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A study of outcome after single stage achilles tendon reconstruction with coverage of soft tissue defect

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Abstract
Introduction- Ruptured tendoachilles along with skin defect is a complex problem to reconstruct. Both things require a priority. Single stage reconstruction of ruptured tendoachilles tendon with skin cover using flap allows us to perform both. This procedure gives excellent result, shortens the stay, thereby reducing the cost. This method is a simple solution to the complex problem like ruptured tendoachilles with skin defect.
Material and method- In this study, 30 patients with rupture of tendoachilles tendon due to penetrating injury, with skin defect are presented. The repair was done using aponeurotic part of tendoachilles tendon, taken from proximal part of tendoachilles in the midline measuring around 2 to 2.5 cm in width and desired length, with intact distal attachment. The tendon was turned upside down by 180 degrees and sutured to the distal stump of the tendoachilles tendon without tension and for some patients end to end repair done. The skin defect was covered using distally based superficial sural artery flap or lateral supramalleolar flap in the same sitting. The follow-up period was 6 months.
Result- 23 nos, 3 nos and 4 nos patient showed excellent, good, poor outcome respectively. In 5 patients had any flap loss or related complications and among them 2 patients had marginal flap necrosis. 83.4% of patients had no flap loss or complication. Complication like abscess and partial loss STSG(donor site) was seen in one case respectively which was treated conservatively by antiobiotics and dressing.
Conclusion-Single stage tendoachilles reconstruction and soft tissue coverage can be used with good functional result and patient satisfaction.

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I. INTRODUCTION

The Achilles tendon is the strongest and largest tendon in the body[1]. It originates at the muscles of gastrocnemius and soleus within the lower leg, and inserts into the calcaneal bone of the foot. This forms a linkage that allows for plantar flexion of the ankle joint, a vital locomotive function. Less obviously, the Achilles tendon – like other tendons - also prevents excessive joint displacement from occurring when under high loading, and thereby preventing joint injury[2, 3].

When the force exerted on the Achilles tendon exceeds its ultimate tensile strength, catastrophic failure may occur[4]. The Achilles tendon is also the most common site of overuse injury in both men and women[5], this typically occurs as a result of repeated loading that exceeds the elastic limit of the tendon[6]. Typically, the micro and macroscopic tendon structure degenerates, causing inflammation, edema, pain, weakening[7]. The Achilles tendon is most at risk from traumatic injury when loaded at a high strain rate, or following eccentric muscular contraction[6] and thus it is a common cause of complaint in athletes[8]. Approximately 7 per 100,000 males experience Achilles tendon rupture, typically at ages 30-39 years. The decrease in tendon tensile strength with age, probably when combined with a change in lifestyle, means that rupture rates peaks in females aged 80 years and over[9]. In both instances rupture typically occurs at the midsection and thus coinciding with avascularity[10]. Whilst the etiology of rupture in this region remains unclear, on healing the collagen fibers of the injured region are replaced by fibrotic scar tissue, meaning a changed structure and organization. However, despite an improvement over a long period of time, the repaired tendon will always have properties inferior to the normal healthy tendon[11].

Causes of Achilles tendon rupture include sudden forced plantar flexion of the foot, direct trauma, and long-standing tendinopathy or intratendinous degenerative conditions. Sports that are often associated with Achilles tendon rupture include diving, tennis, basketball, and track. Risk factors for a rupture of the Achilles tendon include poor conditioning before exercise, prolonged use of corticosteroids, overexertion, and the use of

quinolone antibiotics. The Achilles tendon rupture usually tends to occur about two to four cm above the calcaneal insertion of the tendon. In individuals who are right-handed, the left Achilles tendon is most likely to rupture and vice versa [12]. The exact cause of Achilles tendon injury appears to be multifactorial. The injury is most common in cyclists, runners, volleyball players, and gymnasts. When the ankle is subject to extreme pronation, it places enormous stress on the tendon, leading to injury. In cyclists, the combination of low saddle height and extreme dorsiflexion during pedaling may also be a factor in an overuse injury.

Achilles tendonitis is often not associated with primary prostaglandin-mediated inflammation. It appears there is a neurogenic inflammation with the presence of calcitonin gene-related peptide and substance P present. Histopathological studies reveal thickening and fibrin adhesions of the tendon with the occasional disarray of the fibers.

Neurovascularization is frequently seen in the degenerating tendon, which is also associated with pain. Tendon rupture is usually the terminal event during the degeneration process. After rupture, type III collagen appears to be the major collagen manufactured, suggesting that the repair process is incomplete. Animal studies show that if there is more than 8% stretching of their original length, tendon rupture is most likely[11].

The proximal segment of the tendon receives its blood from the muscle bellies connected to the tendon. Blood supply to the distal segment of the tendon is via the tendon-bone interface.

In our people, acute injuries to achilles tendon with open wounds in tendoachilles (TA) region is more common unlike the West where chronic ruptures and sport injuries are more common. This is because most Indians use Indian toilets which are a common cause of open injuries to achilles tendon [closet injuries]. Also most of us do not wear shoes hence the TA region is not protected at work place. TA region is a poorly vascularized area which may cause problems in healing.

Stable skin cover over exposed tendoachilles is absolutely essential for proper healing and recovery of tendoachilles function. Exposed tendoachilles can be a result of open injuries, repair of closed TA rupture, complications after repair like suture dehiscence, skin necrosis, infection; delayed exposure and recurrent rupture [13-16]. Tendoachilles injuries (open and closed) leading to complete disruption of the tendon is commonly seen in developing countries. The diagnosis of closed tendon rupture is made on clinical examination with positive Thompson test. Open TA injuries resulting in exposed tendoachilles may be associated with avulsion of the overlying skin.

The combined loss of the skin and achilles tendon is a serious therapeutic challenge. Management of tendoachilles injuries involves two critical aspects. First being the repair or reconstruction of the ruptured tendoachilles, Secondly management of the skin overlying the repaired tendoachilles.

Complicated primary cases, cases presenting late, recurrent rupture of tendoachilles, delayed exposure of TA and open TA injuries associated with skin avulsion require a flap cover for successful outcomes. Various flaps have been described in literature for cover over TA like distally based skin flaps, advancement flap, free tissue transfers and islanded flaps [17-20].

Many one-stage procedures have been used to reconstruct combined Achilles tendon and overlying skin defects, such as using a combined gastrocnemius musculocutaneous V–Y island flap or a fascio-aponeurotic turnover from the gastrocnemius muscle combined with a wide fasciocutaneous flap. There is no question that one stage reconstruction is an efficient way to reconstruct complex Achilles defects with a fully vascularized reconstruction, but at the expense of increased technical complexity and cost [21-23].

Reconstruction of the Achillean region has acquired the reputation of being a challenge for the surgeon; the reasons are the particularities of the area. An ideal resurfacing should be stable, thin enough to allow footwear and to obtain an anatomical contour, able to withstand shoe friction and providing a gliding surface for the underlying tendon. If the defect concerns also the Achilles tendon (rupture, laceration, tendon loss), then the reconstruction should also provide a quasi-normal range of movement (ROM) at the ankle joint and restore the power of plantar flexion adequate for walking, jumping, and running. Simple Achilles tendon lesions (either closed or open) are usually addressed by orthopedic surgeons, whereas if tissue defect is present or there are complications following previous surgery (skin necrosis, infection, etc), the reconstruction is undertaken by plastic surgeons; often, an interdisciplinary approach proves to be the best option.

The vast array of reconstructive methods should be used judiciously, considering the defect's characteristics and the functional and aesthetic requirements, choosing the best solution for each patient.

Random local flaps are usually not available, due to damage of the tissue from the vicinity and to the anatomical particularities of the area (there is no skin excess and an increased risk of exposure of noble elements within the secondary defect). Pedicled regional flaps are a good option for relatively small to medium size defects. If needed, tendon repair could be done during the same surgical procedure and be covered with the well-vascularized tissue of the flap. The "classical" regional options include fasciocutaneous and muscle/ musculocutaneous flaps. One of the most used is the neurosensory distally based island sural flap. It includes the superficial and deep crural fascia, the sural nerve and superficial sural artery, the short saphenous vein and the

skin island. Another possibility is the medial plantar flap, providing similar tissue and also protective sensibility. Muscle/ musculocutaneous flaps used in reconstruction of the area are gastrocnemius, peroneus brevis or abductor halucis[24-26].

The most recent and modern option of regional flaps for coverage is represented by perforator flaps. Since first description, their use in coverage of the Achillean region increased in popularity. They spare the main vascular trunks of the leg causing minimal donor-site morbidity, require relatively rapid dissection and provide a reliable territory. It can also be accompanied by Achilles tendon reconstruction, if needed. A particular, most useful variant of the perforator flap is the "propeller" technique, which implies flap's rotation up to 180º around its pedicle, facilitating direct closure of the donor site.

Existence of such a great number of reconstructive procedures described in the literature proves that the problem is difficult to solve and an attempt at systematizing the surgical options is rewarding, allowing the individual case particularities to determine the best surgical solution.

Complex soft tissue defects jeopardise successful repair of injuries to the achillies tendon, while specific anatomic limitations predispose these tendon repair to wound complications, including infection, wound dehiscence and contracture. Several method of secondary autologus tissue reconstruction such free and regional flaps have been described to avoid and address wound complications.

Even though there are several treatments for Achilles tendon rupture, there is no consensus on which one to undertake. There is a wide variation in the management of Achilles tendon injury between orthopedic surgeons and sports physicians. Further, there is no uniformity in postoperative rehabilitation. Experts recommend that an interprofessional approach may help achieve better outcomes.

The purpose of this prospective study is to present our experience and functional results in patients who will undergo reconstruction of combined defect of overlying skin and Achilles tendon.

