"A STUDY OF LAPAROTOMY WOUND CLOSURE WITH SKIN STAPLES"

Dissertation submitted to

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DEPARTMENT OF GENERAL SURGERY

MADURAI MEDICAL COLLEGE AND GOVERNMENT RAJAJI HOSPITAL, MADURAI – 625020

APRIL – 2015

CERTIFICATE

This is to certify that this dissertation titled **"A STUDY OF LAPAROTOMY WOUND CLOSURE WITH SKIN STAPLES" at Government Rajaji Hospital, Madurai** submitted by **DR. V.PRAVIN KUMAR**, to the faculty of General Surgery, **The TamilnaduDr. M.G.R. Medical University, Chennai** in partial fulfillment of the requirement for the award of MS degree (Branch I) General Surgery, is a bonafideresearch work carried out by him under my direct supervision and guidance from September 2013 to August 2014.

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DECLARATION BY THE CANDIDATE

I, **DR. V.PRAVIN KUMAR**, solemnly declare that the dissertation titled **"A STUDY OF LAPAROTOMY WOUND CLOSURE WITH SKIN STAPLES"** is a bonafide and genuine research work carried out by me in the Department of General Surgery, Madurai Medical College, during the period of September 2013 to August 2014, under the guidance and supervision of **DR. S. LAKSHMI, M.S., D.G.O.,** Professor of Surgery, and overall guidance by **DR. A. SANKARA MAHALINGAM, M.S.,** Professor and Head, Department of Surgery, Madurai Medical College, Madurai. This is submitted to The Tamilnadu **Dr. M.G.R. Medical University, Chennai**, in partial fulfillment of the regulations for the award of MS degree (Branch I) General Surgery course on April 2015.

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Place: Madurai

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LIST OF ABBREVIATIONS USED

ML : MIDLINE LAPAROTOMY

UML : UPPER MIDLINE

LML : LOWER MIDLINE

SSI : SURGICAL SITE INFECTION

SU : SUTURE

ST : STAPLER

DU : DUODENAL ULCER PERFORATION

IU : ILEAL ULCER PERFORATION

AAW : ANTERIOR ABDOMINAL WALL

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INTRODUCTION

INTRODUCTION

Surgery is derived from the earlier name chirurgery, which means handwork.

It is a science and art that shows the manner how to work man's body exercising all manual operations necessary to heal or as much as possible by using of most expedient medicines.

Brilliant developments of surgical skills and instrumentation have provided a precise understanding of an operative intervention. Today most surgical procedures are assessed by rigorous scientific methods, and such procedures become reproducible and predictable. Elaborate algorithms are available to calculate the requirement to replace or repair, to lengthen or shorten, to ablate or enhance, to drain or not.

However traditional axioms are often contravened. Urgent operations and insertion of foreign bodies are undertaken when one is confronted with acute sepsis; adhesive and staples are substituted for sutures; balloons challenge the bypass, and lasers, the scalpel. The essence of modern surgeon is now, more than ever before, that quality called JUDGEMENT-the ability to know what to use, when to use it, and for how long.

Many surgeons have genius without industry, others have industry withoutgenius; while many have both are still in judgment.

John Abernethy

Any surgical intervention will result in a wound in order to get access to and deal with underlying pathology. In this situation surgeon's task to minimize the adverse effects of wounds, remove or repair the damaged structures and harness the process of wound healing to restore function.

The principle aims of tissue repair of surgical skin incisions are rapid acquisition of strength and minimum tissue damage with minimum inflammation and a good scar. Many factors including the choice of suture materials and its placements influence these aims. But of particular relevance is the accurate co-optation of dermal edges; eversion or inversion leads to sub optimal healing.

For many years it has been possible to approximate the skin edges using sutures. However, sutures have the disadvantages of consuming more time in applying with a cosmetically inferior scar. The use of automatic stapling device for skin closure has become more popular of late to overcome these disadvantages. At the present time cost effectiveness of these is debatable.

ABSTRACT

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BACKGROUND AND OBJECTIVE

Laparotomy is one the common surgeries performed in general surgery. Regarding closure of skin in laparotomy there are various materials in use nowadays. This study compares and analyses the advantages and disadvantages of two of the most commonly used methods which are silk suture and skin staples.

METHODS

Between September 2013 and August 2014, 60 patients who got admitted to Department of Surgery, Madurai Medical College, GovernmentRajaji Hospital and underwent midline laparotomy were selected. Of the 60 cases 30 were undergoing elective laparotomy while the other 30 underwent emergency laparotomy. They were equally segregated into two study arms each containing 30 patients with 15 elective and 15 emergency laparotomies. In one arm the laparotomy wound was closed with silk mattress suture while in other arm skin staples were used. Both the groups were compared regarding reduction in surgery time, effect of wound healing, infection rate, post operative pain, and cosmesis. Data was collected and analysed by various statistical methods.

RESULTS

The time needed to closed the wound was reduced significantly with the use of skin stapler than suture. It was found that the operative time was reduced to nearly one fourth with use of stapler. For a given length of incision it was found that stapler needed more bites than suture. The stapler group had significantly less post operative pain with all of them falling below pain score 3. It was found that there was no significant difference in rate of infection and appearance of post operative scar between the two groups.Apart from the more efficient use of theatre time, the psychological effect of rapid wound closure at the end of a long operation on surgeon and theatre staff was very evident during this study.

INTERPRETATION AND CONCLUSION

Using skin staples for closure of laparotomy wounds significantly reduced operative time with less post op pain with no difference in appearance or rate of infection when compared to closure by sutures.

KEY WORDS

Laparotomy, Skin staples, Suture, Infection, Time

AIMS AND OBJECTIVES

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1. To study the operative time required for suture and staple repairs

2. To study the effect on wound healing and complications with the use of sutures and staples.

3. To study the cosmetic results of these two techniques

4. To study the degree of post operative pain and patients acceptance with these two techniques.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

History

The act of sewing is as old as Homo sapiens. In Susrutasamhitha 600 BC there is mention of suture material made from animal sinews, braided horsehair, leather strips, and vegetable fibers. This text describes about the various sizes and shapes of needles.

The earliest wound closure can be found in the Edwin Smith papyrus, the oldest surgical attempt at medical record know to man, written in Egypt around 3000 to 2500 BC. As early as 5000-3000 BC eyed needles were used, to pass suture material through surgical wounds.

John Hunter and Philip were the exponents and routine use in surgery.North America Indians used extreme heat to seal vessel. African natives tied bleeding vessels with threads and closed wounds with strips of vegetation wound round the protruding ends in a figure of eight.

South Americansclosed the wounds using large black ants, which the bite the wound edges together, with their teeth acting like suture or Michael clips. The ant's body is then divided to only leave head like retained suture.

Egyptian literature of about 1600 BC mentions the use linen strip layered with an sticky mix of honey and flour and thus inventing the original skin closures strips.

Aurelius Cornelius Celsus, an italian and a physician wrote a monumental book in medicine about 30 AD and it is known as De Re Medicina. Celsus mentions that sutures were of older origin should be smooth and straight, so that they are easy to handle on the part. The referral is to wool or linen is not mentioned in detail. He wrote in his seminal book about small metal clips similar to Michael clips of today.

Galen of Pergamon A.D 150 in his work, De Medendo, comments for the first time on the use of catgut but makes it plain that it was, known to the ancients. Catgut which was manufactured from the intestines of grass eating animals is still used in current surgical practice and amounts to nearly one third of cases done today.

Avicenna, known as the prince of physicians, contributed to suture development by his thought that common things like linen thread, when used in environment of pus failed and broke easily. Thus he started searching for new materials and discovered pig's bristles and thus inventing the first monofilament suture

The prince of surgeons is undoubtedly Albucasis, born in 936 AD. He used sutures and first described the mattress suture which is still used today.

Ambrose Pare described a method of closing facial wounds by dry suturing .this involvespasting bits of plaster on each side of wound and suturing it together. Cosmesis was the aim of this novel suture.

John Hunter (1728-93) opined that suturing is not always necessary and when it is necessary it should always be intermittent type. Instead of sutures he advocated using bandage or plaster over the wound.

Following Hunters opinion about bandage and plaster over the wound, physicians started searching for new material like leather. He discovered that these strips started dissolving after contact with wound and opined that suture which would dissolve in the body will be of considerable benefit

He then started experimenting on animals with suture of buckskin,andsucceded. He then started experiments on leather,tendon,catgut but realized catgut dissolved slowly. His experiments were seminal and first of its kind during his period and advocated absorbable suture which would get absorbed after holding the wound together

By 1867, Lister who was known for antisepsis also started what was called carbolic crusade.

Years later he published a seminal article regarding suturing and antisepsis. He conceived that glass or other objects left in the wound did not cause infection. He opined that infective pathogens must lie within suture itself.Thus came the concept of antiseptic ligatures.

Lister had also contributed in the manufacture of surgical catgut. He observed that chronic acid was used to tan leather, which he incorporated into his formulation.

By 1900 the catgut industry was firmly established in Germany due to the use of sheep intestine in their sausage industry. Many methods of sterilization were used but the introduction of iodine sterilization by Claudius in 1902 established what was to become the standard method of preparation for nearly half a century.

With the advent of World War I, Britain was left in an embarrassing situation of having little or no catgut industry. Some farsighted Edinburgh surgeons realizing the problems requested the local pharmacist, George Merson to undertake the commercial manufactures of this material. Merson also began to sell eyeless needled sutures where one strand of suture material is attached to the butt of the needle.

These patented products were called ‘mersutures’ and greatly reduced the tissue damage caused by pulling through a double strand of material, of the many technical advances in suture manufactures was the introduction of sterilization by irradiation in 1960 using cobalt 60 isotape. This allowed sutures to be packed and sealed and then sterilized, there by eliminating the dangers and difficulties of aseptic transfers. This revolutionary development was a breakthrough, which brought in its wake many improvements in packaging.

As mentioned earlier, Linen and Cotton were already in use. Silk was the next suture of choice in non-absorbable suture range. It became very popular because of excellent handling properties. It is extensively used in all surgical procedures.

Halstead was its main proponent. These natural non-absorbable sutures had certain disadvantages and with the technological advance, polyester and polyamide were introduced and replaced the previous non-absorbable sutures in many surgical procedures. Polyester was made available as braided, coated and non-coated. Recently polyester is made available as Monofilament in fine size. Later on monofilament polypropylene was made after extensive research. It is a very strong suture material fulfilling many characteristics of ideal suture material. It is very extensively used today almost replacing the silk, cotton and linen.

Then came the era of Synthetic absorbable sutures. The development of these began in 1931 with the production of synthetic absorbable fibre of polyvinyl alcohol.

In the second half of sixties it was discovered that polyglycolic acid can be processed into an absorbable suture material with very favourable properties. Subsequently, Glycolide and Lactide were combined in suitable proportions to develop a suture known as polyglacting 910. Later, this was coated to make smooth. Further research resulted in development of PDS, VICRYL and MONOCRYL.

Suture technology and suture sterilization has thus kept its pace of advancement along with the latest techniques in surgery and provided the surgical fraternity in a wide range of sutures in different sizes swaged to needles as fine as 30 microns.

A surgeon of today would not have been able to perform the various surgical procedures and achieve the excellent results without these sutures and needles.

Surgical stapling was developed in 1908 by HultiHumer in Australia. The original instrument was massive by today's standards weighing 7.5 pounds.

Modifications performed by Von Petz provided a lighter and simpler device, and in 1934 Fredrick of Ulm designed an instrument that resembled the modern linear stapler. The next major advances came from Russia after World War II. In 1958, Ravich, who, through research and development, refined the instruments to their current state and wide spread use today.

John T Kanagaye, Cheryl W Vance, Linda Chan, and Nancy Schonfeld at the Children's hospital, Los Angles, USA, following a study, revealed that staple closure was safe, rapid and cost effective. Staples were six times faster than the standard sutures with no observed complication rate. Removal was less painful and the scar was cosmetically acceptable.4

Eldrup et al analyzed 137 patients undergoing abdominal or thoracic surgery, and concluded that the main advantage of using staples was the time saved, as closure with mechanical sutures took one third of the time required for the conventional method. On the other hand closure with staples resulted in the major disadvantages of additional expense, as the cost was forty seven times higher than that of the suture with Dermalon5.

Meiring et al reported slightly better cosmetic results in a group of 40 patients undergoing laparotomy with an 80% in time saving. They also concluded that the final cost of t he stapler was crucial for selecting the method.

Harvey and Logan studied a group of 20 patients undergoing surgery for varicose veins in both lower limbs, using a different method of skin closure in each leg. They reported a saving of 66.6% in closure time and a similar cosmetic result.

They considered the use of staples a valid method for select patients with a large number of wounds; however the additional cost would not be justified for small sutures.

Zwart and Ruiter achieved better cosmetic results with the sub cuticular suture than with metal suture 1 month after surgery; however, after 6 months, the results of both the methods were similar. They argued that it is advantageous to use sutures with staples in contaminated surgery.

Ranabaldo and Rowe-Jones compared sutures with staples and sub cuticular suture in 48 patients undergoing laparotomy and concluded that the difference in time was significant. Nevertheless, the cost was five times greater with staples; hence, the use of subcuticular sutures was preferred6.

Luiz R Medina dos Santos et al in their study of 20 consecutive patients concluded that the use of skin staplers speeds up closure by 80%, with a better cosmetic results, ands does not increase the incidence of complications, although the slightly higher cost was involved7.

TECHNIQUES OF WOUND CLOSURE

Surgeons must be very careful

When they take the knife!

Underneath their fine incisions stirs the culprit – life –

Emily Dickinson.

The poignant poetry of Emily Dickinson eloquently emphasizes the primacy of the surgical operative event. Whereas the surgeon must exhibit a capability for compassionate interest and concern in all that illness implies to the patients and the patient's family, he or she must also devise an objective pattern for decision making in the most impersonal aspect of the operative procedure. The discipline is properly named: surgery is derived from its earlier name chirurgery which means "hand work" Halstedian teaching emphazied gentle handling of the tissues

careful haemostasis to enhance healing to prevent infection. These principles remain valid today.

Basic Principles: Wound healing is a complex and dynamic process and is influenced by surgical technique. Optimal wound healing, with a minimal scar that compromises neither appearance nor function, is the desired result. This process is affected by both local and systemic factors. Many local conditions are readily controlled at the time of wound closure, and several fundamental principles of surgical wound closure exist that should be adhered to in the management.

An incision is properly planned as to shape, direction, and size. In general incisions are made along the normal skin lines. Skin margins should be handled gently to minimize necrosis that may promote infection or delay wound healing.

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In closing wounds, sutures are either used in an interrupted or continuous fashion. The purpose of a suture is to hold tissues in

apposition until the wound has healed sufficient enough as to be self-supportive.

The following important points must be remembered.

1. Adequate incision should be taken.
2. Tissues should be handled gently.
3. Heavy retraction of tissues should be avoided.
4. No mass ligature should be applied as it will cause necrosis of large amount of tissue.
5. Excessive use of cautery should be avoided.
6. Appropriate needle and suture should be used for a given procedure.
7. Use of eyeless needle sutures will avoid tissue trauma.
8. Dead space should be obliterated and meticulous haemostasis should be obtained.
9. Wound should be drained only if indicated.
10. Sutures should be removed when union is sound.

In wound closure, the surgical technique is quite important but a good scientific knowledge of different sutures and needles and how they perform will aid the surgeon to achieve optimum wound healing. Since suture technology has kept pace with advances in surgical techniques, it is imperative on the part of the surgeon not only to be fully aware of them but also to keep them in their surgical armamentarium.

Various types of skin stitches in common uses are : -

- Continuous over hand sutures
- Continuous blanket
- Ordinary interrupted sutures
- Eversion suture
- Subcuticular suture
- Automatic skin staplers
- Superficial sutures either they may be continuous or interrupted.

