veterinaire.,* **28** (178): 375-377.

Lillehei,R.C.; Goldberg,S.; Goot,B.; and Longerbeam,J.K (1963a).: *Am.J.Surg.,* **105** :58.

Longmire,W.P.; and Ravitch,N.M (1946).: A new method of constructing an artificial oesophagus. *Ann.Surg.*, 123:819.

Lortat-Jacob,J.L.; and Giuli,R (1973).: Oesophageal replacement. *Prog. Surg.*, 12 :77-95.

Maclaren,D.S.; and Pallet,P.L (1970).: Lowered blood glucose concentration during protein energy malnutrition. *Wld.Rev.Nutri.Diet.*12-43.

Majumdar,K.; and Ghosh,A.K (1983).: Depression of blood glucose during vitamin A deficiency. *Ind.J. Phy & Alli.Scs.*:37-67.

Meyes,M.B(1964).: Wound tension and vascularity in the aetiology and prevention of skin flap sloughs. *Plast.Reconstr.Surg*, 56:945.

Mikulicz,J. (1886).: Ein fall von resection des carcinomatosen oesophagus mit plastichem ersatz des excidirten stiickes. *Prag.Med.Wscha*, 11:93.

Mipton,T.; Edgerton,M.; and Baltimore,M. (1952).: *Ibid*, 31: 239.

Miyamoto,Y.; Hattori,T.; and Nosoh,Y. (1984).: One stage antethoracic reconstruction of the thoracic oesophagus using myocutaneous flaps. *Brit.J.Plast.Surg*, 37(4): 577-579.

Moran,R.E(1952).: Revascularisation of the heart by a pedicle skin flap. *Science*, 116:319.

Moran,R.E(1952b).: Revascularisation of the heart by tubed pedicled graft of skin and subcutaneous tissues. *Plast.Reconstr.Surg*, 10:295.

Moreina,A.L.; Guimara,S.A.; Oleveira,H.P.; and Silva,R.V.P.D.A(1980).: Use of xylazine hydrochloride in dogs. *Vet.Bull.*50(12). Abstt:8520.

Mulliken,J.B.; and Healey,N.A(1979).: Pathogenesis of skin flap necrosis from underlying haematoma. *Plast.Reconstr.Surg*, 63:540.

Mutoc,T.A.; Fried,M.P.; Horowitz,Z.; Bohrick,L.E.; and Stromo,M. (1986).: Reconstruction of the cervical oesophagus by the free transfer of a jejunal loop. An experimental study in dogs. *Ann.Otol.Chis.Cervicofac*, 103(4): 227-233.

Myers,M.B.; Cherry,G(1968).: Causes of necrosis in pedicle flaps. *Plast.Reconstr.Surg*, 42:43.

Natsume,T.; Ike,O.; Okada,T.; Takimoto,T.; Shimuizu,Y.; and Ikada,Y. (1993).: Porous collagen sponge for oesophageal replacement. *J.Biomed.Mater.Res*, 27(7):867-875.

Ochsner,A.; and Owens,N. (1934).: Antethoracic oesophagoplasty for impermeable stricture of the oesophagus. *Ann.Surg*, 100:1055.

Ohsawa,T. (1936).: Surgery of the oesophagus. *Arch.Jap.Chir*, 10:605.

Ong,G.B.; and Lee,T.C. (1960).: Pharyngo-gastric anastamosis after oesophagopharyngectomy for carcinoa of the hypopharynx and cervical oesophagus. *Brit. J. Surg*, 48: 193-200.

Orsoni,P.; and Toupet,A. (1950).: Utilisation du colon descendant et de la partie gauche du colon transverse pour I' Oesophagoplstie pre-thoracique. *Pr. Med*, 58:804.

Pal,A.S.; Singh,B.; Kumar,A.; and Prakash,P (1992).: Mechanical, histological and histochemical evaluation of split sternothyroideus pedicle graft for cervical oesophagoplasty in dogs. *Ind.J.Vet.Surg*,13(1):13-15.

Pang,C.Y.; Forrest,C.R.;Neligan,P.C(1986).: Augmentation of blood flow in delayed random skin flaps in pigs: effect of length of delay period and angiogenesis. *Plast.Reconstr.Surg.* 78:68-73.

Panwar,B.S.; and Kathuria,J.D (1979).: Determination of some biochemical values in army dogs. *J.Res.Vet.Corp* (1979).

Pareira,M.D.; Serkes,K.D.; and Lang,S (1960).: *Proc.Soc.Exptl.Biol.Med.* 103:9.

Parker,N.R.; Walter,P.A.; and Gay,J (1989).: Diagnosis and surgical management of oesophageal perforation. *JAVMA*, 25(5) :587-594.

Pavletic, M.M.; and Peyton,L.C (1983).: Plastic and reconstructive surgery in the dog and cat. *In* Bojrab,M.J.(ed): **Current Techniques in Small Animal Surgery II**. *Lea & Febiger*, Philadelphia.