II. REVIEW OF LITERATURE

History and background:

The Achilles tendon:

"This tendon, if bruised or cut, causes the most acute fevers, induces choking, deranges the mind, and at length brings death" – Hippocrates

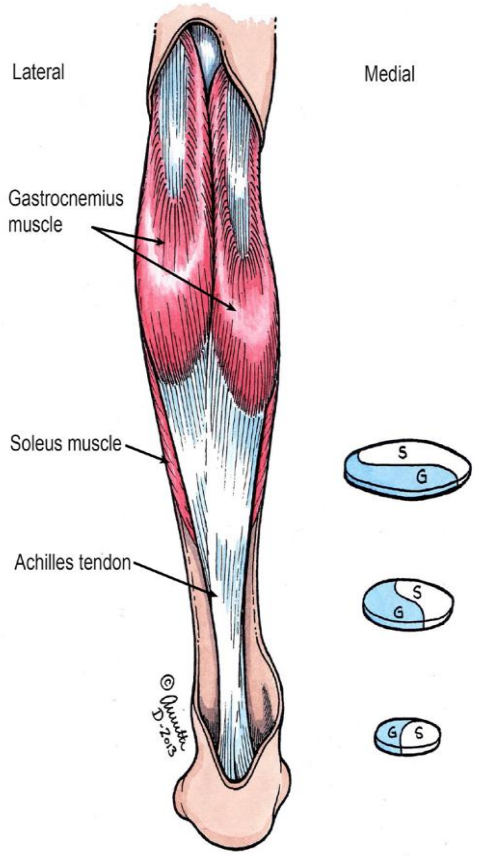
Achilles is the heroic Greek warrior of Homer's *Iliad*, son of Peleus and the nymph Thetis. In the classical version, his mother Thetis made Achilles immortal by immersing him in the river Styx. As she was holding him by the heel, this part of his body remained vulnerable. Another, less famous story tells that Thetis anointed him in ambrosia and put him into the fire to burn all the mortal parts of his body. Peleus interjected this before she had completed the mission of burning all the mortal parts, leaving the heel vulnerable. In the Trojan War, Achilles killed Hector, the prince of Troy. Hector's brother Paris killed Achilles, with assistance from Apollo, in revenge, by shooting a poisoned arrow into Achilles' unprotected heel.

In 1693, Philip Verheyen (1648-1711), a Dutch surgeon, was the first actually to coin the Achilles tendon after the Greek hero Achilles. It had previously been known as "tendomagnus of Hippocrates"[26]. It dates back from 19th century where the expression of Achilles heel is described as an area of weakness.

The Achilles tendon is, however, not weak. On the contrary, it is the thickest and strongest tendon in the human body. It is the conjoined tendon of the gastrocnemius and soleus muscles and transfers the force to the calcaneus. Despite its strength, it is susceptible to both overuse injury and acute injury, such as a complete rupture.

Anatomy and physiology:

The superficial group of muscles in the posterior crural compartment consists of the gastrocnemius, soleus and plantaris muscles. The most superficial muscle, the gastrocnemius, has two heads of origin. The medial head that arises from the medial condyle of the femur is slightly larger and extends a little more distally than the lateral head. The lateral head arises from the lateral surface of the lateral condyle of the femur. The origin of the soleus muscle is entirely below the knee at the posterior aspect of the head and superior fourth of the fibula, the soleal line and the middle third of the medial border of the tibia. The gastrocnemius and soleus muscles are sometimes together called the triceps surae muscle[27]. The plantaris muscle is very small and absent in approximately 10% of the population and its tendon lies in close proximity to the Achilles tendon[28].



The plantaris tendon can be used as a graft for reinforcement during Achilles tendon surgery. The Achilles tendon is formed by three flat and broad aponeuroses from each muscle in the triceps surae. The Achilles tendon becomes progressively rounder in shape until it reaches four centimeters from the insertion site at the superior calcaneal tuberosity where it becomes flatter again. Kager's fat pad is located in Kager's triangle between the anterior aspect of the Achilles tendon, the posterior aspect of the tibia and the superior aspect of the calcaneus. It has been hypothesized that this fat pad lubricates the anterior part of the Achilles tendon and also reduces pressure from the tendon29. There is a retrocalcaneal bursa that is locat¬ed between the tendon and the calcaneus. Between the skin and the tendon, there is a subcutaneous bursa, which reduces the friction between the tendon and the surrounding tissues. The fibers of the Achilles tendon rotate 90° during its descent, such that the fibers that lie medially in the proximal portion become more posterior further distally .This spiraling of the tendon contributes to the elongation and elastic recoiling within the tendon28. The gastrocnemius muscle acts on both the knee and ankle joint by flexion of the knee and plantar flexion of the ankle but also via supination of the foot. The soleus muscle only acts over the ankle joint and therefore produces a plantar flexion and, to the same extent, a supination of the foot. The gastrocnemius muscle contains a larger num¬ber of white, type II fibers producing fast action that is important during activities like running. The soleus muscle contains more of the slow, red type I fibers and is important for maintaining posture30. The triceps surae muscles are innervated by the tibial nerve31.

Biomechanics:

The function of the Achilles tendon is to transmit the forces from the triceps surae muscle to the calcaneus. The tendon possesses substantial elastic potential and, together with the muscular components, this gives the muscle-tendon complex efficiency of force production during various activities[32]. This muscle-tendon complex is active when walking, jumping and running but also during standing for postural control. For optimal function, the tendon must be capable of resisting high tensile forces with limited elongation[32]. When the Achilles tendon is stretched, the stretch shortening cycle (SSC) is activated and the tendon stores elastic energy that is released during the shortening phase[33]. The SSC is a combination of actions that begins with a lengthening of muscle and tendon during an eccentric movement. This is followed by a concentric muscle contraction and the tendon releases the elastic force[34]. The force is higher during this eccentric-concentric action

compared with just a concentric action, due to the utilization of the passive components in both the muscle and tendon[33,34].

Komiet al.[31] have studied the in-vivo forces at the Achilles tendon during activities like walking, cycling and running. During a normal gait cycle, they found that the force is built up before the heel contacts the ground and is then released shortly after. There is a second force peak in the Achilles tendon at the end of the push-off phase.

The mechanical properties of tendons can be described in a force-deformation (elongation) curve. Force and deformation are commonly measured when testing tendon structures and these variables together provide a quantitative description of the mechanical behavior of tendons[33]. The more common description in the literature is the stress-strain curve that describes the material property of the tendon[32]. The tendon stress is measured as the force divided by the cross-sectional area of the tendon and strain is measured as the change in the percentage of tendon length during loading. This means that a tendon with a larger cross-sectional area is able to resist higher forces than a thinner tendon and a longer tendon can be stretched further than a shorter tendon before permanent damage occurs.

Young's modulus is the slope of the linear region of the stress-strain curve and it describes the stiffness of the tendon. The Achilles tendon fibers are at rest in a curly configuration but become fully stretched at a strain of 1-3%. At this stage, the tendon is able to return to its initial length when the force is released. When the tendon is stressed and elongated more than approximately 4%, some fibers start to break. Further stress on the tendon will cause the failure of the rest of the fibers in an unpredictable manner and this will result in a complete tendon rupture[33]. There is a variation between studies of tendon strain at failure of 4-16%[33,34] and 8%[35] is often used as the strain level at which macroscopic failure occurs.

Epidemiology:

Jozsaet al[36] reported that, of all the tendons requiring surgery, the Achilles tendon is the most frequently ruptured. The incidence of Achilles tendon ruptures in the population is increasing[37,38]. Leppilahtietal[38] reported an annual incidence rising from 2/100,000 in 1979-1986 to 12/100,000 in 1987-1994 and, in a more recent study, Houshian et al[37] reported an annual incidence rising from 18/100,000 in 1984 to 37/100,000 in 1996. The incidence was highest in the 30-39 year age group. Houshianet al[37] showed that 73% of the injuries were sports related and the peak of sports-related injuries occurred in the 30-49 age group. There is a second non-sports-related peak in incidence occurring at a mean age of 53 years[38]. There is an almost 200-fold increase in the risk of a contralateral tendon rupture in patients who have previously suffered an Achilles tendon rupture[39]. Most Achilles tendon ruptures occur in men and the ratio between men and women is between 3:1 and 18:1, in general approximately 10:1[40].

Rupture of tendoachilles:

Etiology:

Injury to the Achilles tendon is often multifactorial, with both intrinsic and extrinsic forces recognized. Individual patient characteristics such as increasing age, male sex, and obesity have been shown to have positive correlation with Achilles tendon pathology[41]. Extrinsic factors such as the use of fluoroquinolones and corticosteroids (both oral and intrasubstance) have also been shown to lead to weakening of the Achilles, with associated tendinitis and an increased risk of rupture[42,43]. The risk for development of Achilles pathology with these drugs is even higher in patients greater than 60 years old.

The inherent characteristics, function, and blood supply of the Achilles Tendon predispose it to both acute and chronic rupture.

- In the situation of an acute rupture, patients are usually engaged in athletic activities[44], accounting for 68 % of injuries.
- It is common in stop-and-go sports such as badminton, soccer, volleyball, basketball, tennis, racquetball, squash as eccentric movement puts an enormous amount of stress on the tendon.
- There are some conditions that predispose to rupture with research suggesting that injuries in this patient population are more likely to be missed on first examination[45]These include:

➢ The natural ageing processes
➢ Participation in recreational sports
➢ Obesity
➢ Use of some commonly prescribed medications such as fluoroquinolone and steroids
➢ Poor running mechanics.
➢ Altered biomechanics like flat foot(pesplanus), high foot arch (pescavus) and leg discrepancy.

Three categories of indirect injury that may result in rupture are[28]

1. Pushing off with a weight bearing forefoot while also extending the knee, as occurs at the beginning of a sprint, running, and some forms of jumping
2. Sudden and unexpected dorsiflexion of the ankle, which may occur when a person slips off a chair or a ladder, when stumbling into a hole, or suddenly falling forward
3. Violent dorsiflexion of a plantar-flexed foot when one falls from a height.

A complete rupture of the Achilles Tendon will show the following characteristics[45-50]**:**

- Often the rupture will coincide with a loud crack or pop sound.
- When palpating the tendon, a gap may be felt.
- The back of the heel will be swollen.
- Decreased active plantar flexion of the ankle.
- Increased passive dorsiflexion
- Inability to heel raise
- Impaired gait.
- A positive outcome of the calf muscle squeeze test or Thompson test.
- Some patients will have a history of tendinopathy in the heel or a prior cortisone injection.