Simple suture is the most widely accepted technique. The point of needle is driven into one skin edge a little distance from the margin and perpendicular to the surface using the curve of the needle. The point is

taken across the wound at depth and then directed through the subcutaneous tissue of the other edge aiming a little beyond the intended spot of penetration. The point is then drawn back to its intended position and then taken out through the other skin surface, again perpendicularly reef or squire knot is then tied adjusting the tension on the first throw. In this way skin edges are little everted so counteracting any tendency to invert23.

In certain situations the tendency to invert is so marked that positive steps must be taken to evert the skin edges. Interrupted mattress sutures do this. In vertical mattress suture the first step is same as the simple suture but then the needle is passed back taking tiny bites of both the skin edges in the same vertical plane and tied.

In the horizontal mattress suture after placing what is essentially simple suture another one is placed in the opposite direction. A few mm along and the ends are tied again. These sutures should not be used on the face.

Continuous subcuticular suture is an excellent technique, when it has been mastered. Either monofilament or absorbable suture material may be used. Starting at one end of the wound, thread is first fixed by placing a simple suture or by tying over a beady working inside the wound, small equal bites of tissue are taken alternating at each skin edge

just below the surface. When the end of the wound is reached, a suture is taken back to the surface through a single puncture. The tension is carefully adjusted along the length of the wound and then tied, again with a single suture or a bead. They lower the skin tension on the skin margins and allow earlier removal to avoid hatch markings. These should not be placed in the superficial dermis. Carefully placed subcuticular sutures give an excellent scar20.

In many situation absorbable subcuticular sutures may be used to approximate the dermal layer so that skin stitches do not require inserting or removing. Their insertion requires a careful technique to avoid an irregular scar and it is essential that the knot is placed well away from wound edge22.

Continuous over and over suture is quick to insert but some times does not give a very satisfactory cosmetic result and should certainly to be avoided on the face.

Continuous suture saves much time in the closure of a long wound. However should infection or hematoma formation occurs it is necessary to remove a part of the suture for drainage. Sharp needles and fine suture materials should be used for all wound repairs, the suture being evenly placed and tied without strangulating the tissues.

Interrupted sutures should be removed early, 4 to 5 days on the face and 7days elsewhere, but longer in the lower limb and vertical abdominal wounds.

Non absorbable material with a smooth surface should be employed for skin use.

Silk allows accurate tension to be applied to each knot where as nylon requires additional hitches for security.

All knots are placed to lie at one side of the wound so that they do not become buried in the scar.

Suture Materials

Sutures may be described by several characteristics:

- The diameter of a suture is stated numerically with the number of zeros in the suture size increasing as the diameter of the material decreases.
- E.g.8-0 silk suture is thinner than 5-0 silk suture
- The number of strands present
- Ability of the tissues to absorb suture

Classification

Sutures are conveniently classified into two broad groups

1. Absorbable
2. Non absorbable

Suture Materials

Absorbable

Non-Absorbable

Monofilament 1. Surgicalgut

1. Polyamide
2. Polypropylene
3. Collagen
4. Stainless steel
5. Polyester
6. Monocryl
7. PDS II
8. Polyglactin 910

Multifilament

1. Polygycolic Acid

2. Surgical silk

3. Polyglacting 910

4. Surgical linen

5. Cotton

6. Polyamide braided

7. Polyester braided

8. Stainless steelOthers

9. Surgical Stapler

Absorbable can further be classified into

1. Natural and synthetic

2. Non-absorbable can also be classified into natural, metallic and synthetic.

Advantages and Disadvantages

Multifilament sutures consist of multiple strands braided together, to increase the flexibility, tensile strength, and knot holding capability.

Multifilament sutures are generally easier to handle and to tie than monofilament sutures. However, they can harbour bacteria and are not suitable in the presence of infection and contamination.

Monofilament sutures are more smooth and strong. They do not allow any bacteria to survive. The drawback of monofilament is they do not handle as well as multifilament sutures.

For skin closure, the non-absorbable suture materials used fall into two broad categories;

- Braided materials – such as silk and nylon
- Monofilament – such as nylon, polypropamide

Monofilament consists of single strand on synthetic material. This reduces the resistance of passing the suture tissues and decreases the bacterial adherence because of smooth surface contour. But any crushing or kinking of the suture may result in a weak spot in the strand and can lead to surface breakage. Knot slippage is greater with monofilament suture.

Braided materials are easier to handle. And the knot and the tension of the stitch can be adjusted very accurately. They suffer from producing

the degree of drag through the tissues. And by their capillary action may cause tissue reaction at the stitch, which may lead to stitch abscess.

A 3-0 gauge suture material on a straight cutting needle will be found suitable for most minor surgical procedure.

The quantity of suture used must be adequate to secure the tissue, but excess material increases tissue reaction (foreign body) and inflammation of healthy tissues.

Therefore the surgeon must base the suture material on the tissue being repaired, the size and the design of the suture and its ability to retain tensile strength.

Absorbable suture is prepared from either from animal tissue or synthetic polymers. Those from natural sources elicit a foreign body response from tissues with resultant digestion from tissue enzymes,where as synthetic absorbable polymers are hydrolyzed to smaller monomers which are metabolized by tissues.

Non-absorbable sutures are permanent and resist digestion by body enzymes or hydrolysis by tissue.

Strength of Suture

- Strength of suture material is expressed using the terms Stress and Strain.
- Strength represents instantaneous force applied to the sutures (N/Msq).
- Strain is a measure of instantaneous length / starting length (Units).
- Strength is peak stress at the point of suture rupture whereas the toughness is the energy required to rupture the suture (J/mtq).

Non Absorbable Sutures

Silk :

Silk is derived from the cocoon of the silkworm larvae. It is basically a protein like keratin of hair and skin and is covered initially by an albuminous layer. This albuminous layer is removed by a process of degumming prior to making of sutures.

The suture is braided around a core and coated with a wax to reduce capillary action.

The material has high tensile strengths, which is probably totally lost after two years.

Tissue reaction is greater to silk than to synthetic non-absorbable sutures, due to the fact that silk is a foreign protein. The cellular reaction is usually polymorphonuclear and is less intensity than surgical gut. Encapsulation of the silk with a fibrous capsule usually occurs in 14-21 days. handling properties are probably best of all suture materials and it knots easily and securely. It is sterilized by gamma irradiation.

Surgical silk is available as Eyeless needled sutures in sizes 7-0 to 1. it is also available as sutupackpre cut sutures in sizes 6-0 to 3 and 0 reels as non sterile sutures in sizes 6-0 to 4.

Virgin silk is available for ophthalmic surgery in sizes 9-0 and 8-0 and on special micro point needles.

Nylon:

Nylon is available in both monofilament and Multifilament form. Although nylon is not absorbed, progressive hydrolysis of the nylon in vivo may result in gradual loss of tensile strength over time. So nylon suture should not be used in suturisation when permanent retention of tensile is required30.

Prolene (Polypropylene) 29,30

Is a monofilament synthetic suture material and is chemically extruded from a purified and dyed polymer, which is neither absorbed nor weakened by the action of tissue enzymes. It has an extremely high tensile strength, which it retains indefinitely on implantation. This lack of adherence to tissues facilities its use as a permanent suture. It can extend up to 30% before breaking and hence is useful in situations to accommodate the post operative swelling, and there by helps to prevent tissue strangulation. Handling is good and knotting is very secure since the material deforms on knotting and allows knot to bend down on itself. It has no coefficient of friction and slides through tissue readily. By tapering the end of the suture it may be swaged in to a needle of similar diameter which provides a haemostatic advantage in vascular anastomosis.

It is extremely smooth and it is less thrombogenic as compared to silk. It is inert and non-biodegradable. Being monofilament, it should be carefully handled during surgery, as rough handling and inadvertent crushing will damage it. Rough handling may cause a fracture on the strand, which may break later in the postoperative period. It is sterilized by ethylene oxide.

Cotton:

Cotton is derived from the hairs of the seed of the cotton plant. It is twisted to form a suture. Tissue reaction is like silk and linen tends to be a polymorphonuclear cellular type. Handling is good but not so good as silk. It is weaker as compared to linen.

Linen:

Linen is made from flax and cellulose material. It is twisted to form a fiber to make a suture. Tissue reaction is similar to silk and the material handles and knots well. It gain 10% in tensile strength when wet and is fairly unique in this respect. It is very extensively used for tying pedicles and as ligatures. It has excellent knotting properties.

Stainless Steel :

Stainless steel has an enviable reputation among non-absorbable sutures for strength and low tissue reaction (Inertness). The steel techniques are very exacting and the penalties for poor techniques costly. Steel can pull or tear out of tissues and necrosis can result from too tight a suture. Barbs at the end of steel can tear gloves, breaking sterile techniques or traumatizing surrounding tissues. Kinks in the wire can render it practically useless

Staplers

HumerHulti in Australia developed surgical stapling in 1908. the original instrument was massive by today's standards, weighing 7.5 pounds. Modifications performed by Von Petz provided a simpler and lighter stapling device and in 1934

Fredrick of Uln designed an instrument that resembled the present modern linear stapler.

The most major advances came from Russia after world war II in 1939. The instrument was brought to the US by Ravitch, who research and development refined the instrument to the current state and the wide spread use today. The most significant modification has been the

introduction of absorbable staples. When these are used in gynecological operations morbidity related to infectious granulomas and dysparunia has been diminished26.

The development of disposable skin staplers has been made this method of wound closure an increasingly popular technique. Numerous studies have confirmed the speed and efficacy of stapling compared with suture repair.

They are best avoided in the face and hand. Skin staplers are quick and easy to use, but an assistant is usually required to hold the skin edges accurately with forceps or skin hooks. The application is then aligned on the wound, often there is an arrow or mark to assist and the trigger is pulled. In one action staple is driven into the tissues and closed.

For removal a special extractor is required. Which bends the staple back with its original configuration where upon it can be withdrawn.

Stapler's closure also causes considerably less damage to wound defenses than closure with least reactive non-absorbable suture. Standard suturing causes significantly more necrosis than stapling in myocutaneous flaps.

Biological Response of Tissues to Suture Materials

A cellular response occurs whenever a foreign material is implanted in living tissues. This response is generally is very mild with most surgical sutures, or more marked if complicated by infection or trauma. If uncomplicated, the acute response usually changes in about 3 days and the original population if replaced by predominantly monocytes, plasma cells and lymphocytes. Small sprouts of fragile blood vessels infiltrate the area and eventually fibroblasts and connective tissue proliferates. This cellular response can be graded or evaluated according to its degree or area size on morphological grounds by observing the type and population of the responding cells in microscopic preparations. In addition to such morphological observations, studies of the enzymes activity at suture sites have been undertaken.

Enzyme Histochemistry has demonstrated that all the cellular changes are accompanied by the presence of a variety of enzyme patterns. These studies have been valuable in indicating in-vivo mechanisms involved in the absorption of both surgical catgut and newer synthetic absorbable and also indicate the degree of tissue reaction and also loss of tensile strength of non-absorbable sutures.

The study of biological response to sutures helps in suture selection for a given surgical procedure and assist in the future development of improved suture materials.

The methods of study are : -

Implantation in laboratory animals :

- Rats gluteal muscle or lumbar muscle.
- Rabbits sub cutaneous tissue.

These tissues are chosen because of consistent cellular response.

Although a precise comparison can not be made, the reaction in humans is generally is similar to but less intense than that seen in the experiment animals transfer of findings in animal studies would therefore appear to be acceptable with only moderate limitations. Results in

animals in all probability represent a faster rate of healing than occurs in human since the animal experiments are controlled and carried out in most ideal circumstances and do not have the varying adverse influence of long standing pathology, debility, infection, pyrexia and pulmonary complication as occurs in human post operative cases.

Histological evaluation of suture implant sites :

- This is carried out with absorbable and non-absorbable sutures.
- Tissue reaction to plain gut is more than to chromic to natural absorbable sutures.
- It has been observed that the tissue reaction to polypropylene is minimal followed by polyamide and polyester while tissue response to silk, linen, and cotton is more pronounced.

Suture tensile strength retention in tissues

Adequate suture tensile strength is required in surgery; however a suture usually needs to be no stronger than the tissues, which are sutured. Animal model systems have been developed for evaluating tensile

strength retention in-vivo for both non-absorbable and absorbable suture materials.

Suture strands were implanted sub continuously in rats and rabbits. Animals were sacrificed at various time periods: 0, 56, 90, 180, 390 days for non absorbable sutures; 0, 7, 14, 18 and 21 days for absorbable sutures. The breaking strength of the recovered suture strands was measured with a strong testing machine.

Suture strength and suture absorption :

It is important to realize that the rate of tensile strength loss and the rate of suture absorption are separate event. For e.g. a suture sample can lose tensile strength rapidly in tissues and yet absorb slowly, or it may vary adequate tensile strength during the vita time of wound healing and then absorb rapidly. This later relationship would make the most effective absorbable sutures5.

Enzyme histochemicalstudies :

These help to study the mechanisms of suture absorption in tissues. It has been found that cellular protease usually supplied by macrophages are required for surgical gut absorption. With the synthetic absorbable

sutures, cellular enzyme activity was not played a key role in the metabolism of suture breakdown products.

Rabbit ear chamber studies :

Implantation of absorbable sutures in the rabbit ear chamber can supply valuable data of the in-vivo absorption characteristics. Direct and continuous microscopic observations of suture behavior in the tissues are not readily obtained by other methods. This technique is particularly useful for the examination of the new absorbable materials implanted in tissues.

Tissue Reaction for Staplers

Staplers are made up of stainless steel they are virtually inert. They have uniform shape and constant staple depth providing even wound tension rectangular staple design minimizes tissue trauma and minimizes tissue compression there by causing minimal tissue reaction and trauma.

Results of the Above Study

- It is higher to plain gut than to chromic gut.
- Tissue reaction disappears faster with plain gut.

- Tissue reaction is minimal with polypropylene and polyester while it is very high to silk, linen and cotton.
- Synthetic absorbable sutures stay strong for a long period compared to surgical gut.

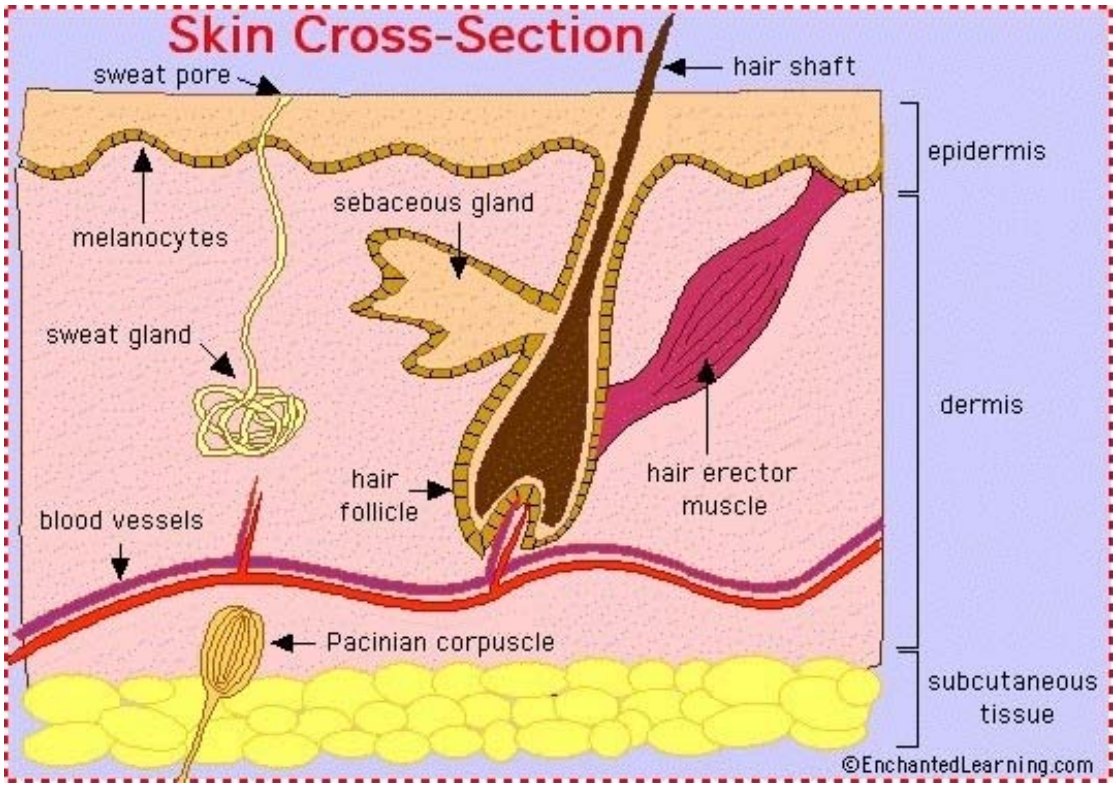


Figure-1: Skin cross-section

ANATOMY OF SKIN

Skin consists of two components; epidermis and dermis. The surface epithelium of the skin is the epidermis and is of the keratinized stratified squamous variety. Various skin appendages – sweat glands, sebaceous glands, hair, and nails are specialized derivatives of this epidermis, which is ectoderm in origin.