Pavletic,M.M (1981).: Canine axial pattern flap, using the omocervical, thoraco-dorsal and deep circumflex iliac direct cutaneous arteries. *Am.J.Vet.Res.* **42**:391.

Pavletic,M.M (1981).: Reconstructive oesophageal surgery in the dog: A literature review and case report presentation. *JAAHA*,17:435.

Pavletic,M.M (1992).: Oesophageal reconstructive techniques *in* Bojrab,M.J.; Birchard,J.S.; and Tomlinson,L.J. **Current Techniques in Small Animal Surgery**, *Lea & Febiger*, Philadelphia. 205-212.

Pavletic,M.M(1980).: The vascular supply to the skin of dog : a review. *Vet.Surg*, 9:77.

Pavletic,M.M(1985).: Pedicle grafts in Slatter,D.H edition: **Textbook of Small Animal Surgery**, *W.B.Saunders and Co.*, Philadelphia. pp:458.

Pavletic,M.M.; Kostolich,M.; Koblik,P.; Engler,S (1987).: A comparison of the cutaneous trunci myocutaneous flap and latissimus dorsi flap in the dog. *Vet.Surg*, **16**(4):283-293.

Pavletic,M.M.; Walter,S.J.; Henry,R.W.; and Naffe,A (1982).: Reverse saphanious conduit flap in the dog. *J.Am.Vet.Med.Assoc*, **182**:380.

Payer,E (1917).: Falle von antethorakaler oesophagoplastik. *Munich.Med.Waschr*, **64**:783.

Perthes,G(1917).: Lappenvorbereitung in situ.Ein never weg zur bildung langer plasticher lappen ohne gefahr der nekrose. *Zbl.Chir.* **44**:644.

Petrov,B.A (1954).: Retrosternal artificial oesophagus (in Russian) *Khirugiya* (Moscow), No:1, pp:108.

Ranger,D(1964).: *Proc.R.Soc.Med,* 57:1099.

Raymond,C.D.; Donald,L.O.; and Michael,G.O (1986).: Use of a tubed pectoralis myocutaneous flap for salvage of a failed colonic bypass of the oesophagus. *Surg.Gynecol.Obstet,* **162**(5): 477-479.

Reinhoff,W.F (1944).: Discussion of paper by J.H.Garlock,"causes of mortality following radical resection of the oesophagus for carcinomas".*J.Thorac.Surg,* 13:426.

Reinsch,J.F(1974).: The pathophysiology of skin flap circulation:The delay phenomenon. *Plast.Reconstr.Surg.* 54:585-598.

Richard,G.C.; Franklin,H.C.; and Kenneth,L.P (1956).: *Surg,***39**:459.

Roux,C (1907).: L'oesophagojejuno-gastrostome, nouvelle operation pour retrecissment infranchissable de l'oesopage. *Sem.Med,* 27:37.

Ryan,R.F.; Krement,E.T.; and Cardona-Loya,O (1981).: One stage cervical oesophageal and pharyngeal reconstruction for a fourth primary cancer. *Plast.Reconstr.Surg,* 67:224-229.

Sapozhnikova,M.A.; Kanshin,N.N.; Abakumov,M.M.; and Pagodina,A.N. (1985).: Pathology of the artificial oesophagus made of skin. *Arkh.Patol.*,47(2):29-35.

Sasaki,G.H.; and Pang,C.Y(1981).: Experimental evidence for involvement of prostaglandins in viability of acute skin flaps: effects on viability and mode of action. *Plast.Reconstr.Surg.* 67:335-340.

Sastry,G.A (1989).: **Haematology in Veterinary Clinical Pathology**. *C.B.S.Publishers & Distributors Pvt Ltd.* New Delhi. pp:20.

Saxena,M.J.; and Madan,P(1997).: Herbals for stress management in pets. *The Veterinarian*, vol:21.

Schalm,O.W.; Jain,N.C.; and Carrol,E.J (1975).: **Veterinary Haematology**, 3rd ed, *Lea& Febiger*, Philadelphia.pp:604.

Sharma,A.K.; Kumar,A.; and Singh,H.P(1983).: Effect of xylazine on thiopental sodium induced anaesthesia in dogs. *Ind.J.Vet.Surg*, 4(1): 39-40.

Shima,S.; Yonakawa,H.; Yoshinumi,Y.; Sigiura,Y.; Seuyoshi,S.; Goto,M.; and Tamaka,S (1988).: Experimental study of segmental oesophageal replacement with gluteraldehyde treated tracheal biograft. *Nippon-Kyobu-Breka-Kiakkai-Zasshi.*, 36(11):2417-2424.

Singh,J.; and Tyagi,R.P.S (1972).: Experimental studies on oesophageal anastamosis with special reference to transplantation in buffalo calves. *Ind.Vet.J.*, 49(8): 814-821.