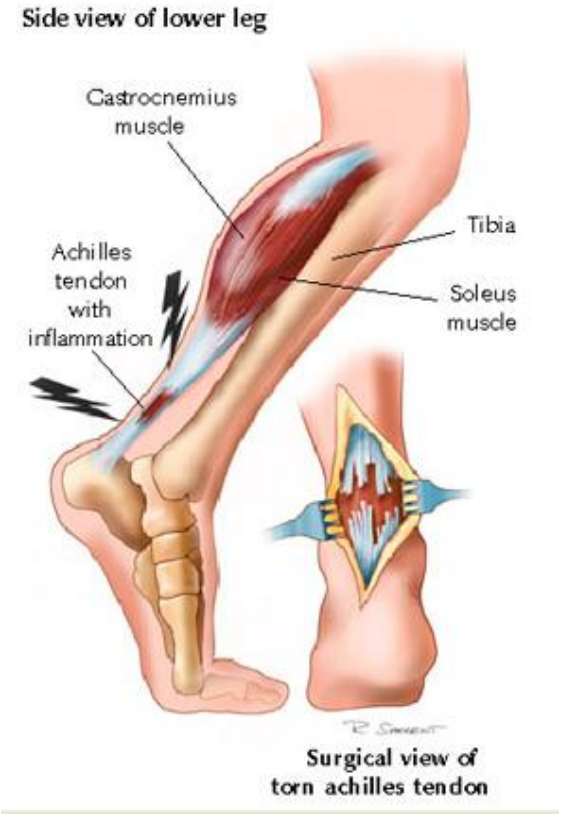
Chronic Presentation (32% of injuries)[45]

In most of the available literature, an Achilles Tendon rupture is described as chronic if it occurs at least 4 to 6 weeks after injury. The symptoms of chronic Achilles Tendon rupture include pain, decreased strength, fatigue, and ankle stiffness. A correct distinction needs to be made because the treatments differ.

- **Achilles tendon rupture classification:**

Achilles tendon tears may be grouped into 4 types[43], according to the severity of the tear and degree of retraction:

1. Type I: partial ruptures ≤50% - typically treated with conservative management
2. Type II: complete rupture with tendinous gap ≤3 cm - typically treated with end-end anastomosis
3. Type III: complete rupture with tendinous gap 3 to 6 cm - often requires tendon/synthetic graft
4. Type IV: complete rupture with a defect of >6 cm (neglected ruptures) - often requires tendon/synthetic graft and gastrocnemius recession



- **Clinical diagnosis:**

Observation: For the inspection of an Achilles Tendon rupture, the therapist may observe the patient in several positions:

1. Standing - to look for fallen arches (flat feet) and other postural complications.

2. Laying - usually on the front. This can be used to observe the tendon more closely for thickening, redness, swelling, and nodules.

3. Walking and running - to look for overpronation.

4. Swelling: a swollen ankle can point to a rupture of the Achilles Tendon.

Palpation: The Achilles Tendon is easily palpable. When palpating along the entire length of the tendon, a gap may be present.

Active movements

In this part of the examination, the therapist asks the patient to fulfill some active movements which can aid in the diagnosis of a tendon rupture.

There are several active movements:

1. Observing the gait pattern can be an important indication for a possible rupture. A patient with an Achilles Tendon rupture can possibly not make a plantar flexion of his ankle. So if the plantar flexion movement in the walking phase is hindered and painful, it can be an indication of an Achilles rupture. A patient with an Achilles rupture will show over-pronation of the injured ankle. The patient will also show a lack of push-off at the end of the stance phase as a result of the dysfunction of the Gastrocnemius and Soleus muscles.

2. Instructing the patient to stand on his/her toes for making a plantar flexion. This will be impossible if the patient has an Achilles Tendon rupture.

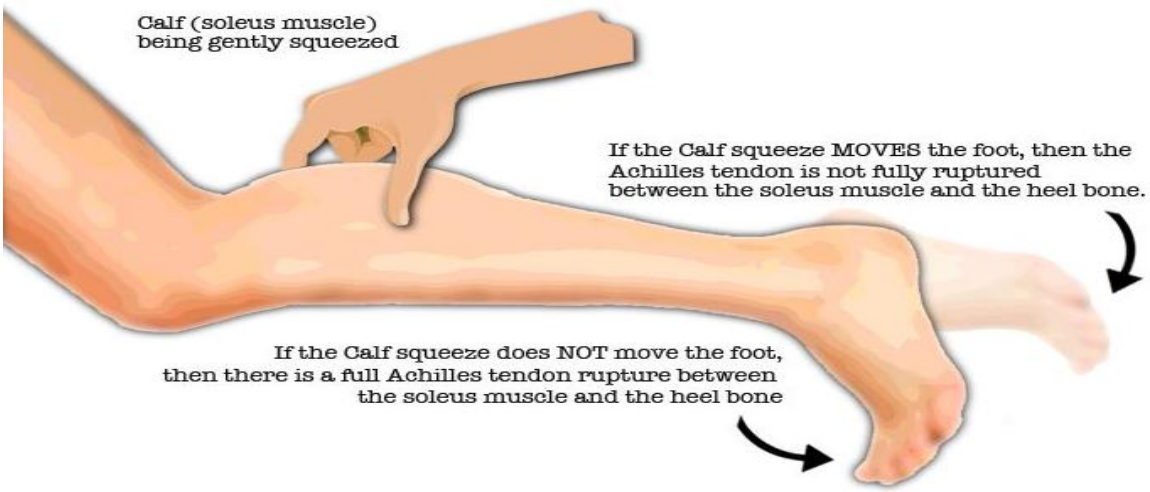
3. Ask the patient to actively plantarflex the ankle.

4. Every active movement containing a plantar flexion of the heel will be almost, if totally not impossible.

Special test:

There exist several special tests for the observation of an Achilles Tendon rupture:

- **Thompson Test** - this test is especially useful for diagnosing complete Achilles tendon ruptures and less useful for the diagnosis of partial Achilles Tendon rupture.

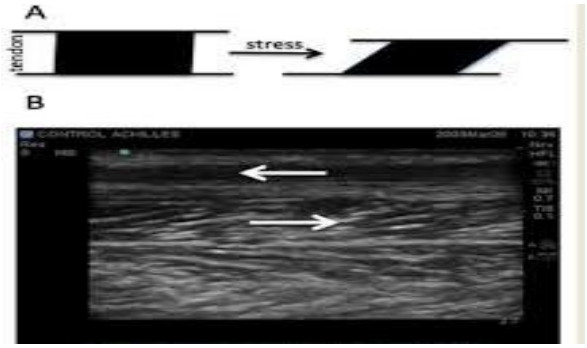


Calf squeeze test for Achilles tendon rupture

- **Matles Test** - the patient lies in a prone position and is asked to actively flex the knee through 90 degrees. The therapist observes the feet and ankles throughout the movement. The test is negative when the foot displays slight plantarflexion; the test is positive if the footfalls into the neutral position or the movement result in dorsiflexion. Maffulli reports a sensitivity of 0.88[45] and considered the most reliable test[51].

- **Achilles Tendon Total Rupture (ATR-score)** - The Achilles Tendon rupture-score is an important questionnaire that refers to the limitations/difficulties a patient with a tendon rupture will face[52,53].

- **Realtime Achilles ultrasound Thompson test -** this test is as the Thompson test, but under ultrasound visualisation. It can be used by surgeons with minimal training in ultrasonography. It provides improved diagnostic characteristics compared with static ultrasound[31].



- **Outcome measures:**

The outcome measures used to evaluate functional results following an Achilles Tendon rupture can be broadly divided into two types:

✓ Objective measures: parameters directly registered by the physiotherapist, such as ankle range of motion (ROM) or calf muscle strength measurements. These objective data, derived from the patient's physical examination, have traditionally formed the basis of functional assessment following an Achilles Tendon rupture[49,53].

✓ Patient-reported measures: over the past two decades, it has become increasingly recognized that the patient's own appraisal of outcome is of the most important when judging the results of treatment[53].

- **Management[54-66]:**

❖ **Non-operative**

- **Functional bracing/casting in resting equines**

Indications:

i. Acute injuries with surgeon or patient preference for non-operative management
ii. Sedentary patient
iii. Medically frail patients

Outcomes:

i. Equivalent plantar flexion strength compared to operative management
ii. Increased risk of re-rupture compared to operative management
iii. New studies show that this may not be significant if functional rehabilitation used
iv. Fewer complications compared to operative treatment

- **Operative**

I. Open end-to-end achilles tendon repair

Indications: acute ruptures (approximately <6 weeks)

Outcomes:

1. Decreased rate of re-rupture compared to non-operative management

2. New Level 1 evidence has suggested no difference in re-rupture rates with functional rehab protocol

3. No significant difference in plantar flexion strength with functional rehab protocol

II. Percutaneous Achilles tendon repair

Indications:concerns over cosmesis of traditional scar

Outcomes:

1. Higher risk of sural nerve damage

2. lesser risk of wound complications/infection compared with open repair

III. Reconstruction with VY advancement

Indications: Chronic ruptures with defect < 3cm

IV. flexor hallucislongus transfer +/- VY advancement of gastrocnemius

Indications: 1. Chronic ruptures with defect > 3cm

2. Requires a functioning tibial nerve

- **Surgical techniques:**

1. Functional bracing/casting in resting equines

Approach: Cast/brace in 20 degrees of plantar flexion

Early functional rehab for those treated without a cast

2. End-to-end achilles tendon repair

Approach: Make incision just medial to achilles tendon to avoid sural nerve

Incise paratenon

Expose tendon edges

Repair with heavy non-absorbable suture

Postoperative care: Immobilize in 20° of plantar flexion to decrease tension on skin and protect tendon repair for 4-6 weeks

3. Percutaneous achilles tendon repair

Approach: Reconstruction with VY advancement

Make V cut with apex at musculotendinous junction with limbs divergent to exit the tendon

is incised through only the superficial tendinous portion leaving the muscle fibers intact

4. Flexor hallucislongus transfer ± VY advancement of gastrocnemius

Approach: Excise degenerative tendon edges

Release FHL tendon at the Knot of Henry and transfer through the calcaneus

Residual hallux plantarflexion weakness

- **Complications:**

a. Re-rupture:

Incidence: Higher with non-operative management (~10-40% vs 2%)

New Level 1 evidence has shown no difference in re-rupture rates

Treatment: Surgical repair

b. Wound healing complications:

Incidence: 5-10%

Risk factors: Smoking (most common)

Female gender

Steroid use,

Open technique (versus percutaneous),

Deep infection

Treatment: Debridement of necrotic/infected Achilles tendon culture-specific antibiotics for 6 weeks

c. Sural nerve injury

Incidence: Higher when percutaneous approach is used.

There is still considerable controversy as the most optimal treatment plan. The Debate is about **nonoperative** vs **surgical repair** for acute ruptures, minimally invasive vs traditional open repair, and early functional rehabilitation protocols instead of a more traditional rehabilitation program are only a few of the arguments that continue to exist in the realm of treatment.