The deeper dermis is mesoderm in origin and consists mainly of bundles of collagen fibres together with some elastic tissue, blood vessels, lymphatic and nerve fibres. While partly due to its thickness and

blood flow, the main factor determining the colour of the skin is the degree of pigmentation produced by melanocytes, which are mainly found in the basal layer of the epidermis. The differences in the skin colour between the light and the dark skinned races are not due to differences in melanocyte numbers, for these are similar in number in all; in the darker skin the melanocytes are more active and thus produce more pigments, but there are also racial differences between melanin which vary in colour from yellow to brown and black.

Sweat glands are distributed all over the skin except on the tympanic membranes, lip margins, nipple surface of prepuce, glans penis and labia minora. The greatest concentration is in the thick skin of the palms and soles and on the face.

Sweat glands are coiled tubular structures that extend in to the dermis and sub cutaneous tissue. Cholinergic fibres of sympathetic nerves supply them. Apocrine glands are large modified sweat glands confined to the axilla, areola, periumbilical, genital and perianal regions. Ducts of these glands open into hair follicles or directly on to the skin surface. Their odorless secretion acquires a smell through a bacterial action. They enlarge at puberty and under go cyclic changes in relation to the

menstrual cycle in females. They are supplied by adrenergic fibres of sympathetic nerves.

Sebacious glands are small saccular structures in the dermis, where they open in to the side of the hair follicles. They also open directly on to the surface of the hairless skin of the lips, nipples, areola, inner surface of prepuce, glans and labia minora. Not present on the palms and the soles. They are particularly large on the face. Androgens act locally on these glands which have no motor innervation.

The arteries of the skin are derived from a tangential plexus at the boundary between the dermis and sub cutaneous tissue. Branches from this plexus form a sub papillary network in the dermis. Arterio-venus anastomoses are abundant in the skin.

The veins have a similar arrangement to the arteries. From a meshwork of lymphatic capillaries in the papillary layer of the dermis, lymphatic pass to a network between the dermis and hypodermis and sweat thence run centrally with the blood vessels.

Cutaneous nerves carry afferent somatic fibres mediating general sensation, and efferent autonomous fibres, supplying smooth muscle fibres of blood vessels arrectorpili muscles and sweat glands.

Tension lines of the skin are formed, due to the pattern of arrangement of collagen fibres in the dermis. Skin creases, such as the flexure lines over joints and wrinkles of aging, run parallel with tension lines. Incisions made along skin tension lines heal with minimum of scarring.

Wound Healing

Wound and their management is fundamental to the practice of surgery. The word healing means replacement of destroyed tissue by living tissue. The tissue injury or frank necrosis causes human to repair by forming the scar tissue. Knowledge of wound healing allows the physician to manipulate the wound to achieve an optimal result in a rapid period of time. All repairs occur through an over lapping series of orchestrated event to limit the damage and restore the function and integrity of the structures.

The amount of damage, time to healing and residuum of scar are all affected by intrinsic and extrinsic factors. The amount of tissue lost or damaged, the amount of foreign material or bacterial inoculation and the length of time of exposure to the toxic factors will affect the period of time to recovery. The greater the insult, longer the reparative process and the greater amount of residual scar.

Intrinsic factors such as atherosclerosis, cardiac or renal failure, chemotherapeutic agents and location on the body, will affect the wound healing.

Blood supply in the lower extremity is worst in the body; blood supply in the face and hands is the best. Older the patient the slower the healing.

Wound can be classified into acute and chronic

Acute wounds proceed in an orderly manner and timely reparative proceeds to achieve sustained restoration of structure and function.

Chronic wounds, for some reason does not proceed to a restoration of functional integrity. It is stalled in the inflammatory phase and does not proceed to closure.

Type of Wound Closure

a. Primary

b. Secondary

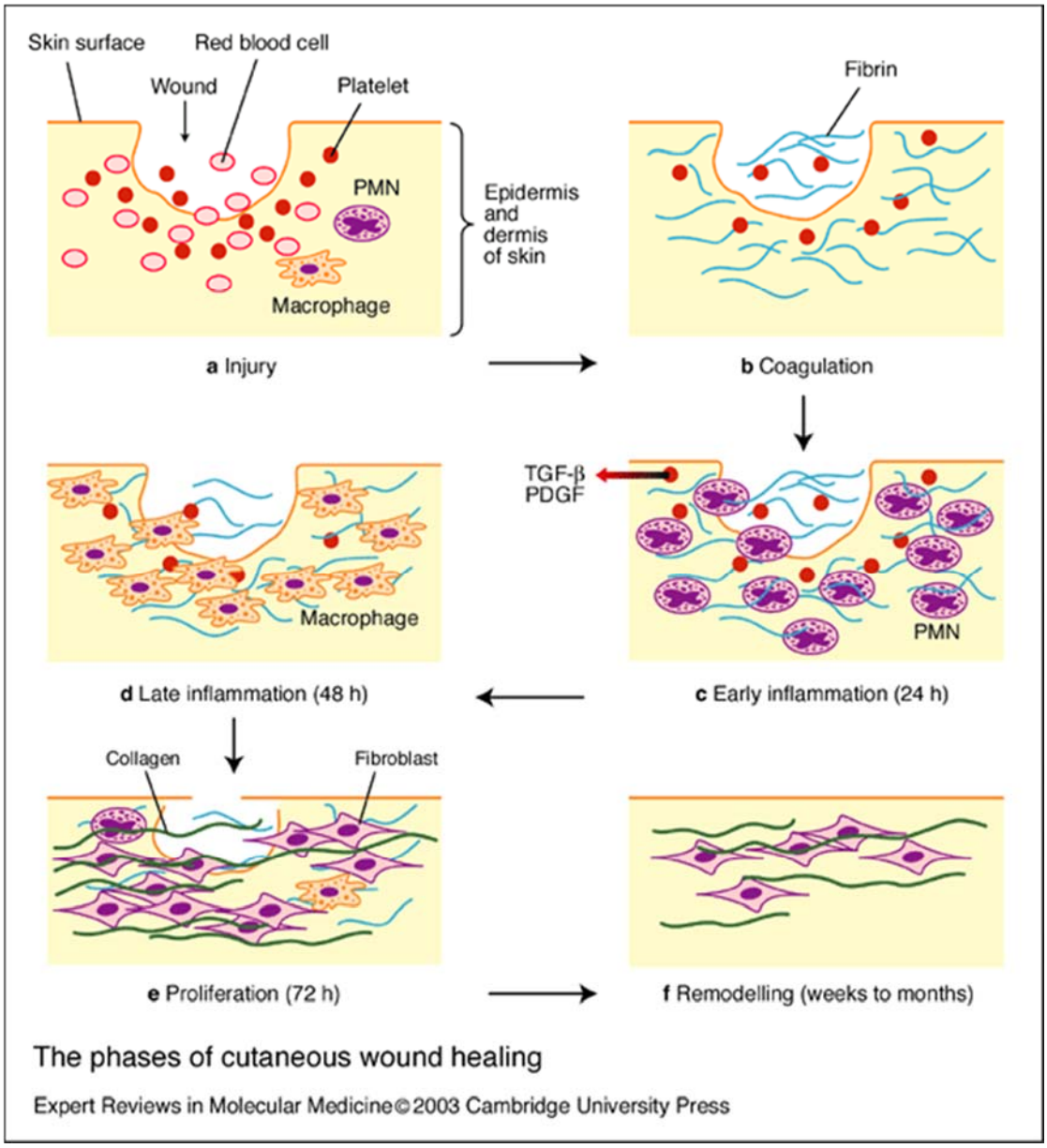
c. And tertiary repair

Primary are those wounds that are closed immediately with simple suturing, skin graft closure secondary closure involve no active intent to seal the wound. This may be the wound that may be highly contaminated to allow surgical intervention or one that patient never presented for medical attention. These wounds close by re-epitheliasation and contraction of the wound.

Closure by tertiary intention or delayed primary closure requiresapproximation of the wound margins delayed for several days after the wound has been created. A wound that is known to be infected, extensively traumatized is treated first with repeated debridement and antibiotics. When it is assessed as ready for closure, surgical intervention such as suturing grafting is performed.

Mechanism Involved in Wound Healing

There distinct biological mechanisms are involved in all wounds healing process, however there are significant differences in the contribution of each mechanism, depending on the type of wound.



The phases of cutaneous wound healing

1. **Epithelialisation** : - Is the process where by keratinocytes migrate and then divide to re surface partial thickness loss of skin or mucosa. Eg; abrasions, blisters, partial thickness skin grafts donor sites and first and second degree burns.

2. **Contraction :** - Is the mechanism where by there is spontaneous closure of full thickness skin wounds or constriction of tabular organs such as common bile duct or esophagus after injury.

3. **Connective Tissue Matrix Deposition :** - It is process where by fibroblasts is recruited to the site of injury and produce a new connective tissue matrix.

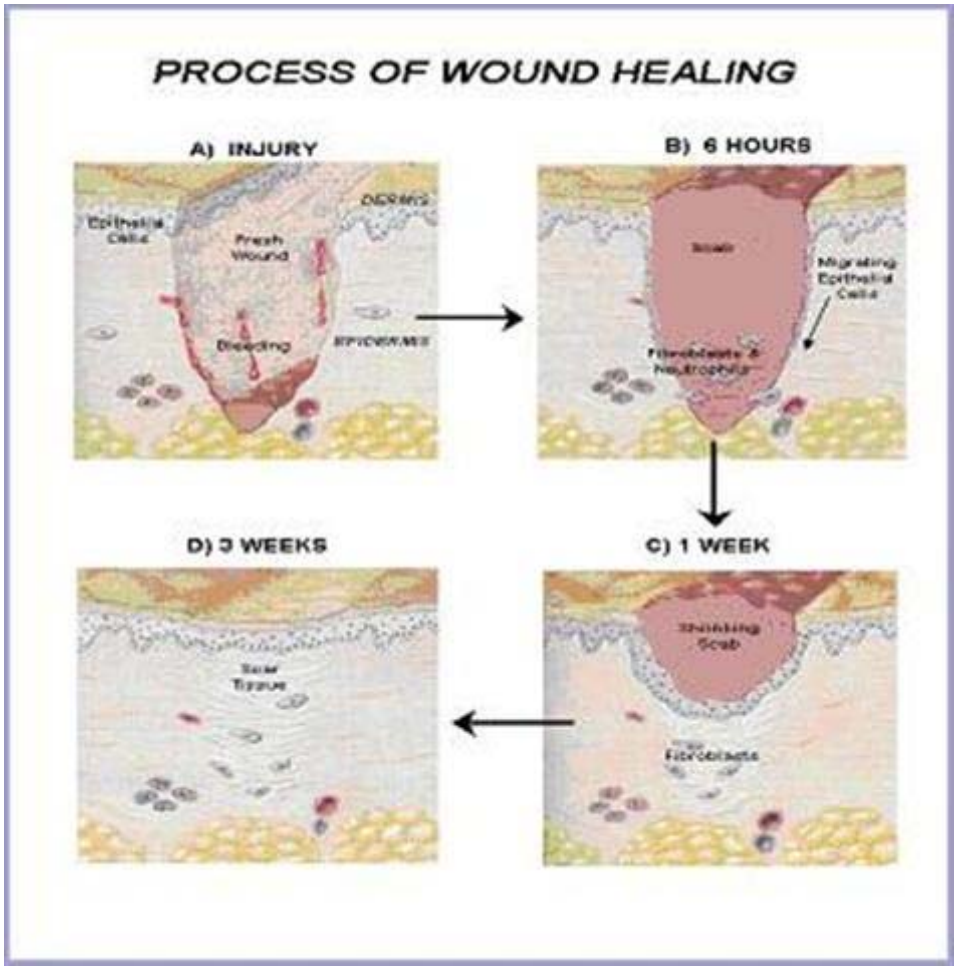
This process is of major importance in primary wound closure, be it skin, tendon or intestinal anastomosis. The cross linked collagen and itsorganization in the connective tissue formed in the process provide the strength and integrity of all tissues.

Phases of Wound Healing

Inflammatory phase also called as reactive phase. The body's defenses are aimed at limiting the amount of damage and preventing further injury.

Proliferative phase also called as regenerative phase is the reparative process with reepithelialisation, matrix synthesis, and neo vascularisation to relieve the ischaemia of trauma itself.

Maturational phase : It is are modeling phase. It is the period of scar contracture with collagen cross linking, shrinking and a loss of edema.



In a long wound such as pressure sore, the eschar or fibrinosis reflects the inflammatory process, the granulation tissue is a part of prolifirative phase, the contracting or advancing edge is part of the maturation phase. All these may occur simultaneously, and the phases with their individual process may overlap.

Inflammatory phase : During immediate reaction of tissues to the injury, hemostasis and inflammation occur. These are attempt to limit the damage by stopping the bleeding sealing the surface of the wound and removing any necrotic tissue, foreign debris or bacteria present.

Healing Responses

1. Stop bleeding
2. Chemotaxis
3. Epitherial migration
4. Proliferation
5. Maturation
6. Contraction
7. Scarring
8. Remodeling of scar

Hemostasis

Disruption of endothelium and exposure of type IV & V collagen platelet aggregation. These platelets release biologically active proteins like (i) From alpha granule platelet derived growth factor (PDGF), transforming growth factor (TGF) –β, insulin like growth factor (IGF)– 1, fibronectin, fibrinogen, thombospondin and von willebrand factor (ii)

From dense bodies – serotonin (iii) From Lysosomes – hydrolase & protease. The clotting cascade is initiated through both the intrinsic and the extrinsic pathways. The fibrin strands trap red cells, from a clot, and seal the wound.

Leukocytes

Leukocytes are chemoattracted and activated, adhering to the endothelium in the area of injury. C5a and leukotriene B4 promote neutrophil adherence and chemoattraction. Monocytes & endothelial cells produce interleukin (IL)-1 tumor necrosis factor (TNF) – a these chemotactic factors bring about 'diapedesis', facilitated by capillary permeability caused by serotonin, histamine and bradykinin.

Neutophils with the help of lgG and complement system phagocytose the bacteria.

The activated Neutophils can scanvenge necrotic debris, foreign material & bacteria.

Although this activity (forming hydroxyl radicals, O-H) is helpful for debriding the wound and allowing the scaffolding of the reparative process to be laid down, it is also further destructive to surrounding viable tissue. Thus, early intervention to debride a wound and remove

bacteria will limit the amount of inflammation (especially “oxidative burst”) and subsequent scarring.