Singh,R.K.; and Kumar,A(1992).: Metabolic effects of surgical stress in buffaloes. *Ind.J.Anim.Scs.* 62(4):311-314.

Soloman,J.; Neudalman,J.; Kissen,L.; Gassner,S.; and Levy,M.J (1977).: Experimental segmental replacement of the oesophagus by biological tissues. *Israel. J. Med.Scs.*, 13(3):272-277.

Spencer,W.G(1925).: Celsius De Medicina .*Proc. R. Soc.Med.* 19:123.

Stephenson,J.C.; Blevines,D.D.; and Christie,G.J(1978).: Safety of xylazine ketamine combination in dogs-two years study. *Vet.Med.Small.Anim.Clinic.* 73(3):303-306.

Straw,R.C.; Tomlinson,J.L.; Constantinesen,G.; Turk,M.A.M.; Hogan,P.M (1987).: Use of vascular skeletal muscle graft for canine oesophageal reconstruction. *Surg.*, 16(2):155-163.

Swaim,S.F(1980).: **Surgery of Traumatised Skin : Management and Reconstruction in the Dog and Cat**. *W.B.Saunders Comp.*, Philadelphia.

Sweet,R.H (1945).: Transthoracic resection of oesophagus and stomach for carcinoma-analysis of postoperative complications, causes of death and the late results of operation. *Ann.Surg.*, 121

Torek,F (1913).: The first successful case of resection of the thoracic portion of the oesophagus for carcinoma. *Surg.Gynecol.Obstet*, **16**:614.

Torek,F (1925).: Carcinoma of the thoracic portion of the oesophagus. Report of a case in which operation was done 11 years ago. *Arch.Surg.Chicago*, **10**:353.

Trevor,P.B.; Smith,M.M.; Waldro,D.R.; and Hedlund,C.S (1992).: Clinical evaluation of axial pattern flaps in dogs and cats: 19 cases (1981-1990).*JAVMA* **21**(4):608-612.

Tsur,H.; Danilier,A.; and Strauch,B(1980).: Neovascularisation of skin flaps: route and timing. *Plast.Reconstr.Surg*, **66**:85.

Tvedton,H.W (1981).: Haematology of the normal dog and cat. *Vet.Clinic.of North.America:Small.Anim.Pract.* 11(2):209-217.

Varshney,A.C.; Kumar,A.; Jadon,N.S.; and Verma,M.C (1992).: Studies on haematological and biochemical alterations following caesarean section in cows. *Ind.Vet.J.* July,1992.

Vidne,B .; Levy,M.J (1970).: Use of pericardium for oesophagoplasty in congenital oesophageal stenosis. *Surg*,68:389.

Von Fink,F (1913).: Ueber plastichem ersatz der specierohre. *Zbl.Chir.*, **40**:545.

Von Hacker (1891).: Zur pharyngo-und oesophagoplastic. *Zbl. Chir.*, **18**:121.

VonDeilen,A.W(1951).: Repair of massive defects by the use of local sliding flaps. *Plast.Reconstr.Surg.* 7:316.

Vulliet,H (1911).: De'Loesophagoplastic et des diverse modifications. Sem.Med., 31:529.

Withington,E.T(1929).: **Medical History From The Earliest Times,** *Scientific Press*, London.

Wong,W.W(1951).: The local use of heparin in plastic surgery. *Plast.Reconstr.Surg.* 8:111.

Woodruff,M.F.A (1960).: **The Transplantation of Tissues and Organs.** Springfield, Ill; *Charles C. Thomas*, Publications.pp:217-272.

Wookey,H. (1942).: The surgical treatment of carcinoma of the pharynx and upper oesophagus. *Surg.Gynecol.Obstet*,75:499.

Wookey,H. (1948).: The surgical treatment of the carcinoma of the hypopharynx and the oesophagus. *Brit.J.Surg*, 35:249.

Woolfson,A.M.; Heathy,R.V.; and Allison,S.P (1979).: Insulin to inhibit protein catabolism after injury. *New. Eng. J .Med*, 300(1).

Yamataka,A.; and Miyano,T. (1994).: Tubed latissimus dorsi musculocutaneous flap for thoracic oesophageal replacement in dogs: possible clinical application. *Surg.Today*,24(9):852-853.

Yamataka,A.; Miyano,T.; Segawa,O.; and Nozawa,M. (1994).: Tubed latissimus dorsi musculocutaneous flaps for thoracic oesophageal replacement : an experimental study. *J.Paediatr. Surg*, **29**(5) :590-593.

Young,C.M(1980).: The revascularisation of pedicle skin flaps in pigs: a functional and morphological study. *Plast.Reconstr.Surg*, **70**:435.

Yudin,S.S. (1944).: The surgical construction of 80 cases of artificial oesophagus. *Surg.Gynecol.Obstet*, **78**:56.