The treatments of acute Achilles tendon rupture include operative and nonoperative treatments. Operative treatments mainly consist of open repair, percutaneous repair, mini-open repair, and augmentative repair. Traditional open repair has lower re-rupture rates with higher risks of complications. Percutaneous repair and mini-open repair show similar re-rupture rates but lower overall complication rates when compared with open repair. Percutaneous repair requires vigilance against nerve damage. Functional rehabilitation combining protected weight-bearing and early controlled motion can effectively reduce re-rupture rates with satisfactory outcomes. Biological adjuncts help accelerating tendon healing by adhering rupture ends or releasing highly complex pools of signaling factors[54].

The combined loss of the skin and Achilles tendon is a serious therapeutic challenge. The combined loss of the Achilles tendon and overlying soft tissue has been treated with multi-stage procedures. The patients not only need soft tissue resurfacing operation but also another Achilles tendon reconstruction operation later. Many one-stage procedures have been used to reconstruct combined Achilles tendon and overlying skin defects, such as using a combined gastrocnemius musculocutaneous V–Y island flap or a fascio-aponeurotic turnover from the gastrocnemius muscle combined with a wide fasciocutaneous flap. There is no question that one stage reconstruction is an efficient way to reconstruct complex Achilles defects with a fully vascularized reconstruction, but at the expense of increased technical complexity and cost.

Open achilles tendon injuries when associated with tendon and skin loss present a complex problem to the treating surgeon. In treating such patients, the priorities would be preventing infection, reestablishing tendon continuity, and obtaining durable soft tissue cover[50].

Many excellent reviews have documented the considerable experience of the evolving management of the ruptured Achilles tendon. Although high satisfaction rates have been reported concerning open operative repair of the Achilles tendon ruptures, the main disadvantage is a postsurgical complication rate ranging from 3% to 17% [27-30,36]. Skin and tendon necrosis associated with wound infection in the Achilles tendon region may be catastrophic, and poses one of the greatest challenges to the foot and ankle surgeon.

Prevention of infection, reconstruction of the skin and tendon defects, and restoration of the function must all be accomplished in order to consider the result a success.

Reconstructive procedures including:

- Turned-over fascioaponeurotic flaps,
- Pedicled local flaps, and
- Various free flaps with nonvascularized and vascularized fascial or tendon grafts have been proposed as potential treatment options.

The long-term functional results following free transfers of compound tissues to the Achilles tendon region have been reported, but these series are heterogenous; they consist of cases who have incomplete and complete ruptures. They also do not include recovery of strength and a discussion of the morphologic changes of the reconstructed tendon as part of their objective evaluation.The "classical" regional options include fasciocutaneous and muscle/ musculocutaneous flaps. One of the most used is the neurosensory distally based island suralflap[55-58]. It includes the superficial and deep crural fascia, the sural nerve and superficial sural artery, the short saphenous vein and the skin island. Another possibility is the medial plantar flap, providing similar tissue and also protective sensibility[59]. Muscle/musculocutaneous flaps used in reconstruction of the area are gastrocnemius, peroneus brevis or abductor halucis[31-34].

The most recent and modern option of regional flaps for coverage is represented by perforator flaps. Since first description, their use in coverage of the Achillean region increased in popularity[14]. They spare the main vascular trunks of the leg causing minimal donor-site morbidity, require relatively rapid dissection and provide a reliable territory[51]. It can also be accompanied by Achilles tendon reconstruction, if needed[60]. A particular, most useful variant of the perforator flap is the "propeller" technique, which implies flap's rotation up to 180º around its pedicle, facilitating direct closure of the donor site.

Free tissue transfer is technically more demanding, requires microsurgical expertise and longer operative time, usually general anesthesia and adequate postoperative monitoring, so it is not the first option of treatment for simple coverage of the Achilles region if loco-regional flaps are available. If the size of the defect overpasses certain dimensions or if the patient refuses supplemental regional scars (especially young females), free flaps are the procedure of choice.

Free flaps used for coverage purposes included fascial, fasciocutaneous and muscle flaps. The most popular are the radial forearm flap and the lateral arm flap[61,62]. Both are thin, suitable in size and could be innervated. For larger defects there were described the scapular/parascapular and the latissimusdorsi flap[63].

On the other hand, if the defect to be reconstructed is complex (after severe trauma or/and infection), involving both skin and tendon, maybe associated with bone damage or exposure, microsurgical free transfer becomes the required method of treatment. It allows creating a single composite flap, suitable for the reconstruction of a specific defect, including several types of tissues in the desired relationship based on a single pedicle.

MastacaneanuM et al[60] did a study and analyse that choosing surgical solution for single staged reconstruction should follow an algorithm based, in order, on the defect's characteristics, best functional and esthetic outcome, donor site morbity, surgeon's expertise and patient's preferences.

The sural artery flap with its modifications, popularized by Masquelet et al[64] has been extensively described for providing cover in the distal leg and foot[61,62,63]including achilles tendon reconstruction with overlying skin defects. Rajendra Prasad et al[55] have used the lateral belly and tendon of the gastrocnemius to bridge 8 cm of achilles tendon defect and a sural artery flap for cover. Arslan E et al[65] used a cadaveric achilles tendon allograft for reconstruction and a crosslegsural artery flap in a 10-year-old boy.

Multiple factors determine the choice of the reconstructive management of complex Achilles tendon and overlying tissue defects. They include the size, the configuration, and the condition of the tendon and tissue surrounding the tendinous defect. Lesions of the Achilles tendon can be either open with a gap or closed, neglected, without a gap, but with diseased and attenuated tissue, and they all may indicate tendon replacement and provision of durable gliding coverage[66].

Single-stage procedures with the provision of a vascularized neotendon for segmental reconstruction seems to be superior compared with techniques relying on "avascular" tendon replacements[57].

The single stage reconstruction performed in a co-ordinated fashion resulted in reduced surgical time. A recent study with similar management, with a combined orthopaedic and plastic surgery team showed an excellent outcome in this location of injury[58].

III. AIMS & OBJECTIVES

The study was planned with the aim of generating information about the outcome of patients underwent reconstruction for combined defect of overlying skin and Achilles tendon in a tertiary care hospital, Kolkata, West Bengal. The objectives of the study were as follows

1. To evaluate epidemiological profile and nature of injury who presented with combined Achilles tendon injury with soft tissue loss in the Department of Plastic & Reconstructive Surgery, IPGME & R, Kolkata.
2. To analyze the surgical options for single stage Achilles tendon coverage and reconstruction among the study subjects.
3. To evaluate the outcome of patients those who underwent reconstruction for combined defect of overlying skin and Achilles tendon in the study setting.

IV. MATERIALS & METHODS

- **Study type and design:** It was an observational study with longitudinal design.
- **Study setting:** The study was conducted in the Department of Plastic & Reconstructive Surgery, IPGME&R, Kolkata. IPGME &R is a premier tertiary care teaching hospital of the Govt. of West Bengal located in the heart of the city of Kolkata spread over an area of 34 acres. It caters to patients from all districts of West Bengal as well as adjacent states of eastern India.
- **Study period:** Study was conducted from 1st March 2019 to 29th February 2020, 12 months period.
- **Study population:** Patients presented with combined defect of overlying skin and Achilles tendon and underwent reconstruction for mentioned defect in the department of Plastic & Reconstructive Surgery, IPGME&R, Kolkata, were the study subjects.
    - **Inclusion criteria:**
        1. Patients presented with combined defect of overlying skin and Achilles tendon
        2. Patients underwent reconstruction as one stage procedure.
    - **Exclusion criteria:**
        1. Patients with peripheral vascular diseases
        2. Patients underwent primary repair TendoAchillies tendon and presented with exposed defect.
        3. Unwilling to participate in the study
- **Sample size:** The study was conducted upon 30 study subjects.

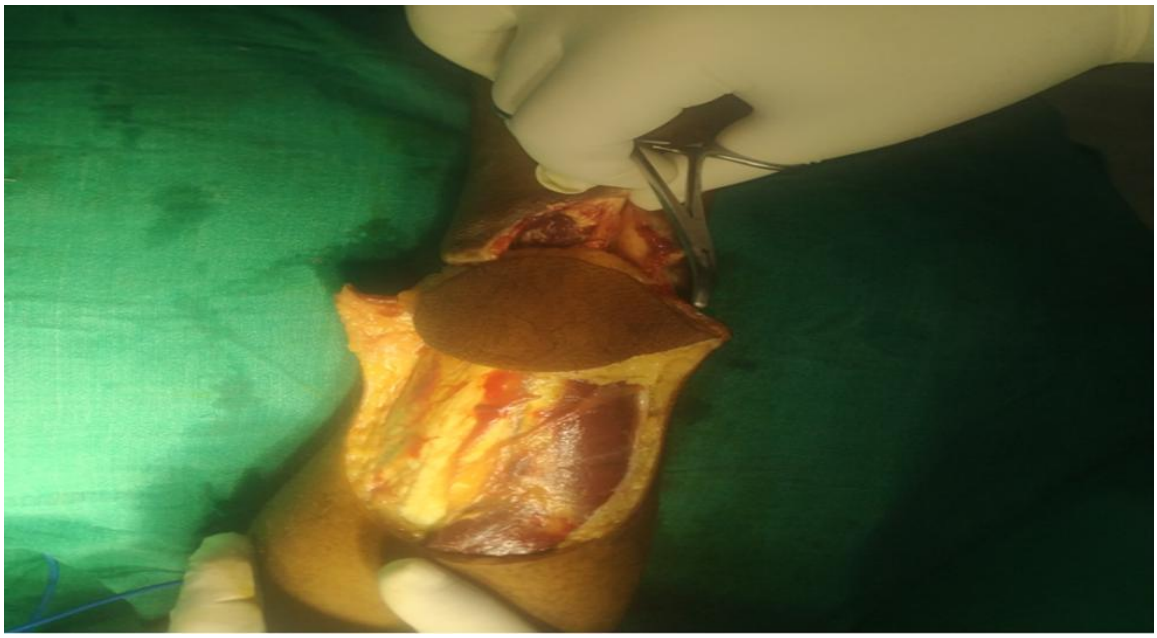
- **Sampling technique:** Patients who presenting with combined defect of overlying skin and Achilles tendon and fulfilled the inclusion criteria during the study period, were selected by consecutive sampling. So all accessible patients were taken as part sample till the desired sample size was achieved. No control group was required for this study.

- **Tools and techniques:**
  - **Tools:** The required tools were
    1. Consent form
    2. Pre-designed Performa
    3. Standard instruments &equipments used for flap surgery and Achilles tendon repair
  - **Technique:**
    1. Interview of the study subjects.
    2. Follow up at 1, 3 and 6 month of interval for any unfavorable outcome.