Lymphocytes

The macrophage processes the foreign debris including bacteria or enzymatically degraded host proteins and presents these to lymphocytes. This will stimulate lymphocyte proliferation and cytokines release. T-cells produce IFN-γ, which targets the monocytes, or macrophage, stimulates them to release TNF alpha & IL-1, INF- γ also inhibits monocyte migration, which probably keeps these cells at the site of injury. IFN - γ can cause glycosaminoglycan (CAG) synthesis and suppress collagen synthesis. Thus, this may be an important mediator of the chronically open, nonprogressing wound.

Macrophage

The macrophage is the one cell that is truly central to wound healing, serving to orchestrate the release of cytokines and stimulate many of the subsequent processes of wound healing. Monocytes are chemoattracted later than leukocytes and at the same time as lymphocytes. Monocytes convert to macrophages in the wound. Some wound macrophages, however are tissue macrophages that proliferate locally.

Bacterial debris, C5a and TGF-β are chemotactic for monocytes and activate it to release cytokines like IL-1. The activated macrophages release free radicals as well.

Macrophages also includesghospholophase thus degrading cell membrane phospholipids releasing thromboxane A2, prostaglandin F2α, LT B4 & LTC4. LTB4 is a potent chemotactic for Neutrophil. Macrophages secrete collagenase when activated by bacterial degradation by products through cyclic AMP pathway. TNF alpha and IL-1 induces fever, increases collagenase production, cartilage and bone resorption. Macrophages release several different colony- stimulating factors to induce proliferation and differentiation of stem cells from the bone marrow.

Activated manocytes release TGF α and β is the most potent stimulant of fibroplasia and chemotactic for monocytes. TGF- α stimulates epidermal growth and angiogenesis. As the concentration of TGF β rises in the inflammatory site, the fibroblasts are directly stimulated to produce collagen and fibronectin, thus leading into the proliferative phase.

Proliferative Phase

As the acute responses of hemostasis and inflammation begin to resolve, scaffolding is made for repair of the wound. Central to this phase are the repair processes of angiogenesis, fibroplasia, and epithelialization. This stage characterized by the formation of granulation tissue, consisting of a capillary bed, fibroblasts, macrophages, a loose arrangement of collagen, fibronectin, hyaluronic acid and bacteria.

Angiogenesis

Epithelial cells migrate through degraded basement membrane of postcapillaryvenules. Activated endothelial cells also degrade the basement membrane. Migrating endothelial cells divide and form tubule or lumen. Eventually basement membrane is deposited forming new capillary. Both acidic and basic fibroblast growth factors (FGF) stimulate angiogenesis. Heparin not only stimulates the migration of capillary endothelial cells but also adheres many growth factors like basic FGF, endothelial cell growth factor, cartilage derived growth factor etc, to basement membrane. TNF α is chemotactic for endothelial cells and stimulates endothelial cell proliferation to form capillary tube. TGF β is a chemoattaractant for fibroblasts and assists angiogenesis by signaling the fibroblasts to produce the FGFs.

Several of the matrix materials from the wound site are angiogenic like fibronectin and hyaluronic acid. The complex interaction of extracellular matrix material and cytokines causes angiogenesis. Angiogenesis is necessary to support a wound environment that can repair the injury.

Fibroplasia

Fibroblasts are chemoattracted to the inflammatory site by noxious stimuli, where they divide and produce the components of the extracellular matrix. PDGF and basic FGF make fibroblasts competent to replicate. IGF and epidermal growth factor stimulates the competent fibroblasts to replicate. As the early activities of wound healing progress, the interaction of several different cell lines and cytokines result in the fibroblast proliferation that characterizes a wound cleft.

Epithelialization

When a gap occurs in the epidermis, the wound is first sealed by a blood clot. Epidermal cells migrate from the periphery or the depth of epithelium lined skin appendages to resurface the wound. Some cellular proliferation occurs as well. If the basement membrane zone is intact, epitheliazation proceeds more rapidly. The basal cells are stimulated to

migrate, their attachment to adjoining cells and to the dermis loosen, and those epithelial cells that are in the leading edge of migration becomes phagocytic. Cells slightly behind the leading edge begin to divide.

The epithelial cells move as an intact sheet until the edges establish contact. if the basement membrane zone is not intact, it will be repaired first. Initially wound cleft is coated with fibrin, fibronectin, laminin, type IV Collagen and hyaluronic acid.

Epithelial cells by expressing fibronectin receptors and releasing proteases migrate through the wound cleft. Matrix material like vitronectin, collagen types I, III, IV, Tenascin and laminin bring about epithelil adhesion and spreading.

Collagen structure:

Collagen is a triple helix molecule. The fiber forming collagens are type I, III, V and XI. Procollagen synthesized at rough endoplasmic reticulum is secreted to extracellular space. Several Proteases cleave the procollagen, forming the collagen monomers. The monomers assemble into fibris. Lysylhydroxylysyl oxidation and cross linking occur, forming the collagen fiber. Ascorbin acid Stimulates collagen synthesis.TGF- β, IGF-1 and IGF-2 increase collagen synthesis.Gluconcoriocoids and IFN-γ inhibits procollagen gene transcription.

Several generic disorders are caused by abnormalities in collage. Osteogenesisimperfecta is caused by a deletion of one procollagen alpha - allele. Variations of ehlers –Danlos syndrome are caused by abnormal type III collagen, deletion of part of the type I collagen gene, abnormal copper utilization, or deficiency in Lysol hydroxylase, all of which combine to form abnormal collagen. Collagen type VII absence leads to epidermaolysisbullosa as the anchoring fibrils connecting the lamina densa in the basement membrane zone fail to anchor the epidermis to the underlying dermis.

Elastic fibres:

Both IGF-1 & TGF-β stimulate production of elastin.

Glucocortiocoids reduce adult skin cell production of elastin, as does basic FGF.

Matrix metalloproteases (MMP's) produced by fibroblast and monocyte degrade the elastin in the wound cleft.

Glycosaminoglycans:

Are found in the tissues, i.e. on the surface of the cells.

These molecules support cells, provides tissue turgor and facilitated cell-cell interaction. Wound cleft has sulfated GAG along with fibrin, fibronectin, and hyauronic acid. Fibroblasts deposit the collages into a fibronectin and GAG scafforl.

The proteoglycans (e.g.: Heparan sulfate) in general are important as a cushioning effect for tissue such as cartilage because they resist compression owing to the hydration shell that accompanies them. Dermatan sulfate is increased in granulation tissue and collagen deposition. As they are able to bind water and cation, they an selectively attract these in the extracellular environment of the world war.

Maturational Phase:

All wounds contract. As they do so, they pull normal surrounding tissue into the area of wound, reducing the amount of disorganized scar that eventually must remain. However, although scar Contraction is normal, scar contracture is not. Contracture results when an important area has too much Scar to prevent the normal wound contraction from causing a functional disability. Wound contraction appears to occur by complex interaction of the extracellular materials and Fibroblast. In a contracting wound, fibroblasts undergo change to stimulated cells called as Myofibroblasts. They have contractive ability. MMP's also play an

important role in wound contraction. They allow cleavage of the attachment between the fibroblasts and the collagen so that the lattice can be made to contract. Once the wound is healed, the wound will remodel and mature.

The fibroblast population decreases, and the dense capability network regresses. Wound strength increases rapidly Within 1 to 6 weeks and then levels off as sigmoid curve up to 1 year after the injury. Cross linking of Collagen causes further would contraction and increase in strength, it also results in a scar that is more Brittle and less elastic than normal skin.

Factors Affecting Wound Healing

Various factors which influence wound healing can be divided into two groups: Systemic

(General) factors and local factors

Systemic factors (General factors)

Age: The aging process effects all the stages of wound healing, but macrophages are particularly imparted. As these play such a central role in the wound healing process, there is significant delay from this aging effect alone.

Nutrition:

(i) **Protein deficiency :** Protein depletion causes impairment of granulation tissue and collagen formation. It is not always due to inadequate intake but 40may be due to excessive loss e.g.: nephritic syndrome, cirrhosis etc. in a malnourished patient wound healing is badly affected both delayed and qualitatively poor wound healing. Especially methionine and cystine have beneficial effects if they are provided in nutrition.

(ii) **Vitamin C**: It is required for normal collagen synthesis. Enhances conversion of praline to hydroxyl praline and lysine to hydroxylysine.

Maturation of collagen does not occur in the absence in the absence of vit C.

(iii) **Vitamin A**: It is required for proper epithelialization. Deficiency of vit A will impair pronocyte activation, fibronectic deposition that further affects cellular adhesion, and compairment of the TGF-β receptors.

Zinc, Calcium, Copper, Manganese deficiency : Zinc is a necessary cofactor for RNA polymerase and DNA polymerase (enzymes of protein synthesis). There is some failure of granulation tissue formulation in case of Zinc deficiency. Others are essential minerals, which are also required for proper wound healing. These may be deplete in intestinal fistula and burns.

Oxygen : Oxygen is required for normal wound healing. Hypoxia causes defective wound healing. Oxygen is required for all metabolic activities of wound healing and for synthesis of oxygen radicals for wound debridement.

Hematological derangement: Neutrophil deficiency, bleeding disorders and anemia al cause defective wound healing and certain genetically inherited phagocytic and chemotactic deficiencies affect wound healing.

Metabolic diseases :

(i) Diabetes mellitus : Impairs wound healing at all stages of the process. The basement membranes of the capillaries are thickened causing decreased perfusion in the microenvironment. Lymphocyte and leukocyte function is impaired, and there is increased collages

degradation and decreased collagen deposition. The collagen that is formed is more brittle than the normal collagen, probably owing to glycosylation from the increased levels of glucose present in the extracellular matrix.

(ii) Jaundice : Impaired fibroblast function and delay in angiogenesis is seen in jaundiced patients.

(iii) Uremia: Retards connective tissue formation and slows epithelial repair.

Drugs and Corticosteroids : - Some exogenous drugs directly inhibit wound healing. Doxorubicin (Adriamycin) is a potent inhibitor of wound healing. Nitrogen mustard, cyclophosphamide, methotrexate, and bis-chloroethyl-nitrosourea (BCNU) are the other most potent wound inhibitors. Tamoxifen is known to decrease cellular proliferation, due to decreased TGF- β production.

Glucocorticosteroid impair fibroblast proliferation and collagen synthesis. The amount of granulation tissue formed is also decreased. Steroids stabilize the lysosomal membranes. This particular effect can be reserved by the administration of vitamin A.

Lonizingradiation : Causes endothelial cell injury with endarteritis resulting in atrophy, fibrosis and delayed tissue repair. As its greatest effect is on cells the G2 through phase, rapidly dividing cell populations are most sensitive to radiation. This would include the keratinocytes during the wound healing process, impairing epithelialization.

Local factors:

(i) **Infection:**

Wound infection is the most common cause of delayed healing. If the bacterial count in the wound exceeds 105 organisms per

gram of tissue, or if any beta-hemolytic streptococcus is present, the wound will not heal by any means including flap closure, skin graft placement, or primary sutures. The bacteria prolong the inflammatory phase and interfere with epitheliazation, contraction and collagen deposition. The endotoxins themselves and destruction of surrounding previously normal tissue. Treatment to decrease the bacterial count, either mechanically or with the use of systemic antibiotics, will therefore limit the amount of inflammation and allow closure of the wound.

(ii) **Blood supply :** Local adequacy of blood supply for wound healing is necessary. Wounds with poor blood heal slowly e.g.: wound over pretibial region, on the legs with varicose veins, on ischaemic limbs, etc. **Foreign bodies:** Impairs and prolongs the wound healing.

(iii) Tissue tension, hematoma formation

(iv) Recurrent trauma.

(v) Complication of radiotheraphy

(vi) Excessive use of topical corticosteroids.

WOUND CARE :

1. Local environment condition must be optimal for cellular metabolism.

2. Drying of exposed tissues not only kills surface cells but also destroys normal blood flow in small vessels some distance from the surface.

3. A suture under tension cause choking off all local blood flow as tissue swell 4. External pressure from carelessly applied dressing can decrease local tissue perfusion.

5. Preparation solution for skin like iodine, either, alcohol if poured into an open wound would kill cells on contact. Open wound must be protected from all substances harmful to living cells.

6. Removal of all dead materials and prevention of fluid collection.

7. Copious stream of saline will flush foreign bodies, undesirable organisms and other surface contaminants.

8. Frequent wet-to-dry dressing can produce debridement.

9. Infection, fibrosis, Hypertrophic, scars and foreign body granulumas follow careless handling.

10. When doing primary closure, wounds should not be closed under tension.

Failure to recognize this results in wide scars, wound dehiscence, or necrosis of wound margins.

11. Absorbable sutures are used when infection is known to be present or when debridement has been difficult non absorbable suture materials produce less tissue reaction but in areas where infection develops it can harbor organisms and infection will not subside until sutures are removed. Including anastomotic leakage, hernia recurrence or fracture non-union.

WOUND DRESSING :

Dressing for primarily closed wounds generally have been over emphasized.

During the 48 hours dressing is required to protect the wound from environment and to absorb wound drainage. After the first 48 hours an epithelial seal is present, and the dressing is merely for appearance for possible comport.

Dressing used in plugging and concealing wound such as lint, cotton wool or passive dressing. New dressing such as polymeric films and foams, particulars and fibrespolymors, hydrogels and hytrocolloids known as interactive dressing, the provide a micro environment which is conductive to healing. One of hydrocolloid dressing (Duoderm / Granuflex), provides a healing environment that improves healing and also stimulates angiogenesis.

Culture autografts and allografts: biological wound covering with epidermal autografts and allografts showed to be replaced rapidly by host keratinocytes thus acting as temporary coverage with stimulating healing process6.

Dressing that deliver specific growth factors, pharmacological agents to stimulate healing or serve as transducers to provide physical forces to wound like electrical stimulation, ultrasound are under trait for managing chronic wounds.

FETAL WOUND HEALING

Fetal tissues repair themselves without scar formation is recent discovery. The fundamental differences in the fetal tissue repair process compared with the adult are

1. Lack of inflammatory response to injury may be due to either sterile environment or due to fetal immune system in immature with decreased chemotaxis, opsonisation and complement activity.

2. Distinct different composition of extracellular matrix containing abundant hyaluronic acid, a glycosaminoglycan rather than collagen (because of persistence of hyaluronic acid stimulation activity (SASA).

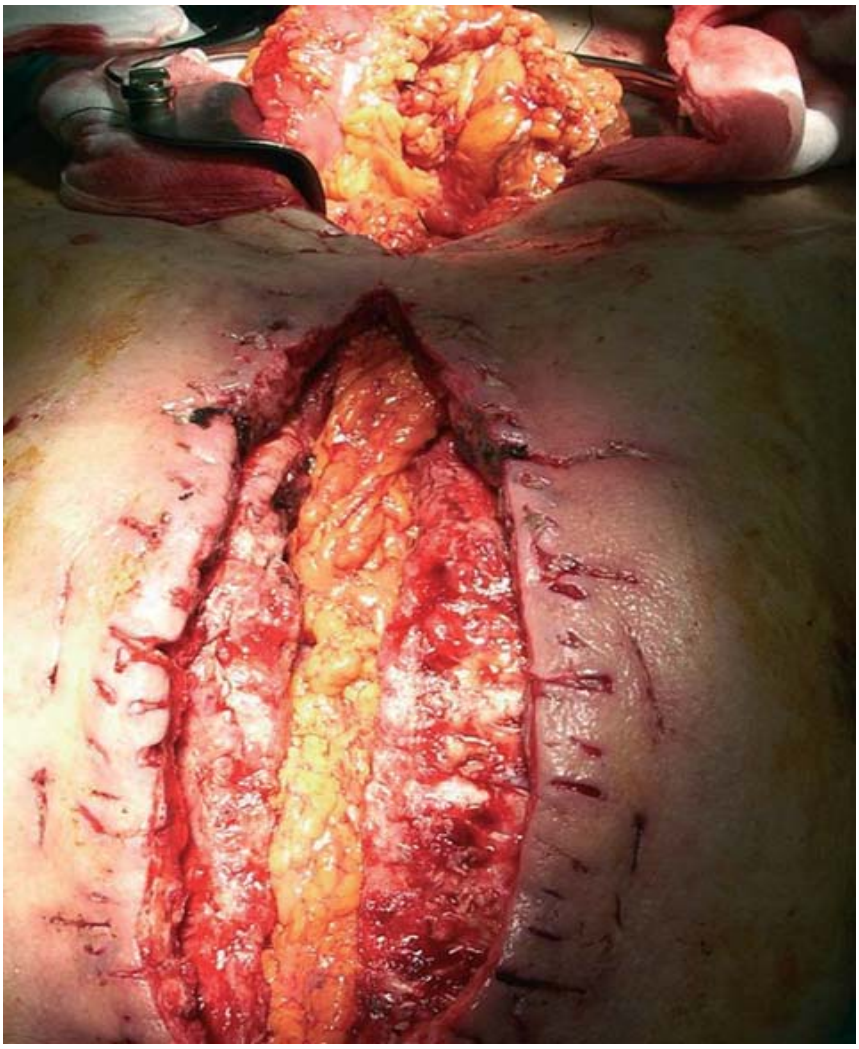
3. Low concentration or absenece of peptide growth factors.