- **Surgical Procedure:**

In all 30 patients the reconstruction was done under spinal anesthesia. Tourniquet was used in all patients. All the patients were operated in prone position, skin flap marked by drawing a line connecting the midpoint of junction between upper-third and lower two-third of posterior surface of leg to lateral malleolus. This line approximately represents septocutaneous perforators from the peroneal artery in lower one-third of leg. Flap was then marked and centered over short saphenous vein according to defect size. Incision was made along superior border of the flap, at midcalf median sural nerve, median sural artery, short saphenous vein were identified suprafascially and ligated, divided and included in the flap. Distally an extension of flap skin paddle was left over the pedicle (racquet-shaped flap), width of flap between 2 to 3 cm, and pedicle is dissected to the pivot point of flap[67]. In 2 patients skin paddle was not used instead subcutaneous paddle was used. Below the flap the tendoachilles tendon was identified, and ruptured end of tendon exposed. Strip of tendoachillesaponeurotic flap approximately 2 to 2.5 cm wide and adequate length was elevated from median raphe of gastrocnemius, and reflected distally with distal 2 cm attachment kept intact, defect in the donor area of tendoachilles was closed by using nonabsorbable 1–0 prolene suture and then tendon flap turned upside down by 180 degrees and sutured to distal and proximal stumps with nonabsorbable sutures without tension[67].

Pic 1- Markings of reverse sural flap



Pic 2- Reverse sural flap harvesting

Pic 3- Gastrocnemius-soleus turned down flip flap technique

Pic 4- Repair of tendoachilles

Pic 5- Coverage of tendoachilles after repair

For two patient, end to end repair of tendoachilles and coverage done by lateral supramalleolar flap. The final defect size is measured after debridement and the relevant landmarks are marked as follows:

1. Lateral malleolus.
2. The point where peroneal artery perforator is localized.
3. The axis of the flap is marked by a line joining the anterior tibial crest to the posterior margin of fibula.

Preoperative Doppler of the region above the lateral malleolus is done to identify the perforator of the peroneal artery in all cases. Usually we start at a point 5cm above the lateral malleolus on the axis of the flap and proceed proximally and distally from this point to localize the perforator. Planning of the flap is done in reverse, a pattern of the flap is made by using sterilized thick foam and the foam is cut as we would cut the skin and tissue from the pivot point to the distal most edge of the flap. This thick a foam helps to estimate the amount of tissue which will be incorporated into turn of the pedicle correctly. The width of the flap at pivot point is kept at least 3 cm. This foam pattern is then transposed to the leg along the axis of the flap. Flap harvest is done retrogradely in a subfascial plane, preserving the paratenon, especially on the tendinousparts of EDL and peroneal muscles. The superficial peroneal nerve is preserved by gently separating it from the fascia. It is then buried under the muscles and a flatbed is created for graft placement. After flap elevation, the tourniquet is released and hemostasis is

ensured. The donor site is covered with a split skin graft and flap insetting is done in a single layer with interrupted vertical mattress sutures[68].

Pic 6-marking of lateral supramalleolar flap

Pic 7- lateral supramalleolar flap harvesting

Pic 8- TA repaired and coverage by lateral supramalleolar flap

- **Description of the study variables:**

I. **Age:** In years
II. **Sex:** Male/Female
III. **Occupation:** Occupation was noted based on main work status over the past 12 months as follows[70]:

○ ***Unemployed:*** An individual who does not currently have a job or business (excluding homemaker).

○ ***Homemaker (household chores)****:* An individual whose primary activity is in carrying out household tasks without being paid.

○ ***Agriculture/farming:*** An individual who spends significant amount of time working in paddy field, family farm or other similar activity without pay.

○ ***Unskilled labour:*** One who does operations that involves the performance of simple duties, which require the experience of little or no independent judgement or previous experience although the familiarity with the occupational environment is necessary. Unskilled workers include tea garden worker, night guard, maid servant, sales worker, washer man, sweeper, daily labour, rickshaw puller.

○ ***Skilled labour:*** One who is capable of working efficiently of exercising considerable independent judgement of his/her duties with responsibility. This includes tailors, carpenters, driver, masons etc.

○ ***Business:*** An individual who sells goods for earning income.

○ ***Professional:*** Medical, engineering, legal.

○ ***Others***

IV. **Injury mechanism:** Lavatory pan injury/RTA/Fall from height/Physical assault

V. **Surgical technique used for Achilles tendon repair:** End to end repair/ Gastrocnemius-soleus turned down flip technique
VI. **Flap used:** Reverse suralfasiocutaneous/ Lateral supramalleolar flap
VII. **Surgical complications:** flap necrosis/ abscess/ partial loss of STSG donor area
VIII. **Outcome after single stage repair:** Outcome was assessed at 1,3 and 6 month interval based on the following parameters:

i. Pain: No / Mild/ Moderate/ severe
ii. Return to pre-injury activity: Yes/No
iii. Condition of flap: Sensation / stability/ Cosmesis
iv. Diameter difference of calf and ankle (affected/unaffected leg):
v. Walk on tip toes: Yes/No

vi. Ankle range motion: affected/ Unaffected

- **Data collection:**

Data collection was started after approval of the study protocol by institutional ethics committee and also by West Bengal University of Health Sciences. Data were collected using a pre-designed proforma from the selected study subjects after fulfilling inclusion and exclusion criteria.

The study subjects were briefed about the study purpose and procedure and also about their voluntary nature of participation. A written informed consent was taken from each of the study subjects prior to data collection. Follow up was done at 1, 3 and 6 month interval to look for any unfavorable outcome.

Clinical outcome was assessed using Percy and Conochie's[69] criteria. An excellent result was attributed to patients who had regained full function, reported no symptoms, had a stable flap, and returned to the same level of activity as before the injury. A good result was attributed to patients with slight stiffness and an adherent scar, but who returned to the same level of activity as before the injury. A fair result was given if there was definite weakness, moderate pain, or some decrease in activity level. Finally, a poor result was defined when there was severe weakness, a limp, an unstable flap, and no return to the level of activity before the injury.

- **Data analysis:**

Collected data of 30 study subjects was checked for consistency and completeness and were entered in Microsoft Excel data sheet. Data were organized and presented using the principles of descriptive statistics in the form of frequency and percentage and also in tables and diagrams. Diagrams were made by Microsoft Excel software. Categorical data were expressed in proportions. Analysis of the data was done by IBM SPSS version 20.

- **Ethical clearance:** Ethical clearance was obtained from the Institutional Ethics Committee of IPGME&R, Kolkata, West Bengal.

V. RESULTS AND ANALYSIS

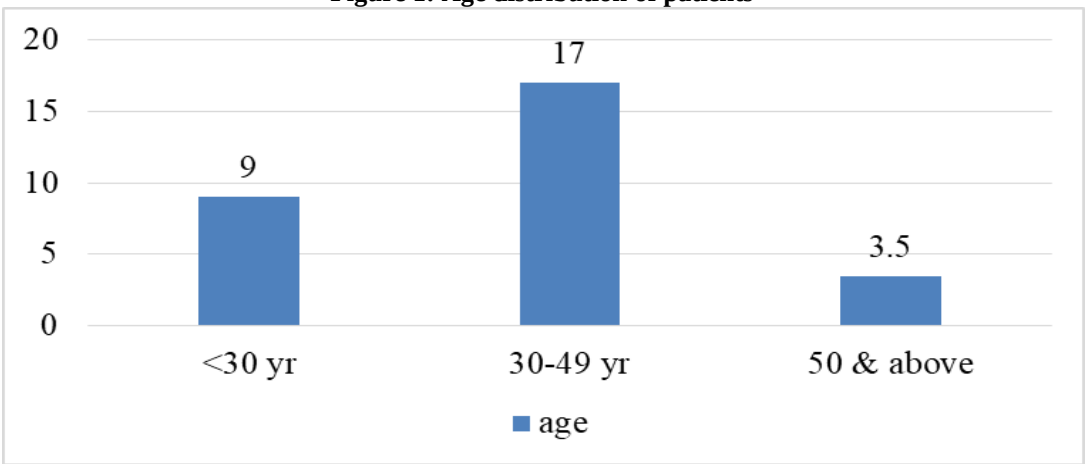
The present study was carried out over a period of one year from 1st March 2019 to 29 th February 2020, in the department of Plastic & Reconstructive Surgery, IPGME&R, Kolkata. Total 30 patients of combined defect of overlying skin and Achilles tendon injury, who underwent reconstructive surgery during the study period, were enrolled in the study. All of them were followed up for a period of six months and the data were recorded for analysis.

Table 1: Age distribution of patients

n=30

Age group	Frequency	Percentage (%)
< 30	9	30.0
30- 60	16	53.3
≥ 50	5	16.7
Total	30	100.0

Figure 1: Age distribution of patients



The above table and bar diagram shows that maximum number of patients was in the 30-49 years of age group (53.3%) followed by below 30 years group (30%), and only 5(16.7%) patients were more than 50 years of age. The mean age at diagnosis was 37.03±12.96 years.

Figure 2: Sex distribution of subjects

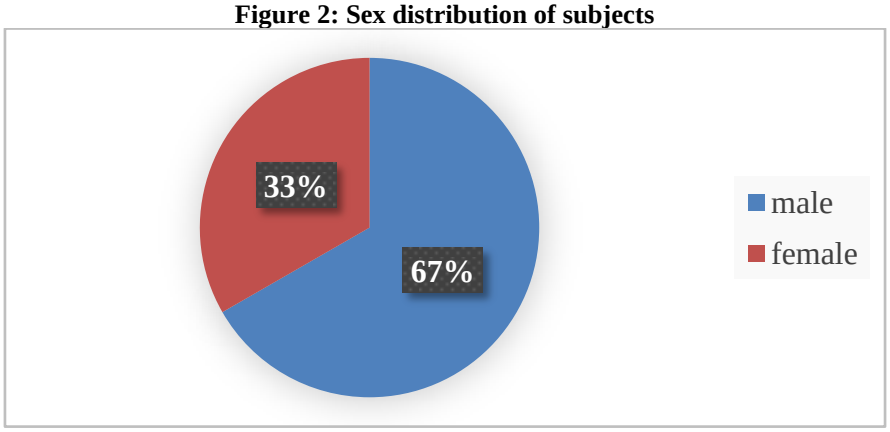


Figure 2 shows that 20 patients were male (67%) while 10 patients (33%) were females.