4. Fetal cells may be programmed for repaid by regeneration, a trait that disappearpostnatally.

5. Intrinsic (i.e., oxygen tension of the human fetus) and extrinsic (amniotic fluid environment) differences between fetal and adult wound healing, with most stating that the intrinsic differences are the key determinants in whether wounds will heal with scars.[32] Intrinsic differences include fetal oxygen tension, which is markedly decreased (fetal sheep, mean PaO2 of 20 mm Hg) when compared with adult animals (adult sheep, mean PaO2 of 116 mm Hg).[33] This decrease in fetal oxygenation is partially compensated by the relative affinity of fetal hemoglobin for oxygen.

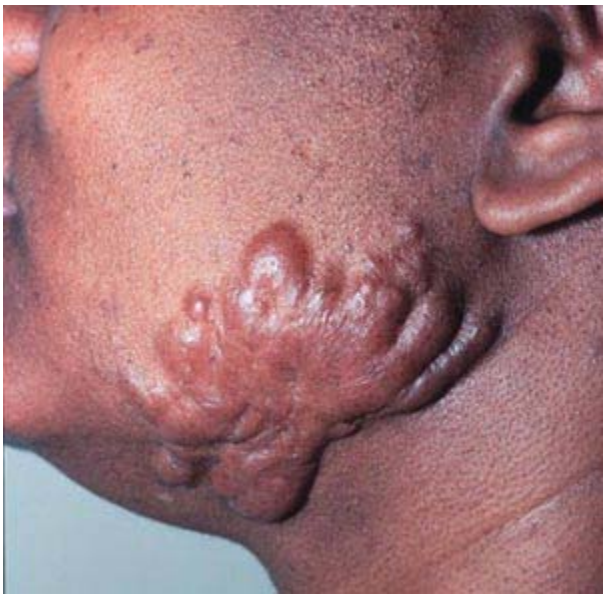
6. The fetal environment, an extrinsic difference between fetal and adult wounds, is characterized by a hyaluronic acid–rich amniotic fluid. Studies suggest that the increased number of hyaluronic acid receptors and increased amount of hyaluronic acid may create a permissive environment in which fibroblast movement is facilitated and thereby results in the increased rate and efficiency of fetal healing.[32]

Complications of Wound Healing



1) Wound dehiscence (bursting) occur in the first few weeks after surgery before substantial completion of collagen cross-linking. Excessive wound tension, sudden increase in mechanical stress, poor metabolic status (hypoproteinemia, Vit C deficiency) result in weak scars and increase likelihood of dehiscence.

2) **Hypertrophic scars and keliod :** Result from post-traumatic tissue over production of connective tissue leading to firm raised flesh.



Etiology :

1. Trauma
2. Tension
3. Hormonal changes
4. Familial predisposition – autosomal recessive or dominant.

5. Associated with other dermatologic disorders – Dissecting cellulitis of scalp, Acnevulgaris, Acneconglobata, Hydradenitissuppurtiva, Pilonodal cyst, Foreign boy reactions.

6. Certain infections – Herpes zoster, small pox, Vaccinia.

7. Certain connective tissue diseases : Ehler – Danlos Syndrome, Rubinstein Taybi syndrome, pachydermaperiostosis, scleroderma.

Clinical features : Predilection sites – Earlobes, shoulders, anterior chest, upper arms, mandibular angles.

Drying of exposed tissues not only kills surface but also destroys normal blood flow in small vessels some distance from the surface.

Pathophysiology : Increased cellularity and metabolic activity. Most prevalent phycprotien is chandroitin – 4 sulphate.

Pathology : Avascular collagen nodules.

Treatment:

1. Intralesionalcorticosterioid : (Triamciloneacetonide) treatment – various needle and syringes described.

Lever – LOK needle and syringe.

2. Mechanical injectors: spring or CO2 powered e.g.: ligmajetmechincal injector.

This therapy may be combined with cryotherapy or surgery.

Local complications: Hypopigmentation, telangiectasia, atrophy, ulceration and necrosis. Systemic complications: Cushingoid habitus.

3. Surgery : Indication – Keloids that do not respond to corticosteroids, pressure therapy, or other topical therapies. Laser surgery can be used.

4. Adjuvant therapy:

1. Oral antihistamines
2. Pentoxifylline
3. Pencillamine (lyayl oxidase inhibitors) or colchicines following surgical excision.
4. Pressure therapy.
5. Radiation therapy (Total dose 1,500 to 2000 rads).
6. Electrical stimulation following excision.
7. Topical retinoids such as 0.025% retinoic acid or 0.05% Tretenoic cream.
8. Human recombinant interfection Gamma (IFN-γ).
9. Silicon gel.

5. Cicatrization or Contractures : Exaggeration of wound contraction process (action of myofibroblasts) results in severe deformity at and around the wound site.

Neoplasia: An enhancement in the rate of cell turnover inereases the likelihood of tumour indication.

Others : Like painful scars, weak scars, pigmentary changes, implantation cysts, wound failure including anastamotic leakage, hernia recurrence or fracture non union.

New Horizons in Wound Healing

Research in the field of wound healing is targeted towards the concept of wound manipulation. Clinical trials have shown the beneficial effect of treatment of chronic wounds with growth factors. Although this treatment is still quite costly, as technology improves, this non-operative

treatment may eventually be less costly than repeated operative intervention. Prospective randomized studies have shown more rapid closure of venous stasis ulcer, pressure sores, and diabetic foot wounds using a variety of cytokine such as TGF-β basic and PGDF. But this therapy is very costly.

Unit the precise cytokine deficit is known for each wound type, application of growth factor remains an educated guess. Chronic wounds have a significance increase in MMPs (Matrix Metalloproteases). This increase in wound gelatinase and collagenase compared with acute wounds may cause enzymatic degradation of the drug treatment as it placed in wound. Before it has the opportunity to effect an improvement. Some investigators are examining be effect of blockage of the MMPs either directly or by increasing the amount of tissue inhibitors of the MMPs. The growth factor are too expensive to simply place in the wound and allow them to be degraded before they interact with the cellular components of the wound. Also chronic wounds in diseases like diabetes the cause in the cellular dysfunction in the fibroblast. Such cases would prevent us of endogenous growth factor. Addition of exogenous growth factor is therefore unlikely to be helpful.

Further manipulation of the wound is possible with genetic intervention. If the application of expensive growth factor allows a chronic wound to proceed to closure, then application of the gene responsible. Safety factor with viral vectors, such as the adenovirus or the herpes simple virus, continue to limit this research to animal and invitro models. Mechanical means such as micro injunction or partical bombardment are less efficient but do not hold the risk of oncogenesis perceived with virul vectors.

Electrical stimulation :

Various experiment have been performed to examine the effect of electrical stimulation on the wound healing process. An increase in the number of fibroblasts has been seen in incisional and second degree burn wounds often stimulated with electrical currents. The motility of fibroblasts has also been found to be influenced by electrical fields, fibroblasts exposed to a continuous electrostatic field have shown a significant increase in collagen synthesis and DNA.

Increase in DNA protein stimulation of fibroblasts depending on the intensity.

Electrical stimulation has been shown to increase the expression of receptors for TGF-β. Reich et at reported the effect of electrical stimulation in reducing the number of mast cells that have been associated with a variety of wound healing complications including fibrosis and hyertrophic scars.

Ultrasound : Ultrasound refers to high frequently mechanical vibrations created by conversion of electrical energy into sound waves that are inaudible to human beings. When ultrasonic waves are applied to soft tissue, they serve as a source of absorbable energy. The absorption of this energy by various tissue components initiates variety of physiological response. The physical effects of ultrasound fall into two categories:

Thermal

Thermal effects: Beneficial effects of this therapy include decrease in paid, decrease in muscle stiffness and spasm, increase in collagen elasticity and acceleration of wound healing. The effect of wound healing has been attributed to thermal enhancement of metabolism and enzyme activity.

Non-thermal effects

Non thermal effects of ultrasonic induction derive primarily from changes in cellular membrane permeabilities as a result of three types of physical forces generated namely: Cavitation, streaming and standing wave formation. Cavitation refers to the formation of microscopic bubbles on any fluid medium upon which the sound waves impinge. Streaming is a measurable mechanical force induced by ultrasound that is unidirectional and steady. The permeability changes generated by cavitational and streaming may affect the diffusion of cellular metabolites, which can elicit a therapeutic benefit. Specific stimulatory effects have also been documented in fibroblasts and macrophages and on angiogenesis.

Negative Pressure–Assisted Wound Closure

One of the largest discoveries was the improvement in wounds with negative pressure–assisted wound closure. Additional studies have demonstrated significant improvement in wound depth in chronic wounds treated with negative-pressure therapy as compared with wounds treated with saline wet to moist dressings.[34] In addition, treatment with negative pressure results in faster healing times with fewer associated complications The exact mechanism of the improvement in healing with

negative-pressure therapy has yet to be determined. Many authors initially believed that the reason for increased wound healing is the removal of wound exudates while keeping the wound moist. As originally hypothesized by Argenta and colleagues, with negative-pressure therapy, there is a fivefold increase in blood flow to cutaneous tissues.[35] Further studies have shown an increase in capillary caliber and stimulated endothelial proliferation and angiogenesis.[36] Interestingly, it is well know that increased bacterial loads result in slowed wound healing; however, despite increased wound healing with negative-pressure therapy, it has been shown to result in increased bacterial counts.[37]

Scaffolds

When dressings alone fail to achieve healing, the clinician now has a variety of advanced therapeutics to turn to. Topical application of

growth factors to chronic wounds has not been as beneficial as anticipated, presumably because they are degraded by proteases in the wound fluid. Researchers are now investigating whether localized gene therapy may be a better delivery system for providing growth factors to the wound bed. In addition, dressings that actively alter the wound matrix are currently being developed. One such device, oxidized regenerated cellulose/collagen, has been found to promote human dermal fibroblast proliferation and cell migration, accelerate wound closure in diabetic mice, and possibly sequester or inactivate proteases. [38] Biodegradable scaffolds, either natural or synthesized, may also alter the wound milieu to be more favorable. Porcine small intestinal submucosa has been demonstrated in a number of applications to provide a scaffold for tissue repair and reconstruction. Though xenogeneic, this acellular scaffold is minimally immunogenic and has been shown to be completely degraded and replaced by host tissue.[39]

Hyaluronic acid conjugated with glycidyl methacrylate, chondroitin sulfate, or gelatin has been shown to have vulnerary effects on wound-healing parameters. [40] [41]

The addition of live cells to scaffolds is a promising therapy for chronic wounds that are very difficult to heal. Whether using actual

cultured skin with both fibroblasts and keratinocytes or fibroblasts integrated into a dermal matrix, the neonatal cells provide growth factors and matrix elements consistent with rapid healing. They are currently cost prohibitive for large wounds and are primarily applicable only to shallow ulcerations.

In summary, the choice of dressings needs to be based on the basics of wound bed preparation and modified according to the characteristics of the wound. Despite the availability of many dressings on the market, there have been no substantial studies showing a difference in healing between dressings of the same category. Thus, a systematic approach that addresses débridement, exudate management, and bacterial burden should be the standard of clinical practice and can be accomplished even in situations with limited resources.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present study is a prospective study consists of 100 cases admitted in GOVERNMENT RAJAJI Hospital, attached to Madurai Medical College, madurai during the study from September 2013 to August 2014 (including sampling procedures, if any) 60 cases for the purpose of the study were selected randomly to receive either staples or conventional sutures for abdominal skin wound closures.

INCLUSION CRITERIA

All patients admitted in general surgery in our unit at GRH who had under gone laparotomy.

EXCLUSION CRITERIA

Children under 13 years will be excluded from this study.

Patients who are not willing to be a part of this study will be excluded.

METHODOLOGY

1. Clinical study will be through questionnaires and clinical examination

2. Post operative observation of patients

3. Regular follow up of patients treated

DATA ANALYSIS

Using statistical analysis

The methods of skin closure for each case was determined after repair of the deeper layers, by the next sequence number from a randomization . The process of closure was timed in minutes, the length of the wound was measured and the number of staples or number of suture packs used was recorded. Staples or sutures were placed by surgeon preference.

Staples were removed with a device that painlessly opened them sideways, while sutures were removed in the conventional way. Wound closures were generally removed at ten days and the ease or difficulty of removal was recorded. Pain attributable to the skin closure was assessed as either present or absent at each stage.

The cosmetic appearance was assessed 'blind' at thirty days.

RESULTS

RESULTS

The following study was conducted at GovtRajaji hospital which is the hospital attached to Madurai medical college. A total of 60 patients participated in this study. Patient selection was such that that we included only the patients undergoing laparotomy in our unit. Of the 60 cases 30 were undergoing laparotomy as an elective surgery as in gastrectomy for cancer stomach or abdominoperineal resection for cancer rectum etc. other 30 cases were those who underwent laparotomy as an emergency surgery like bowel perforation(DU or IU) abdominal trauma etc. of these 60 patients only 4 were under the age group of less than 20. There were 17 patients in the age group of 20 to 40 of which 7 underwnt suture closure whereas 10 underwent stapler closure. There were 30 patients in the age group of 40 to 60 of which 16 underwent suture closure and 14 underwent stapler closure. There were 9 patients in the age group above 60 of which 3 underwent suture closure and 6 underwent stapler closure. The results are as follows

The length of the laparotomy incisions varied and of the 60 cases only one of the case was less than 15 cm (UML or LML)which was closed by staples,20 cases the length was 20 cms of which 12 cases were closed by suture and 8 cases closed by stapler. In another 20 cases the

length of the incision was 25 cms of which 10 was closed by suture and remaining 10 was closed by stapler. The remaining 19 cases were of 30 cmslength (ML) which were mostly in emergency setting where it warrants full thorough laparotomy and often the incision exetends from xiphi sternum to pubis. Of 19 such cases 8 were closed by suture and remaining 11 was closed by staplers.

The number of suture material or stapler required to close the wound was measured. Among the cases less than 15 bites were necessary for about 14 cases closed by suture and one case closed by stapler. About 16 to 20 bites were necessary among 8 of the cases closed by suture and 13 of the cases closed by staplers. More than 20 bites were needed among 8 of the cases using suture and 16 of the cases using staplers. The suture needed every bite approximately 1.8 cm after the previous bite whereas in case of stapler it was approximately 1.2 cm. This was statistically significant with p value of 0.006 with more bites needed for closing a given length of wound using stapler rather than a suture

The time needed to close the given wound was calculated of which 17 of cases closed with staplers were completed within 5 min whereas no case closed with suture was completed in that time. 13 cases closed with stapler required 6 to 10 min whereas 5 cases closed with

suture was able to complete in that time. About 15 cases closed with suture required 11 to 15 min to complete whereas 10 cases closed with suture required 16 to 20 min to close. In contrast no case closed with stapler required more than 10 min and this was statistically significant proving closure of skin with staples reduces the operative time by more than one fourth.