Table 2: Distribution of study subjects according to occupation

n=30

Occupation	Number	Percentage (%)
Daily labor	17	56.6
Housewife	9	30.0
Businessman	2	6.7
Others	2	6.7

Table 2 and figure 3 shows that 17 patients (56%) were daily labor by occupation and 9 (30%) were housewife. Only 1 patient was industrial worker and 1 was student.

Fig 3: Distribution of occupation.

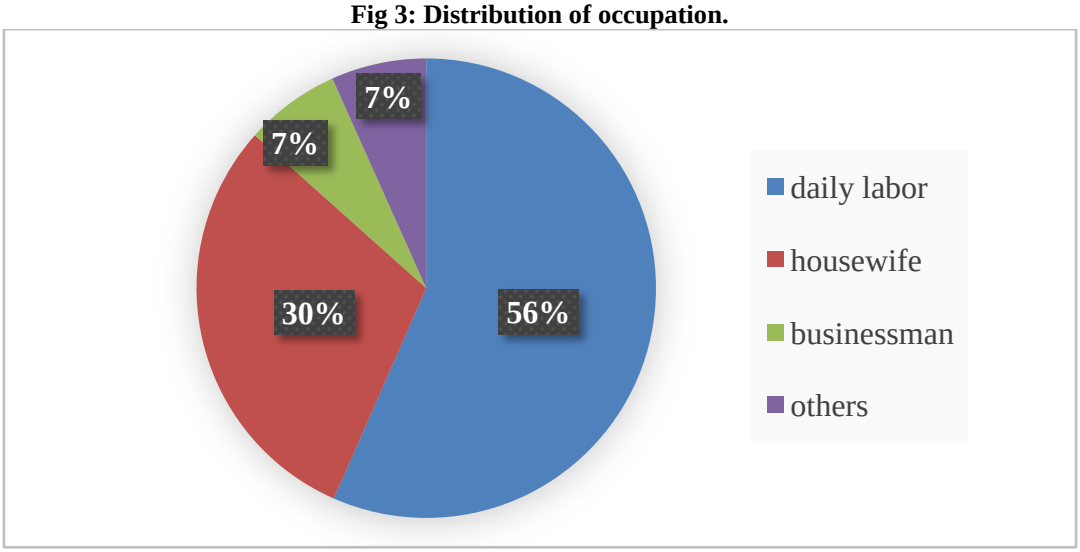


Figure 3 shows that most of the patients were daily labor

Fig 4: Distribution of mechanism of injury.

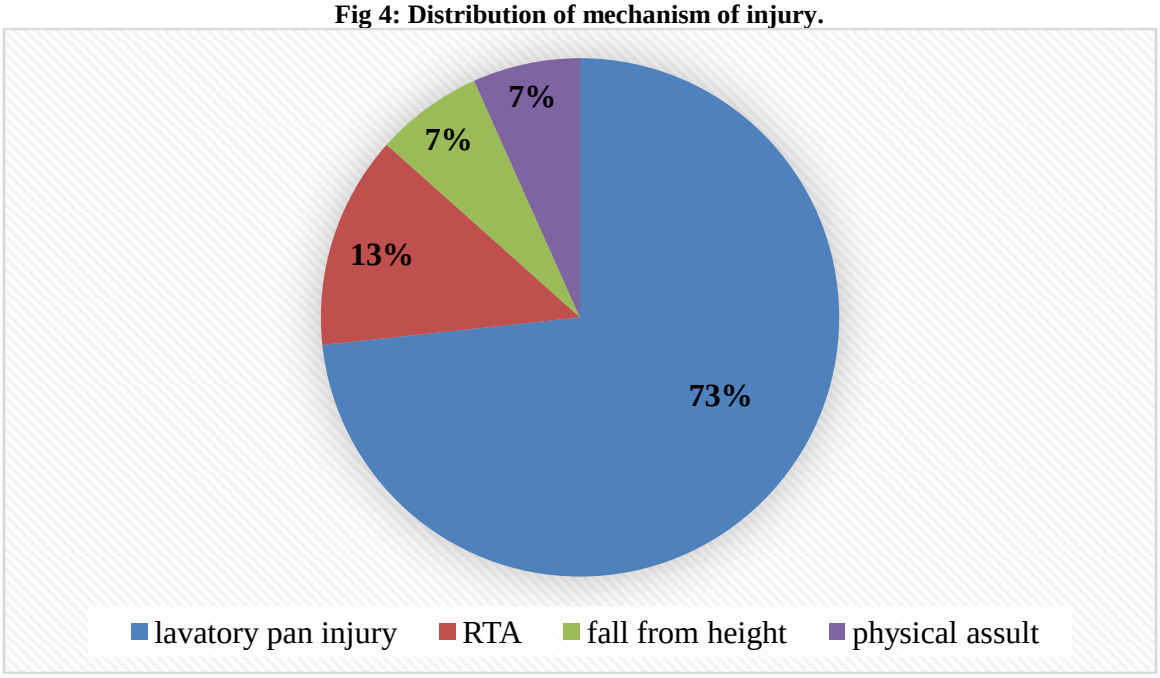


Figure 4: shows that lavatory pan injury was the most common mechanism of injury (73%) followed by RTA (13%). Fall from a height was responsible for 7% injuries.

Fig 5: Surgical technique used for repair of TA

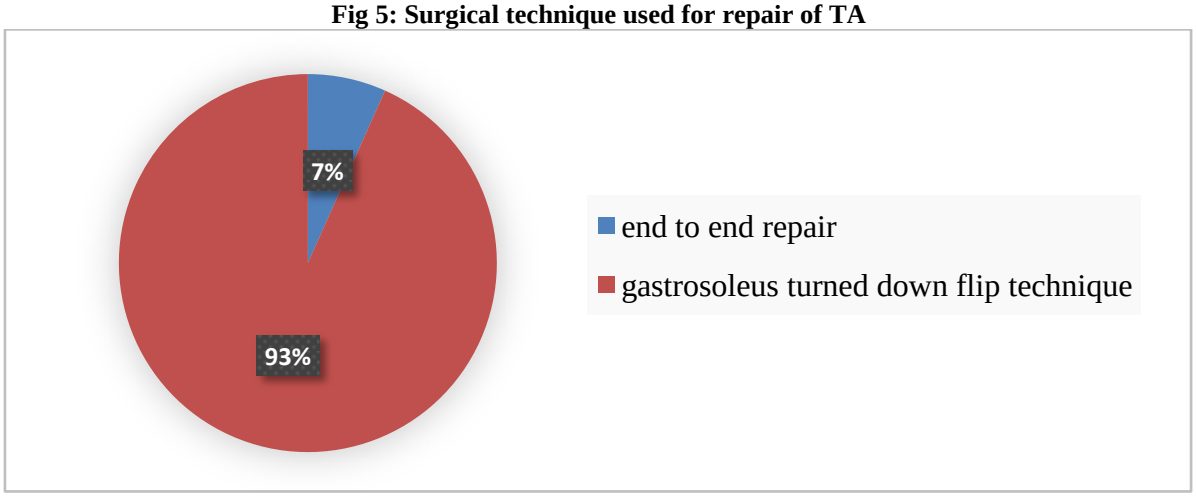


Fig 5 shows that 93% cases Gastrocnemius-soleus turned down flip technique was used for Tendoachilles repair while end to end repair was used in rest 7% cases.

Fig 6: Flap used for surgical repair

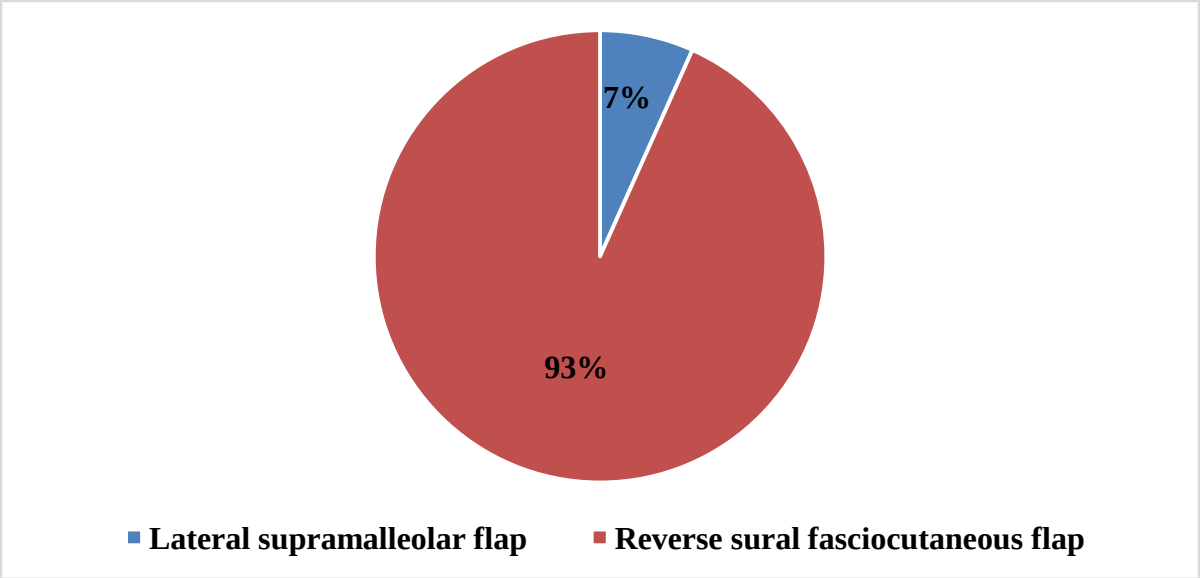


Figure 6 shows that reverse suralfasiocutaneous flap was the most commonly used flap (93%) and lateral supramalleolar flap was used in only 7% cases for the coverage of exposed Tendoachilles.

Table 3: Distribution of study subjects according to surgical complications

n=30

Surgical complication	Number (n)	Percentage (%)
Nil	25	83.4
Distal flap necrosis	1	3.3
Marginal flap necrosis	2	6.7
Partial loss STSG	1	3.3
Abscess	1	3.3
Total	30	100.0

Table 3 shows that only 5 (16.6%) patients had any flap loss or related complications and among them 2 patients (6.7%) had marginal flap necrosis. 83.4% of patients had no flap loss or complication. Complication like abscess and partial loss STSG(donor site) was seen in one case respectively which was treated conservatively by antiobiotic and dressing.