Regarding the appearance of scar about 18 cases closed with suture and 23 cases closed with stapler were good in appearance after one month follow up. About 13 of cases closed with suture and 7 of the cases closed with stapler had fair to poor wound after one month with widening or hypertrophy of scar with itching. Of particular note is that 6 of 13 cases in suture group needed resuturing and 5 of 7 cases in stapler group needed resuturing and all those 11 cases were cases who underwent emergency laparotomy.

Among the suture group 9 cases were infected in the post op period leading to seroma or hematoma or frank pus whereas 6 cases in stapler group were infected and majority of these cases were from emergency laparotomy like DU or IU. However these were not statistically significant and there was no difference in the rate of infection between the two groups.

The pain in the wound site during immediate post op and during removal of suture or stapler was statistically significant. Pain score was based on linear verbal analog score. Among suture group 10 patients had pain score between 1 and 3 whereas all 30 cases in stapler cases fell into pain score 1 and 3. 20 cases of suture group had a pain score between 3 and 4 whereas no case from stapler group had pain score above 3 and this was statistically significant with a p value less than 0.001. Apart from the more efficient use of theatre time, the psychological effect of rapid wound closure at the end of a long operation on surgeon and theatre staff was very evident during this trial.

TABLE 1

NUMBER OF CASES

Suture Method	No. of cases
Suture	30
Stapler	30

A total of 60 patients participated in the study of which 30 of the cases skin was closed with silk suture and remaining 30 by staples

CHART -1

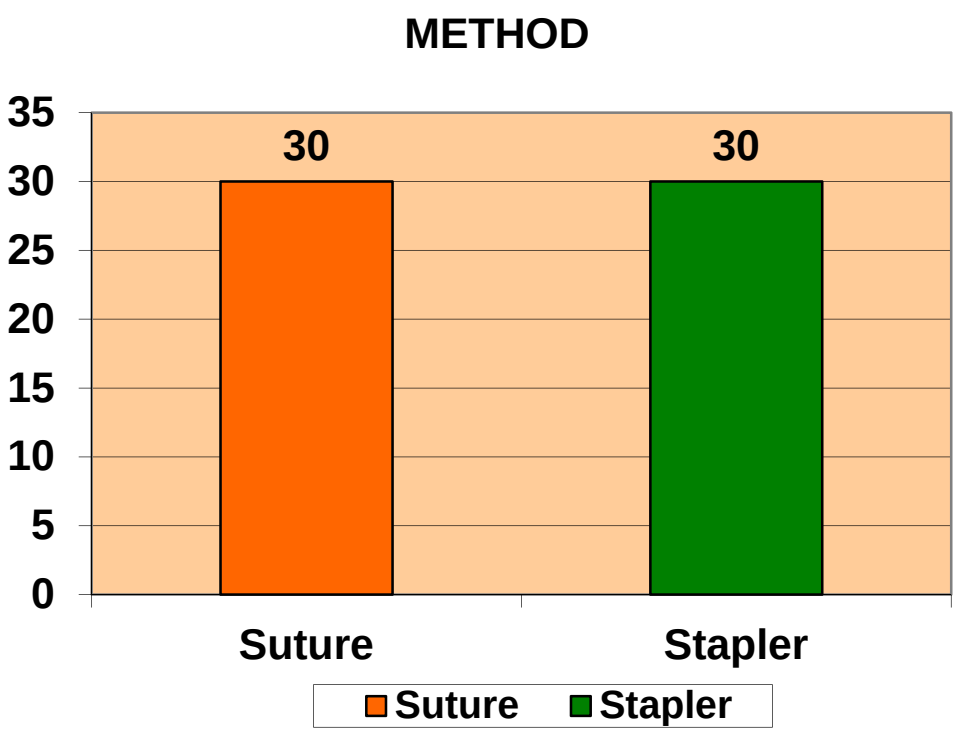

METHOD
35
30
25
20
15
10
5
0
30
30
Suture
Stapler
Suture
Stapler

TABLE 2

AGE DISTRIBUTION

Age Distribution	Suture	stapler
< 20	4	0
21 - 40	7	10
41 - 60	16	14
> 60	3	6

Of these 60 patients only 4 were under the age group of less than 20. There were 17 patients in the age group of 20 to 40 of which 7 underwnt suture closure whereas 10 underwent stapler closure. There were 30 patients in the age group of 40 to 60 of which 16 underwent suture closure and 14 underwent stapler closure. There were 9 patients in the age group above 60 of which 3 underwent suture closure and 6 underwent stapler closure.

CHART - 2

AGE DISTRIBUTION

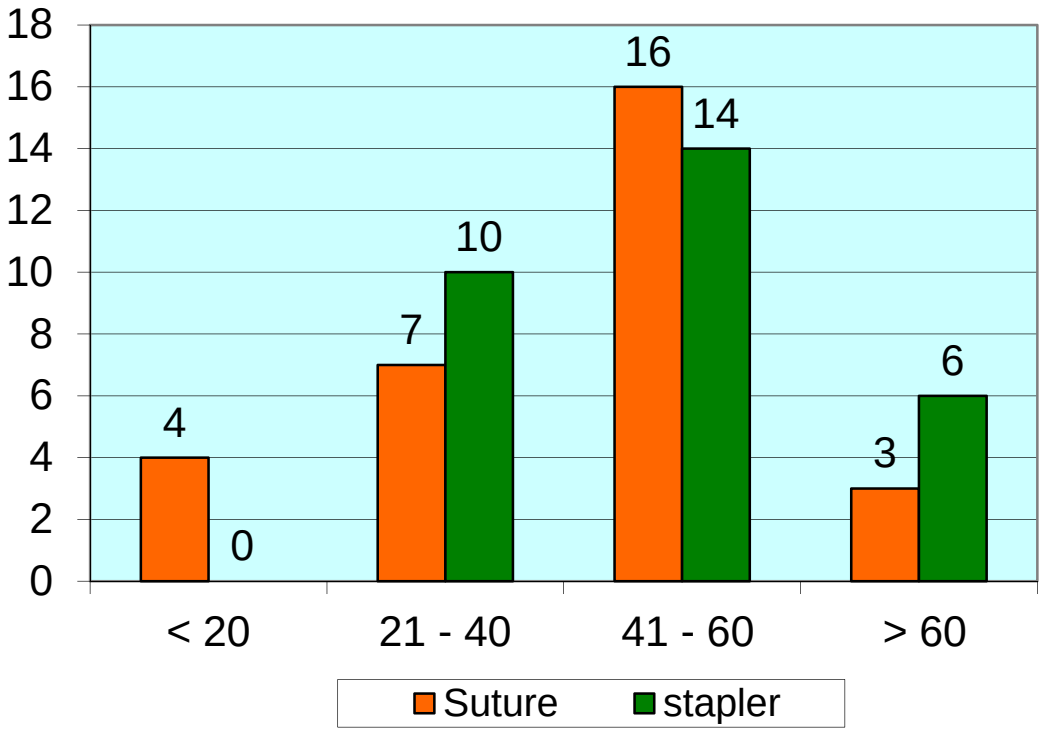


TABLE 3

SEX DISTRIBUTION

Sex	**Suture**	**Stapler**
Male	23	22
Female	7	8

In this study there were totally 45 male and 15 female. Of the Males 23 were of suture group and 22 of Stapler Group. Of 15 Female 7 were of Suture and 8 of Stapler group.

CHART - 3

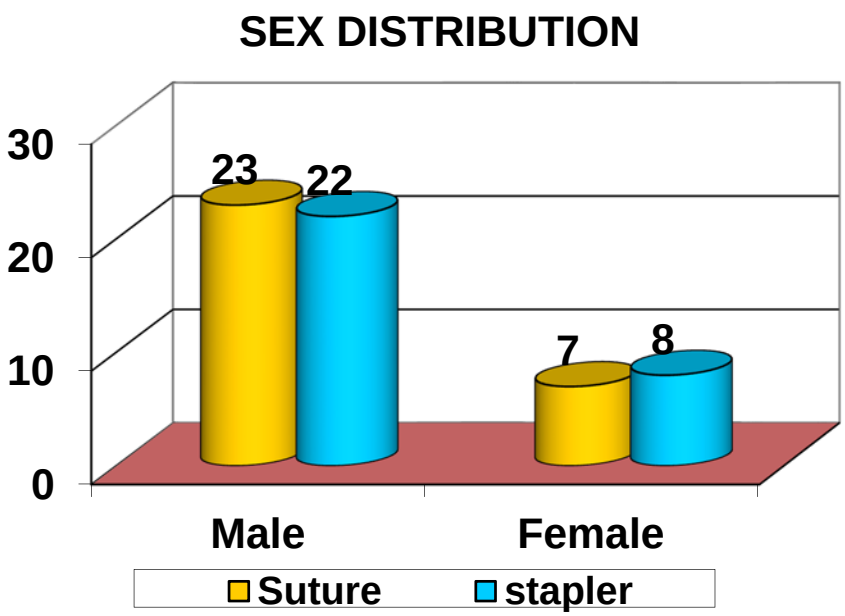

SEX DISTRIBUTION
30
20
10
0
23
22
7
8
Male
Female
Suture
stapler

TABLE 4

LENGTH OF THE INCISION

Length (cm)	Suture	Stapler
15	0	1
20	12	8
25	10	10
30	8	11

The length of the laparotomy incisions varied and of the 60 cases only one of the case was less than 15 cm which was closed by staples,20 cases the length was 20 cms of which 12 cases were closed by suture and 8 cases closed by stapler. In another 20 cases the length of the incision was 25 cms of which 10 was closed by suture and remaining 10 was closed by stapler. The remaining 19 cases were of 30 cms length.

CHART - 4

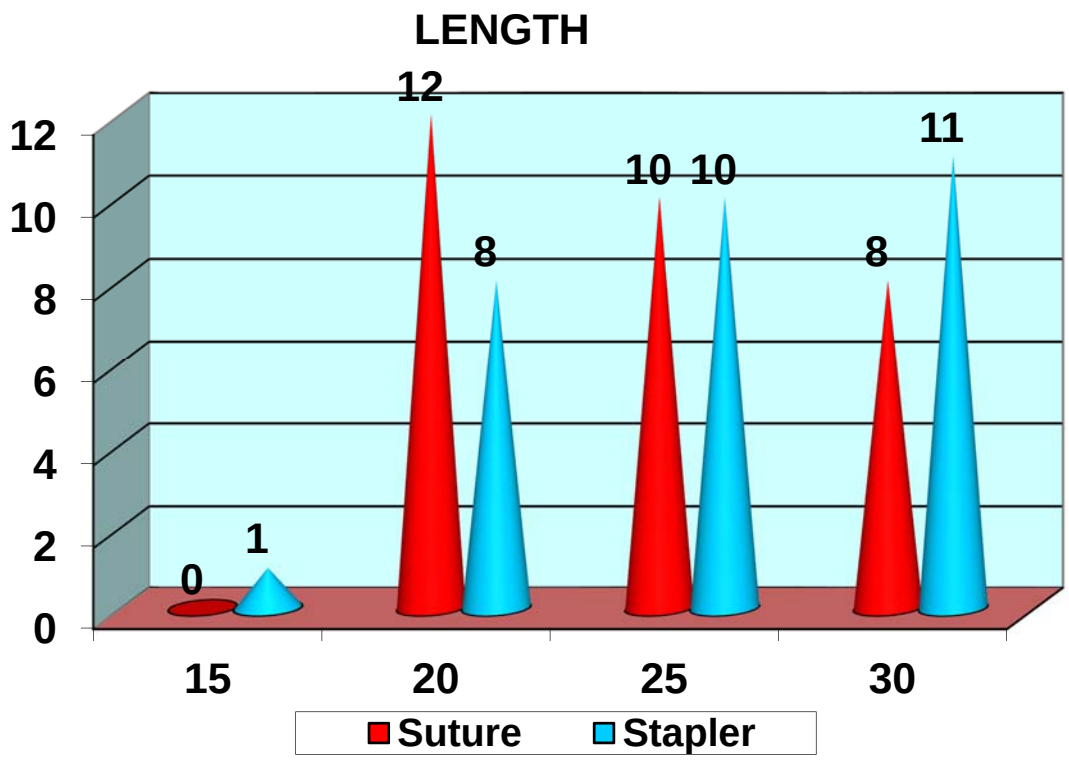


TABLE 5

NUMBER OF BITES

Number	Suture	Stapler
< 15	14	1
16 - 20	8	13
> 20	8	16

Among the cases less than 15 bites were necessary for about 14 cases closed by suture and one case closed by stapler. About 16 to 20 bites were necessary among 8 of the cases closed by suture and 13 of the cases closed by staplers. More than 20 bites were needed among 8 of the cases using suture and 16 of the cases using staplers. The suture needed every bite approximately 1.8 cm after the previous bite whereas in case of stapler it was approximately 1.2 cm.(p value 0.006)

CHART - 5

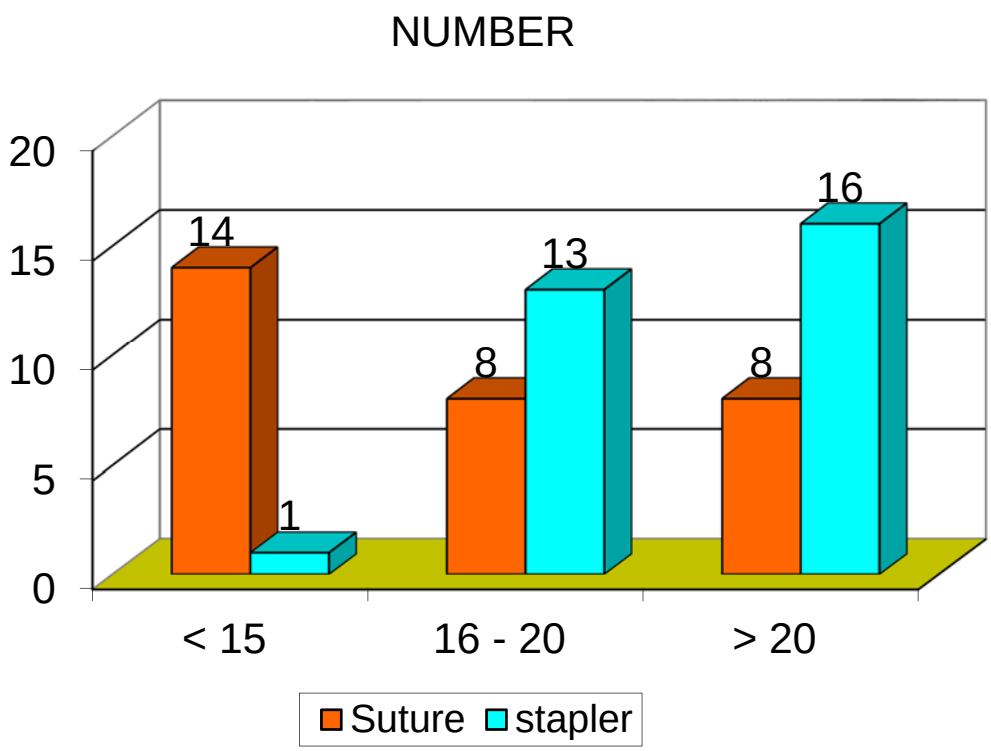


TABLE 6

TIME

Time in minutes	Suture	Stapler
< 5	0	17
6 - 10	5	13
11 - 15	15	0
16 20	10	0

The time needed to close the given wound was calculated of which 17 of cases closed with staplers were completed within 5 min whereas no case closed with suture was completed in that time. 13 cases closed with stapler required 6 to 10 min whereas 5 cases closed with suture was able to complete in that time. About 15 cases closed with suture required 11 to 15 min to complete whereas 10 cases closed with suture required 16 to 20 min to close. No case closed with stapler required more than 10 min and this was statistically significant proving closure of skin with staples reduces the operative time by more than one fourth.(p value 0.001)

CHART - 6

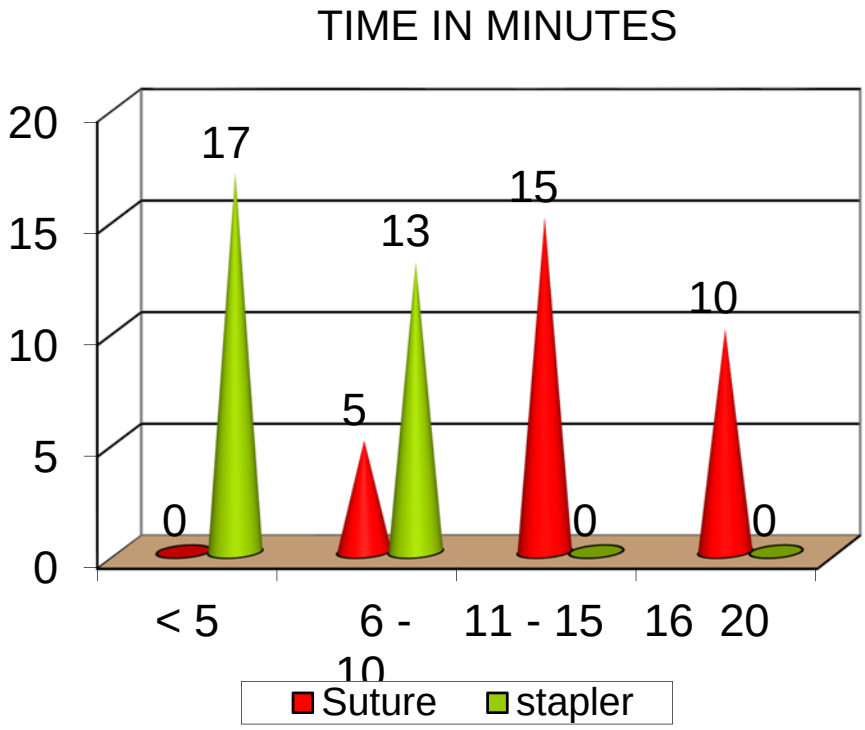

TIME IN MINUTES
20
15
10
5
0
17
0
5
13
15
0
10
0
< 5
6 - 10
11 - 15
16 20
Suture
stapler

TABLE 7

APPEARANCE

Appearance	Suture	Stapler
Good	18	23
Fair	7	6
Poor	5	1

Regarding the appearance of scar about 18 cases closed with suture and 23 cases closed with stapler were good in appearance after one month follow up. About 13 of cases closed with suture and 7 of the cases closed with stapler had fair to poor wound after one month with widening or hypertrophy of scar with itching. (p value 0.689)

CHART - 7

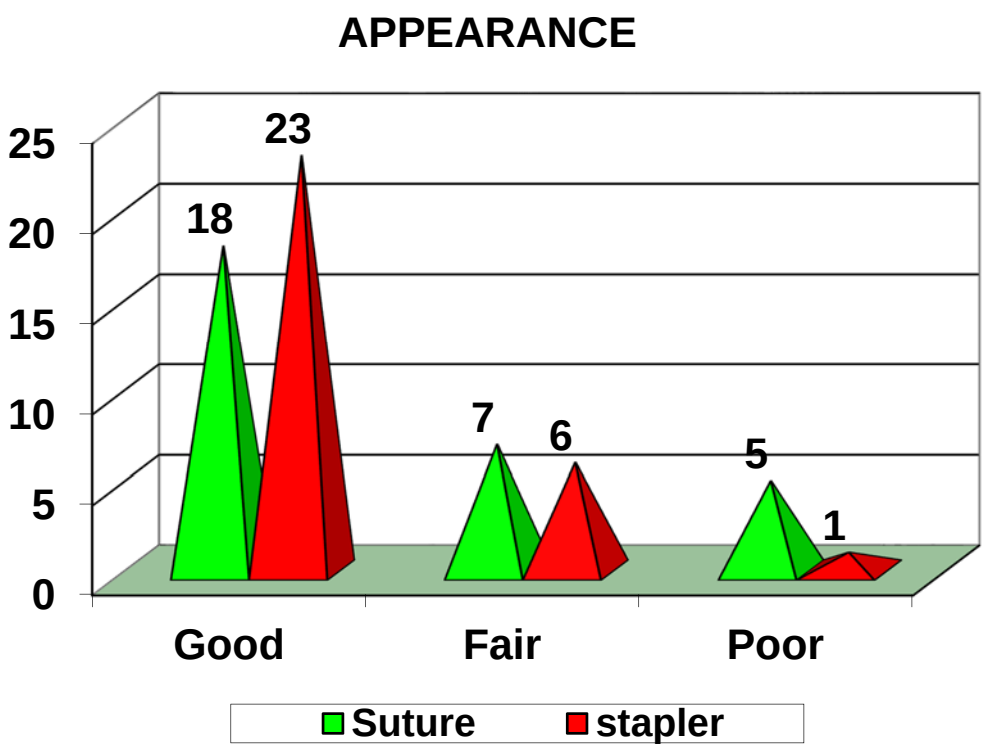

APPEARANCE
25
20
15
10
5
0
18
23
7
6
5
1
Good
Fair
Poor
Suture
stapler

TABLE 8

INFECTION

Infection	Suture	Stapler
Yes	9	6
No	21	24

Among the suture group 9 cases were infected in the post op period leading to seroma or hematoma or frank pus whereas 6 cases in stapler group were infected.(p value 0.686)

CHART - 8

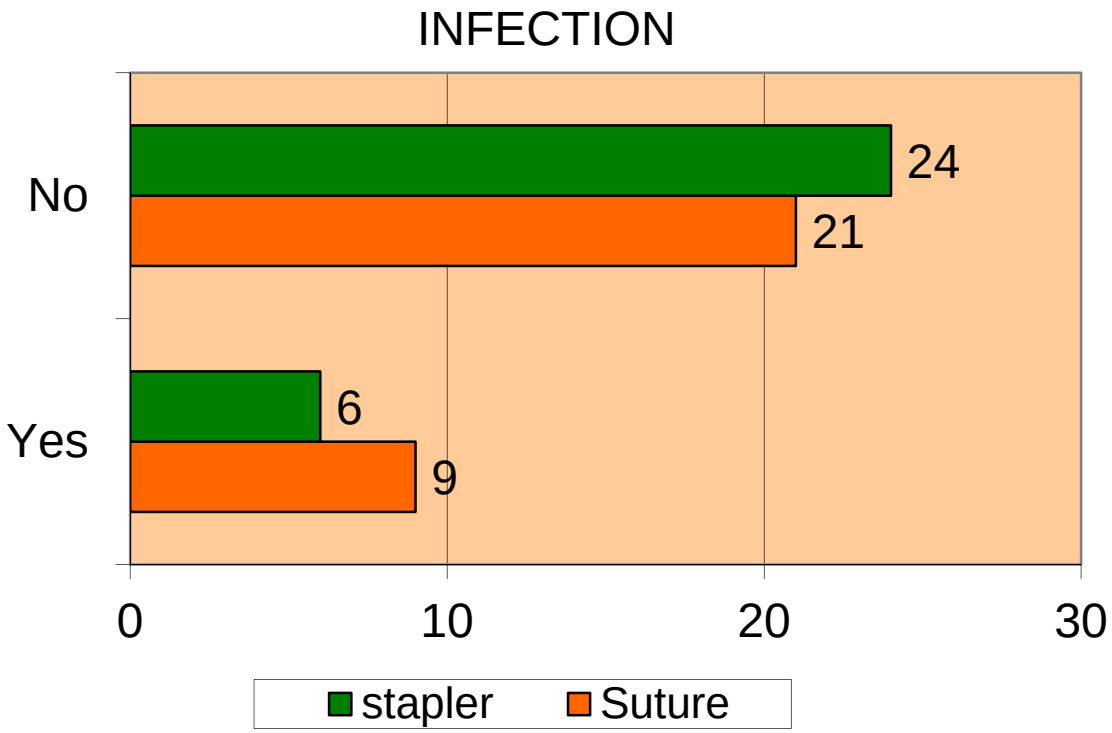


TABLE 9 AND 10

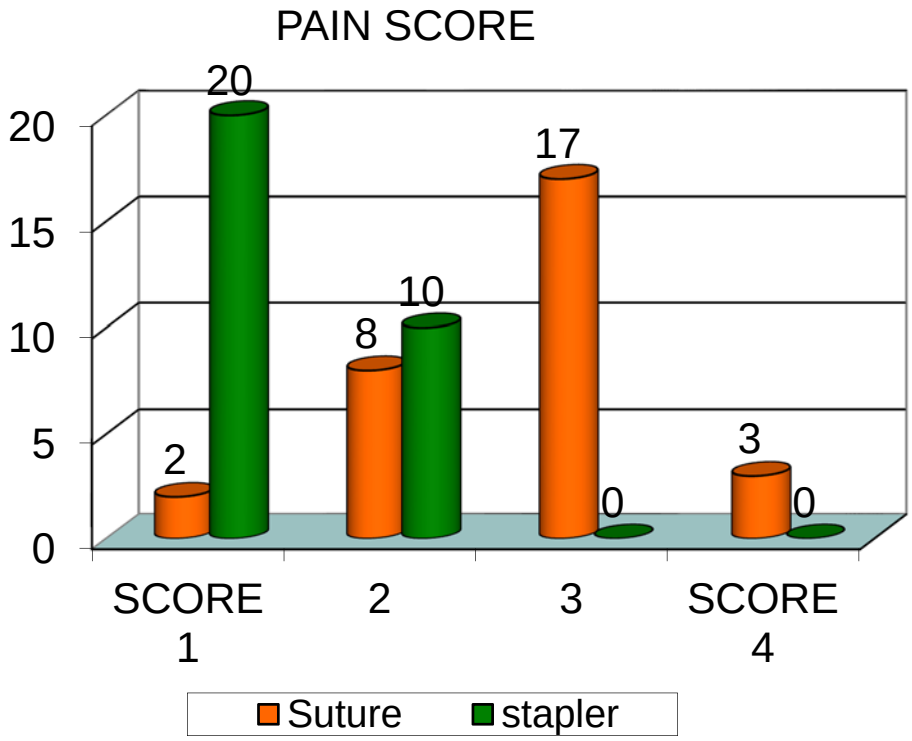
PAIN SCORE

Pain score	Suture	Stapler
Score 3 & 4	20	0
Total	30	30

Pain Score	Suture	stapler
SCORE 1	2	20
2	8	10
3	17	0
SCORE 4	3	0

Among suture group 10 patients had pain score between 1 and 3 whereas all 30 cases in stapler cases fell into pain score 1 and 3. 20 cases of suture group had a pain score between 3 and 4 whereas no case from stapler group had pain score above 3.(p value <0.001)

CHART - 9


PAIN SCORE
20
15
10
5
0
2
20
8
10
17
0
3
0
SCORE 1
2
3
SCORE 4
Suture
stapler

DISCUSSION

DISCUSSION

Wound closure is as important as any other action performed by the surgeon. And apart from the need for producing a healthy and strong scar, it is the surgeon's responsibility to ensure its aesthetically pleasing physical appearance. Skin staples are an alternative to regular sutures in offering this advantage. The present study has helped to highlight the benefits of skin stapler.

In the present study, there was no significant difference between the results of application of staplers or sutures laparotomy wound closure. The scar appearance was good in 90% of the patients who were available for follow up, which is similar to other studies. Medina dos Santos et al have compared the cosmetic results of staplers with noncontinuous nylon sutures7. They have observed that the wounds closed with staplers were cosmetically superior in 80% of the cases. There are no studies available in the literature comparing the results of application staplers to various anatomic regions. Though Ranaboldo and Rowe-Jones have compared the results of stapler with subcuticular absorbable sutures for laparotomy wounds and divided them into lower and upper abdominal regions, no mention was made by them regarding the appearance of the scar at various sites6.

There was no significant benefit of staplers over subcuticular sutures in their study.

In the present study, the time taken to complete wound closure was significantly less with the use of staplers as compared to sutures. The average time required to approximate one centimeter of wound was 11 seconds with the stapler whereas with silk suture, it was 45 seconds, more than four times longer. In the study by Ranaboldo et al, the rate of wound closure was 8 seconds/cm with stapler and 12.7 seconds/cm with sutures6. In our study, for a four-centimeter wound, the time taken with stapler was about 45 seconds whereas a similar wound required 3 minute with suture. Thus, there was a saving of 135 seconds or two and a quarter minutes. This is comparable with several other studies. Kanagaye observed that staplers were six times faster than standard sutures4. Eldrup et al analyzed 137 patients and concluded that mechanical sutures took one third of the time taken by conventional sutures5. Meiring et al have recorded that there was 80% time saving, whereas Harvey and Logan have reported 66.6% time saving with the use of staplers8.9 Medina dos Santos et al found in a prospective trial that the mean skin closure time with staple was 5 minutes and 25 minutes with nylon suture7.

The other important factor in favor of stapler is pain which the patient experiences in the immediate post op or during the removal of suture or stapler. This study has shown that patient with wound closed by stapler had considerably less pain in the immediate post op and during removal and the need for post op analgesia was less in this group of patients. Regarding the length of sutures this study shows for a given length the staples needed more bites when compare d to suture

In the suture group, there were fifteen cases with postoperative wound infection and SSI of which 11 cases needed resuturing. These results are significantly less when compared with other studied. Kanagaye et al, in their study of 45 pediatric cases observed no complications in the staple group.

To summarize, considerable alteration has taken place from the conventional skin suture technique and switch over to the new era of cosmoses, in the forum of skin stapling to achieve a near virgin scar less skin in a considerably quicker time.

According to the study conducted by TuuliMehodinn G43, RampersadRoxane M, Toby O Smith, Debbie Sexton44, the risk of developing a wound infection was four times greater after staple closure than suture closure.

CONCLUSION AND SUMMARY

CONCLUSION AND SUMMARY

60 patients admitted for elective and emergency laparotomy were divided into two equal groups wherein one group skin closure was done by silk suture whereas in other group skin closure was done by staples

1. The age group of the patients was between 17 and 77 years
2. There were 45 males and 15 females in the study
3. The length of the incision varied from 15 to 30 cm
4. For a given length of incision stapler needed more bites (once in 1.2cm) when compared to suture(once in 1.8 cm)
5. There was no difference in appearance of scar between both groups
6. There was no difference in rate of infection between both groups
7. The time saved during wound closure was significantly reduced when using skin stapler than suture. It was observed that it reduced the closing time more than half when compared to sutures
8. The immediate post op pain and pain during removal of suture or stapler were considerably less in staples group with patient acceptance being better in staples group.

Thus this study concludes that using skin staples for closure of laparotomy wounds significantly reduced operative time with less post op pain with no difference in appearance or rate of infection when compared to closure by sutures.