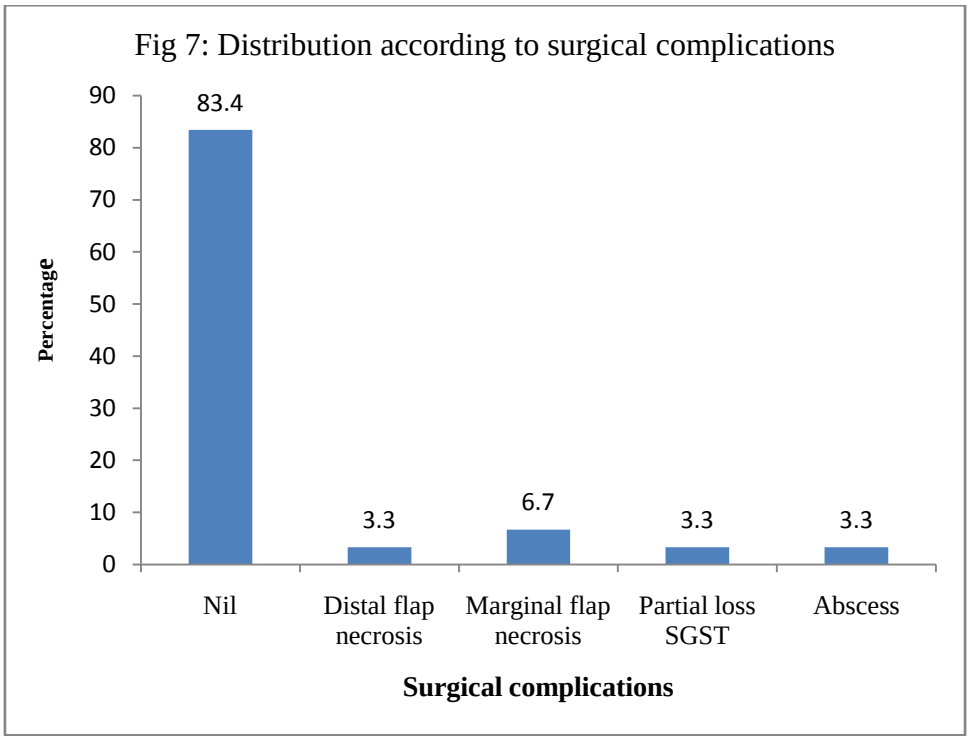


Table 4: Results of clinical evaluation at one month follow up

Case no.	Pain	Return to preinjury activity	Flap			Diameter difference		Walk on Tip Toes	Ankle range of motion (affected / unaffected)	
			Sensation	stability	Cosmesis	Calf	Ankle		Plantar flexion	Dorsi-flexion
1	mild	no	present	good	accepted	-1	2	no	47°/50°	12°/14°
2	no	no	present	good	accepted	-1.5	3	no	45°/48	12°/13°
3	mild	no	present	good	accepted	-2	3	no	42°/46°	10°/12°
4	no	no	present	good	accepted	-1.5	3	no	42°/46°	10°/12°
5	mild	no	present	good	accepted	-1	2	no	45°/48	12°/13°
6	no	no	present	good	unaccepted	-1	2	no	40°/48°	10°/13°
7	no	no	present	good	good	-1	3	no	44°/48°	10°/13°
8	no	no	present	good	good	-1	2	no	46°/50°	11°/13°
9	no	no	present	good	good	-1	2	no	43°/46°	10°/13°
10	moderate	no	present	unstable	unaccepted	-2	2	no	10°/50°	10°/13°
11	no	no	present	good	accepted	-2	3	no	42°/46°	10°/12°
12	no	no	present	good	accepted	-1.5	3	no	42°/46°	10°/12°
13	no	no	present	good	unaccepted	-1	2	no	40°/48°	10°/13°
14	mild	no	present	good	accepted	-2	3	no	42°/46°	10°/12°
15	no	no	present	good	accepted	-1.5	3	no	42°/46°	10°/12°
16	mild	no	present	unstable	unaccepted	-1	2	no	12°/48°	10°/13°
17	no	no	present	good	accepted	-1.5	3	no	45°/48°	12°/13°
18	mild	no	present	good	accepted	-2	3	no	42°/46°	10°/12°
19	no	no	present	good	accepted	-1.5	3	no	42°/46°	10°/12°
20	mild	no	present	good	accepted	-1	2	no	45°/48	12°/13°
21	mild	no	present	good	accepted	-1	2	no	45°/48	12°/13°
22	mild	no	present	good	accepted	-1	2	no	45°/48	12°/13°

23	mild	no	present	unstable	unaccepted	-1	2	no	12°/48°	10°/13°
24	no	no	present	good	accepted	-1.5	3	no	45°/48	12°/13°
25	mild	no	present	good	accepted	-2	3	no	42°/46°	10°/12°
26	no	no	present	good	accepted	-1.5	3	no	42°/46°	10°/12°
27	mild	no	present	good	accepted	-1	2	no	45°/48	12°/13°
28	no	no	present	good	unaccepted	-1	2	no	40°/48°	10°/13°
29	moderate	no	present	unstable	unaccepted	-2	2	no	10°/50°	10°/13°
30	mild	no	present	good	accepted	-1	2	no	45°/48	12°/13°

Table 4 describes the clinical evaluation of reconstructive surgery after one month of period. 43.3% had mild pain whereas, 6.7% had moderate pain. Flap was unstable in 13.3% cases and cosmesis was unacceptable to 23.3% cases. Those with unstable flap also showed poor planter flexion of ankle (13.3%). But patients did not attempt to walk on tip toes.

Table 5: Results of clinical evaluation at three month follow up

Case No.	Pain	Return to preinjury activity	Flap			Diameter difference		Walk on Tip Toes	Ankle range of motion (affected / unaffected)	
			Sensation	Stability	Cosmesis	Calf	Ankle		Plantar flexion	Dorsi-flexion
1	no	no	present	good	accepted	-1	2	yes	47°/50°	12°/14°
2	no	no	present	good	accepted	-1.5	3	yes	45°/48°	12°/13°
3	no	no	present	good	accepted	-2	3	yes	42°/46°	10°/12°
4	no	no	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
5	no	no	present	good	accepted	-1	2	yes	45°/48	12°/13°
6	no	no	present	good	unaccepted	-1	2	yes	40°/48°	10°/13°
7	no	no	present	good	accepted	-1	3	yes	44°/48°	10°/13°
8	no	no	present	good	accepted	-1	2	yes	46°/50°	11°/13°
9	no	no	present	good	accepted	-1	2	yes	43°/46°	10°/13°
10	moderate	no	present	unstable	unaccepted	-2	2	no	10°/50°	10°/13°
11	no	no	present	good	accepted	-2	3	yes	42°/46°	10°/12°
12	no	no	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
13	no	no	present	good	unaccepted	-1	2	yes	40°/48°	10°/13°
14	no	no	present	good	accepted	-2	3	yes	42°/46°	10°/12°
15	no	no	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
16	mild	no	present	unstable	unaccepted	-1	2	no	12°/48°	10°/13°
17	no	no	present	good	accepted	-1.5	3	yes	45°/48	12°/13°
18	no	no	present	good	accepted	-2	3	yes	42°/46°	10°/12°
19	no	no	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
20	no	no	present	good	accepted	-1	2	yes	45°/48	12°/13°
21	no	no	present	good	accepted	-1	2	yes	45°/48	12°/13°
22	no	no	present	good	accepted	-1	2	yes	45°/48	12°/13°
23	mild	no	present	unstable	unaccepted	-1	2	no	12°/48°	10°/13°
24	no	no	present	good	accepted	-1.5	3	yes	45°/48	12°/13°
25	no	no	present	good	accepted	-2	3	yes	42°/46°	10°/12°
26	no	no	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
27	no	no	present	good	accepted	-1	2	yes	45°/48	12°/13°

28	no	no	present	good	unaccepted	-1	2	yes	40°/48°	10°/13°
29	moderate	no	present	unstable	unaccepted	-2	2	no	10°/50°	10°/13°
30	no	no	present	good	accepted	-1	2	yes	45°/48	12°/13°

Table 5 describes the clinical evaluation of reconstructive surgery after three months of period. Only 2 patients (6.7%) had mild pain whereas, another 2 (6.7%) had moderate pain. Flap was unstable in those previous 13.3% cases and cosmesis was unacceptable to those previous 23.3% cases. Total 3 patients (10) % have slightly weak plantar flexon. Those with unstable flap also showed poor planter flexion of ankle (13.3%).

Table 6: Results of clinical evaluation at six month follow u

Case No.	Pain	Return to preinjury activity	Flap			Diameter difference		Walk on Tip Toes	Ankle range of motion (affected / unaffected)	
			Sensation	Stability	Cosmesis	Calf	Ankle		Plantar flexion	Dorsi-flexion
1	no	yes	present	good	accepted	-1	2	yes	47°/50°	12°/14°
2	no	yes	present	good	accepted	-1.5	3	yes	45°/48	12°/13°
3	no	yes	present	good	accepted	-2	3	yes	42°/46°	10°/12°
4	no	yes	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
5	no	yes	present	good	accepted	-1	2	yes	45°/48	12°/13°
6	no	yes	present	good	unaccepted	-1	2	yes	40°/48°	10°/13°
7	no	yes	present	good	accepted	-1	3	yes	44°/48°	10°/13°
8	no	yes	present	good	accepted	-1	2	yes	46°/50°	11°/13°
9	no	yes	present	good	accepted	-1	2	yes	43°/46°	10°/13°
10	moderate	no	present	unstable	unaccepted	-2	2	no	10°/50°	10°/13°
11	no	yes	present	good	accepted	-2	3	yes	42°/46°	10°/12°
12	no	yes	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
13	no	yes	present	good	unaccepted	-1	2	yes	40°/48°	10°/13°
14	no	yes	present	good	accepted	-2	3	yes	42°/46°	10°/12°
15	no	yes	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
16	mild	no	present	unstable	unaccepted	-1	2	no	12°/48°	10°/13°
17	no	yes	present	good	accepted	-1.5	3	yes	45°/48	12°/13°
18	no	yes	present	good	accepted	-2	3	yes	42°/46°	10°/12°
19	no	yes	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
20	no	yes	present	good	accepted	-1	2	yes	45°/48	12°/13°
21	no	yes	present	good	accepted	-1	2	yes	45°/48	12°/13°
22	no	yes	present	good	accepted	-1	2	yes	45°/48	12°/13°
23	mild	no	present	unstable	unaccepted	-1	2	no	12°/48°	10°/13°
24	no	yes	present	good	accepted	-1.5	3	yes	45°/48	12°/13°
25	no	yes	present	good	accepted	-2	3	yes	42°/46°	10°/12°
26	no	yes	present	good	accepted	-1.5	3	yes	42°/46°	10°/12°
27	no	yes	present	good	accepted	-1	2	yes	45°/48	12°/13°
28	no	yes	present	good	unaccepted	-1	2	yes	40°/48°	10°/13°
29	moderate	no	present	unstable	unaccepted	-2	2	no	10°/50°	10°/13°
30	no	yes	present	good	accepted	-1	2	yes	45°/48	12°/13°

Table 6 describes the clinical evaluation of reconstructive surgery after six months of period. Only 6.7% had mild pain whereas, another 6.7% had moderate pain after six months. Majority of the patients (86.7%) were returned to pre-injury activity and all of them can walk on tip toes except 4 patients. Among those 86.7% patients (those were returned to preinjury activity level), 3 patients (10%) have slightly weak plantar flexon and unaccepted cosmesis or scar. Sensation on flap was present in all cases whereas, flap was unstable in those previous 13.3% cases and cosmesis was unacceptable to those previous 23.3% cases. Those with unstable flap also showed poor planter flexion of ankle (13.3%).