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ANNEXURE

STUDY OF SKIN STAPLES AND CONVENTIONAL SUTURESFOR ABDOMEN WOUND CLOSURE

PROFORMA

Name of the patient :

I.P. Number :

Age :

D.O.A :

Sex :

D.O.O :

Address :

D.O.D :

ClinicalDiagnosis :

Operation :

Incision :

Length : in cms

Type :

Surgeon **:**

Suture material **:** **silk / staplers**

Length :

No. of sutures :

Suturing time started :

Time of completion :

Total time taken :

Rate of Repair : (cms/sec)

Date of removal :

No. of days :

Time taken :

Pain score (scale of 1 to 5)

Associated pain/infection/any other :

Condition of wound/scar/appearance :

Follow up after 1 month :

SILK AND STAPLER

CLOSURE BY SILK

CLOSURE BY STAPLER

MASTER CHART

S. No.	Name	Age	Sex	Ip no	Su/ St	Length	No.	T/M	App.	INF	PS	Rem.
1.	Pandi	55	M	51217	SU	20	13	10	Good	No	3	Nil
2.	Pasumpon	55	M	45511	SU	20	15	12	Good	No	3	Nil
3.	Mariapushpam	63	F	44144	SU	20	14	12	Good	No	3	Nil
4.	Kalaiselvam	48	M	44147	SU	20	14	12	Good	No	2	Nil
5.	Manikandan	37	M	37873	SU	20	14	13	Good	No	4	Nil
6.	Dhanalakshmi	48	F	38573	SU	20	14	12	Fair	No	3	Nil
7.	Murugabhoopathi	44	M	28219	SU	20	15	13	Good	No	2	Nil
8.	Madalaimary	46	F	29518	SU	20	14	11	Good	No	3	Nil
9.	Arumugam	38	M	22486	SU	20	14	10	Good	No	3	Nil
10.	Jeyamuragam	33	M	17118	SU	25	17	12	Fair	No	2	Nil
11.	Subburam	18	M	12175	SU	25	16	13	Good	No	2	Nil
12.	Mookayee	60	F	93212	SU	30	24	20	Good	No	2	Nil
13.	Mayandi	43	M	4670	SU	20	15	10	Good	No	2	Nil
14.	Natarajan	58	M	91947	SU	20	15	11	Good	Yes	2	Nil
15.	Syed ibrahim	55	M	86266	SU	30	25	18	Good	No	1	Nil
16.	Krishnammal	65	F	79219	ST	30	24	5	Good	No	1	Nil
17.	Jegannathan	58	M	79991	ST	30	24	5	Good	No	1	Nil
18.	Murugan	65	M	75482	ST	30	22	4	Good	No	1	Nil
19.	Alaguponnu	47	F	71755	ST	20	20	4	Good	No	1	Nil
20.	Vinoth	24	M	65604	ST	20	19	4	Good	No	1	Nil
21.	Thillainayagam	45	M	56153	ST	20	20	4	Fair	No	1	Nil
22.	Veeramakali	70	M	51883	ST	15	10	2	Good	No	1	Nil
23.	Paulraj	52	M	45476	ST	20	16	4	Good	No	1	Nil
24.	Lakshmi	45	F	37306	ST	20	16	4	Good	No	1	Nil
25.	Meena	37	F	28708	ST	25	22	5	Good	No	2	Nil
26.	Jeyaraman	60	M	36524	ST	30	26	6	Good	No	1	Nil
27.	Nadiammal	31	F	30674	ST	20	16	4	Good	No	2	Nil
28.	Mohamed kasim	70	M	33858	ST	25	22	5	Good	No	1	Nil
29.	Kajamydeen	55	M	30340	ST	20	16	4	Good	No	2	Nil

30.	Palaniammal	45	F	30345	ST	20	16	4	Good	No	2	Nil
31.	Manikam	57	M	9083	SU	20	15	10	Fair	No	3	Nil
32.	Ramamurthy	77	M	49697	SU	30	22	16	Fair	Yes	3	Nil
33.	Abdul rahman	50	M	48296	SU	25	14	10	Fair	Yes	3	Nil
34.	Sivakumar	17	M	8304	SU	25	18	12	Good	Yes	3	Nil
35.	Kannan	30	M	7600	SU	30	23	18	Good	Yes	4	Nil
36.	Marimuthu	60	M	41567	SU	30	25	20	Poor	No	4	Nil
37.	Hariharan	18	M	6074	SU	30	22	18	Poor	Yes	3	Nil
38.	Velusamy	40	M	31031	SU	30	21	17	Poor	No	3	Nil
39.	Anandhamurugan	16	M	29630	SU	25	15	11	Good	Yes	3	Nil
40.	Amirthamary	46	F	28437	SU	25	18	15	Good	Yes	1	Nil
41.	Yesuraj	70	M	26800	SU	30	24	20	Fair	No	3	Nil
42.	Kamatchi	47	M	24326	SU	25	18	14	Good	No	2	Nil
43.	Baskaran	45	M	23952	SU	25	17	13	Fair	No	3	Nil
44.	Chellamani	40	F	22558	SU	25	18	16	Poor	No	3	Nil
45.	Maheshwari	35	F	1263	SU	25	20	16	Poor	Yes	3	Nil
46.	Issakki	55	M	19918	ST	25	20	6	Good	Yes	2	Nil
47.	Arockiasamy	25	M	1220	ST	30	25	7	Good	No	2	Nil
48.	Veerachinaya	65	M	53591	ST	25	20	5	Good	No	2	Nil
49.	Geetha	30	M	51356	ST	25	20	5	Good	No	1	Nil
50.	Muniyandi	40	M	49253	ST	25	21	6	Fair	No	2	Nil
51.	Nagammal	60	F	9623	ST	30	25	6	Fair	Yes	1	Nil
52.	Pandi	39	M	9373	ST	30	25	7	Fair	No	1	Nil
53.	Natarajan	31	M	48866	ST	30	25	7	Good	No	1	Nil
54.	Sakthi	26	M	9230	ST	30	25	8	Fair	Yes	1	Nil
55.	Bose	55	M	9231	ST	25	21	7	Poor	Yes	1	Nil
56.	Chellam	46	M	47568	ST	25	20	6	Good	Yes	2	Nil
57.	Ganesan	62	M	47966	ST	30	26	7	Good	Yes	1	Nil
58.	Muthulakshmi	50	F	47264	ST	25	20	6	Good	No	1	Nil
59.	Natarajan	60	M	47002	ST	25	21	5	Fair	No	2	Nil
60.	Jagadeesh	32	M	8809	ST	30	26	6	Good	No	1	Nil

KEY TO MASTER CHART

SU : SUTURE

ST : STAPLER

NO. : NUMBER OF BITES

T/M : TIME IN MIUTES

APP : APPEARANCE

INF : INFECTION

PS : PAIN SCORE

REM : REMARKS

Ref.No.6506/E1/5/2014

Madurai Medical College,
Maduai -20. Dated: 31- 07 .2014.

Institutional Review Board/Independent Ethics Committee
Capt.Dr.B.Santhakumar,MD (FM). deanmdu@gmail.com
Dean, Madurai Medical College &
Government Rajaji Hospital, Madurai 625 020 . Convenor

Sub: Establishment – Madurai Medical College, Madurai-20 –
Ethics Committee Meeting – Meeting Minutes - for July 2014 –
Approved list – reg.

The Ethics Committee meeting of the Madurai Medical College, Madurai was held on 22nd July 2014 at 10.00 Am to 12.00 Noon at Anaesthesia Seminar Hall at Govt. Rajaji Hospital, Madurai . The following members of the Ethics Committee have attended the meeting.

1.Dr.V.Nagarajan,M.D.,D.M(Neuro) Ph: 0452-2629629 Cell No.9843052029 nag9999@gmail.com.	Professor of Neurology (Retired) D.No.72, Vakkil New Street, Simmakkal, Madurai -1	Chairman
2.Dr.Mohan Prasad, MS.M.Ch. Cell.No.9843050822 (Oncology) drbkcmp@gmail.com	Professor & H.O.D of Surgical Oncology (Retired) D.No.32, West Avani Moola Street, Madurai.-1	Member Secretary
3. Dr.L.Santhanalakshmi, MD (Physiology) Cell No.9842593412 dr.l.santhanalakshmi@gmail.com.	Vice Principal, Prof. & H.O.D. Institute of Physiology Madurai Medical College	Member
4.Dr.K.Parameswari, MD(Pharmacology) Cell No.9994026056 drparameswari@yahoo.com.	Director of Pharmacology Madurai Medical College.	Member
5.Dr.S.Vadivel Murugan, MD., (Gen.Medicine) Cell No.9566543048 svadivelmurugan_2007@rediffmail.com.	Professor & H.O.D of Medicine Madurai Medical College	Member
6.Dr.A.Sankaramahalingam, MS., (Gen. Surgery) Cell.No.9443367312 chandrahospitalmdu@gmail.com	Professor & H.O.D. Surgery Madurai Medical College.	Member
7.Mrs.Mercy Immaculate Rubalatha, M.A., Med., Cell.No.9367792650 lathadevadoss86@gmail.com	50/5, Corporation Officer's Quarters, Gandhi Museum Road, Thamukam, Madurai-20.	Member
8.Thiru.Pala.Ramasamy, B.A.,B.L., Cell.No.9842165127 palaramasamy2011@gmail.com	Advocate, D.No.72,Palam Station Road, Sellur, Madurai-20.	Member
9.Thiru.P.K.M.Chelliah, B.A., Cell No.9894349599 pkmandco@gmail.com	Businessman, 21 Jawahar Street, Gandhi Nagar, Madurai-20.	Member

The following project was approved by the committee

Name of the PG Student	Course	Name of the Project	Remarks
Dr.V.Pravin kumar	PG in M.S (General Surgery) Govt. Rajaji Hospital and Madurai Medical College, Madurai	"A study of laparotomy wound closure with skin staples"	Approved

Please note that the investigator should adhere the following: She/He should get a detailed informed consent from the patients/participants and maintain it confidentially.

1. She/He should carry out the work without detrimental to regular activities as well as without extra expenditure to the institution or to Government.
2. She/He should inform the institution Ethical Committee, in case of any change of study procedure, site and investigation or guide.
3. She/He should not deviate the area of the work for which applied for Ethical clearance.
   She/He should inform the IEC immediately, in case of any adverse events or serious adverse reactions.
4. She/He should abide to the rules and regulations of the institution.
5. She/He should complete the work within the specific period and if any extension of time is required He/She should apply for permission again and do the work.
6. She/He should submit the summary of the work to the Ethical Committee on completion of the work.
7. She/He should not claim any funds from the institution while doing the work or on completion.
8. She/He should understand that the members of IEC have the right to monitor the work with prior intimation.

Member Secretary
Ethical Committee

Chairman
Ethical committee

31.7.14
DEAN/Convenor
Madurai Medical College & Govt.
Rajaji Hospital, Madurai.

To
The above Applicant
-thro. Head of the Department concerned

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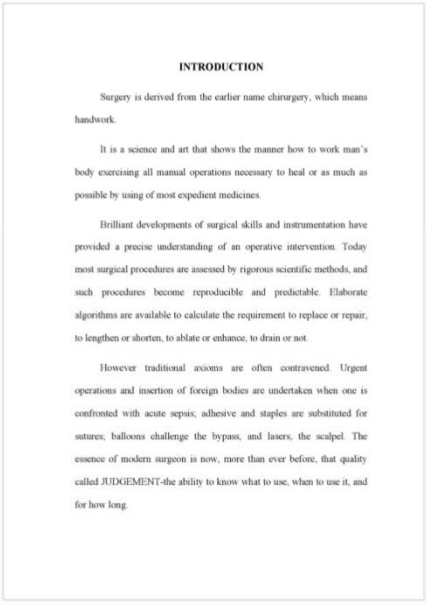


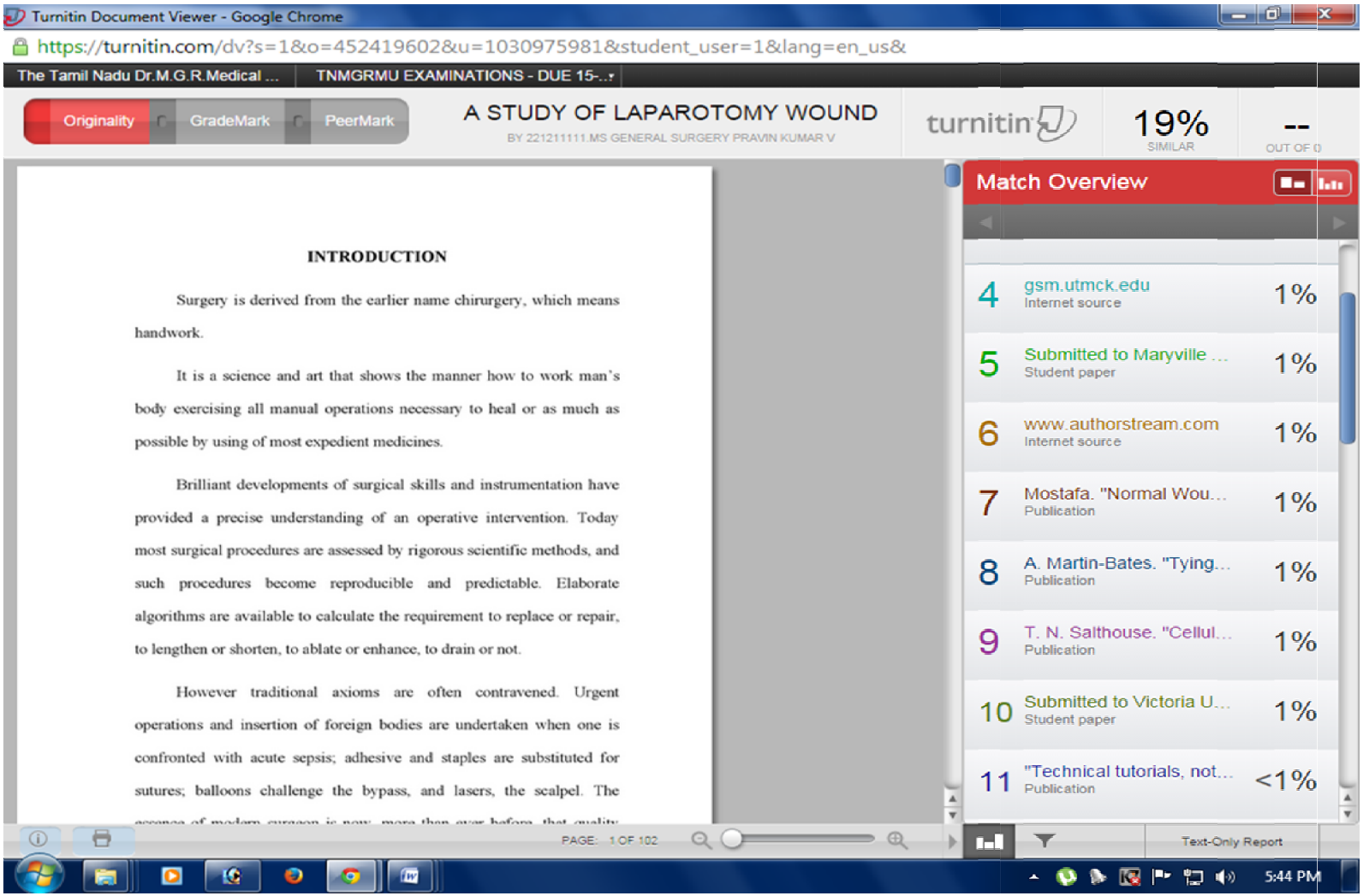
INTRODUCTION

Surgery is derived from the earlier name chirurgery, which means handwork.

It is a science and art that shows the manner how to work man's body exercising all manual operations necessary to heal or as much as possible by using of most expedient medicines.

Brilliant developments of surgical skills and instrumentation have provided a precise understanding of an operative intervention. Today most surgical procedures are assessed by rigorous scientific methods, and such procedures become reproducible and predictable. Elaborate algorithms are available to calculate the requirement to replace or repair, to lengthen or shorten, to ablate or enhance, to drain or not.

However traditional axioms are often contravened. Urgent operations and insertion of foreign bodies are undertaken when one is confronted with acute sepsis; adhesive and staples are substituted for sutures; balloons challenge the bypass, and lasers, the scalpel. The essence of modern surgeon is now, more than ever before, that quality called JUDGEMENT-the ability to know what to use, when to use it, and for how long.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Surgery is derived from the earlier name chirurgery, which means handwork.
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