Table 7: Outcome of surgical reconstruction of TA

n=30

Outcome	Number (n)	Percentage (%)
Excellent	23	76.7
Good	3	10.0
Poor	4	13.3
Total	30	100.0

Fig 8: Outcome of surgical reconstruction of TA

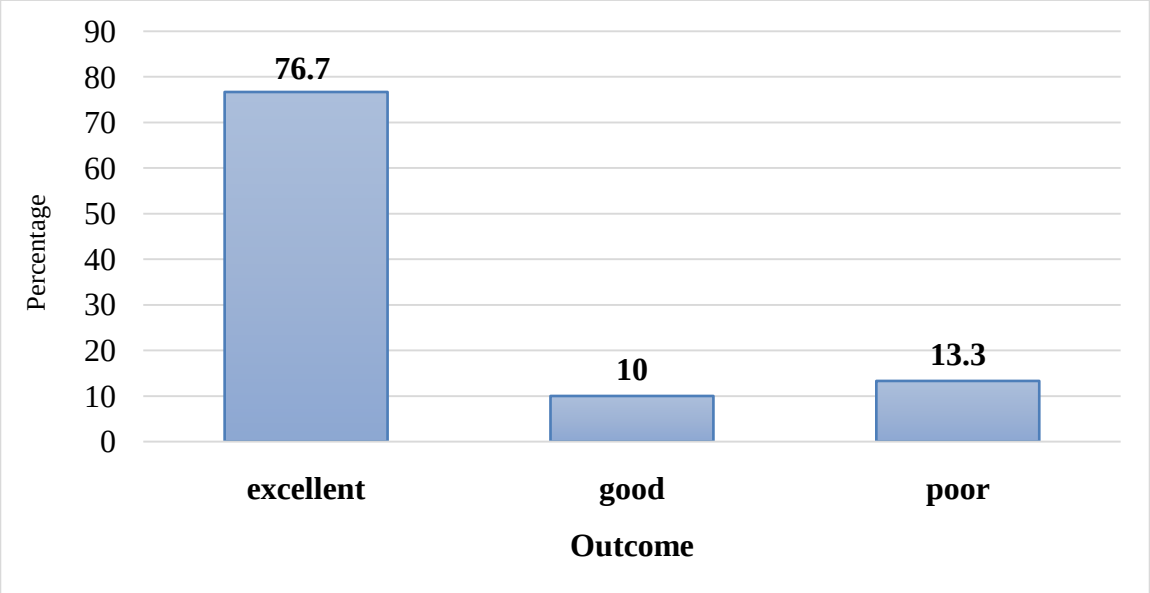


Table 7 and figure 8 shows that (according to **Percy and Conochie's**[69] criteria) only 4 (13.3%) patients had poor clinical outcome (as failed to return preinjury activity level), whereas, 23 patients (76.7%) had excellent outcome and 3 (10%) had good clinical outcome because of mild weak plantar flexon and unaccepted cosmesis but returned to preinjury activity level.

VI. DISCUSSION

The achilles tendon plays a crucial role in the bipedal human beings. Injury to achilles tendon causes great difficulty in walking and running. In our people acute injuries to achilles tendon with open wounds in TA region is more common unlike the west where chronic ruptures and sport injuries are more common. This is because most Indians use Indian toilets which are a common cause of open injuries to achilles tendon. Also most of us do not wear shoes hence the TA region is not protected at work place. TA region is a poorly vascularized area which may cause problems in healing. When the patients present early the management is fairly straightforward. However if the patient is not managed well in the first chance then they may develop complications like skin necrosis over TA region and re-rupture of the tendon, then patient has to undergo more extensive procedures.

There is no question that one stage reconstruction is an efficient way to reconstruct complex Achilles defects with a fully vascularized reconstruction, but at the expense of increased technical complexity and cost. The purpose of this prospective study is to present our experience and functional results in patients who underwent reconstruction of combined defect of overlying skin and achilles tendon.

Demographical characteristics of the study subjects

TA injuries occur in all age groups. In this study the most common age group involved is 30 to 50 years. The mean age at diagnosis was 37.03±12.96 years. Out of 30 patients about 16 patients belonged to this age group (**Table 1, Figure 1**). This finding is similar to a study conducted by **Houshianet al**[14]. **Figure 2** shows that 20 patients were male (67%) while 10 patients (33%) were females. Male: Female = 2:1 in this study. This is a **global phenomenon**[16, 17].

Table 2 and Figure 3 shows that 17 patients (56%) were daily labor by occupation and 9 (30%) were housewife. Only 1 patient was industrial worker and one was student. This is in contrary to the western literature

where athletes were reported to have more TA injuries[14]. This may be explained by difference in socio-demographic background of the patients.

Mechanism of injury

In this present study lavatory pan injury was cited as the most common mechanism of injury (73%) followed by RTA (13%). Fall from a height was responsible for 7% injuries (**Figure 4**). In the western countries where injury is most common among cyclists, runners, volleyball players and gymnasts, **Clement D B et al**[8].

Nature of surgical repair

In this study, 93% cases Gastrocnemius-soleus turned down flip technique was used while end to end repair was used in rest 7% cases (**Figure 5**). **Us A K et al**[32] reported satisfactory resultwith gastrocnemius-soleus turned down flip technique where end to end repair is not possible. End to end TA repair was not possible in maximum cases because patients were attended late in this instititute and were referred from remote area in most cases.

Reverse suralfasiocutaneous flap was the most commonly used flap (93%) and lateral supramalleolar flap was used in only 7% cases (**Figure 6**). **Abhayankar SVet al**[67] reported that single stage reconstruction of ruptured tendoachilles tendon with skin Cover using distally based superficial sural artery flap provides good functional outcome with less hospital stay. The long-term functional results following free transfers of compound tissues to the Achilles tendon region have been reported, but these series are heterogenous; data are inconclusive[44-47].

Surgical complications

In present study only 5 (16.6%) patients had any flap loss or related complications and among them 2 patients (6.7%) had marginal flap necrosis. 83.4% of patients had no flap loss or complication (**Table 3 and Figure 7**). **Jozsa L et al** reported the same; it is a **global finding**[2-6].

Follow up

At one month follow up, 43.3% had mild pain whereas, 6.7% had moderate pain. Flap was unstable in 13.3% cases and cosmesis was unacceptable to 23.3% cases. Those with unstable flap showed poor planter flexion of ankle (13.3%) (**Table 4**).

Clinical evaluation of reconstructive surgery after three months of period showed (**Table 5**) only 2 patients (6.7%) had mild pain whereas, another 2 (6.7%) had moderate pain. Sensation on flap was present in all cases whereas, flap was unstable in those previous 13.3% cases and cosmesiswas unacceptable to those previous 23.3% cases. Those with unstable flap also showed poor planter flexion of ankle (13.3%).

Table 6 describes the clinical evaluation of reconstructive surgery after six months of period. Only 6.7% had mild pain whereas, another 6.7% had moderate pain after six months. Majority of the patients (86.7%) were returned to preinjury activity and all of them can walk on tip toes. Sensation on flap was present in all cases whereas, flap was unstable in those previous 13.3% cases and cosmesis was unacceptable to those previous 23.3% cases. Those with unstable flap also showed poor planter flexion of ankle (13.3%). **Ademoğlu Y**[72] reported the same and maximum patients were returned to preinjury activity level. **Movin T et al**[4] and **Kangas J et al**[71] reported significant reduction in function, when compared with the uninjured side and planter flexion is grossly reduced.

Outcome of surgical reconstruction

Table 7 and Figure 8 shows that only 4 (13.3) patients had poor clinical outcome, whereas, 23 patients (76.7%) had excellent and 3 (10%) had good clinical outcome. **Bullocks J M et al**[47] showed an excellent outcome with this type of single stage surgery. Existence of such a great number of reconstructive procedures described in the literature proves that the problem is difficult to solve and an attempt at systematizing the surgical options is rewarding, allowing the individual case particularities to determine the best surgical solution.

VII. CONCLUSION

Based on the findings and interpretation of the present study as presented and discussed in the previous sections the following conclusions can be drawn:

1. Tendoachilles injuries are more common in middle aged males possibly because more of them get injured at work place.
2. Open injury to achilles tendon by Indian toilet pan is the usual presentation unlike the western countries where injury is most common among cyclist.
3. Primary surgical management if done well produces the best functional outcome.

4. Although high satisfaction rates have been reported, the main disadvantage is a postsurgical complication like flap necrosis.
5. Minor post-op complication was seen in very few cases which were managed conservatively with antibiotic and dressing.
6. In complex defects in TA region, single stage reconstruction with reverse sural flap /lateral supramalleolar flap for exposed TA coverage and TA repair by gastrocnemius-soleus turned down flap/end to end repair according to gap, gives excellent functional outcome.
7. This technique provides stable cover and tendoachilles reconstruction and early healing as both tendon rupture and skin defect are repaired in single stage with no adhesion of tendon to skin and no reruptures.
8. This method of surgical reconstruction is adequate to deal with delayed diagnosis, infection, frayed tendon ends, and a wide gap.
9. Rehabilitation following surgery with adequate immobilization and effective physiotherapy is very important for good functional outcome.
10. Further studies with larger sample size and robust methods are recommended.

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