Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/20864
DOI URL: http://dx.doi.org/10.21474/IJAR01/20864

RESEARCH ARTICLE

"REHABILITATION AFTER FLEXOR TENDON INJURY: A COMPARATIVE REVIEW OF THE DURAN AND KLEINERT TECHNIQUES"

Raj Kumar Sharma[1] , Jasmine Anandabai[2] , Harish Sharma[3] and Muskan jain[4]

1. Associate Professor Jyotirao phule Subharti College of physiotherapy Swami vivekanand Subharti university meerut.
2. Professor Jyotirao phule Subharti College of physiotherapy Swami vivekanand Subharti university meerut.
3. Associate Professor Department of Physiotherapy, Teerthanker Mahaveer University , Moradabad.
4. Assistant Professor Department of Physiotherapy, Teerthanker Mahaveer University , Moradabad.

Manuscript Info

Manuscript History
Received: 20 Febuary 2025
Final Accepted: 23 March 2025
Published: April 2025

Key words:-
flexortendoninjury, modified kleinert technique and modified durantechnique

Abstract

Background/Objectives: Flexor tendon injuries, particularly those affecting the flexor digitorum profundus and flexor digitorum superficialis, are prevalent and often result from penetrating trauma or lacerations. Surgical repair, typically via end-to-end tendon suturing, is essential for restoring function. Postoperative rehabilitation is crucial to prevent complications such as adhesions, stiffness, and re-rupture. This study aims to evaluate the effectiveness of a combined rehabilitation regimen incorporating modified Kleinert and modified Duran protocols in enhancing functional outcomes following flexor tendon repair.

Materials and MethodsA systematic review was conducted to evaluate the benefits of combining the modified Kleinert and modified Duran protocols for flexor tendon rehabilitation. An initial search yielded 28 articles, of which 10 met the inclusion criteria based on relevance, study quality, and focus on combined rehabilitation techniques. The remaining 18 articles were excluded due to factors such as insufficient data, lack of focus on combined protocols, or methodological limitations.
All 10 included studies reported that the combined use of modified Kleinert and modified Duran protocols resulted in superior functional outcomes compared to the use of either protocol alone. These findings suggest that integrating both approaches may enhance tendon healing and functional recovery following flexor tendon repair.

ResultsThe systematic review indicates that combining the modified Kleinert and modified Duran rehabilitation protocols yields superior outcomes compared to using either protocol alone. Studies have demonstrated that this combined approach leads to improved functional recovery, reduced tendon rupture rates, and enhanced range of motion. For instance, a study reported that patients undergoing the combined regimen achieved excellent or good results in a significant majority of cases, with a rupture rate as low as 2.3% . Another study found that the combined protocol resulted in better total active motion and grip strength compared to other rehabilitation methods .PMC

ConclusionThe evidence suggests that a rehabilitation program integrating both modified Kleinert and modified Duran techniques is more effective than employing either protocol individually. This combined approach enhances tendon healing, minimizes complications such as adhesions and re-ruptures, and promotes better functional outcomes. Therefore, adopting a combined protocol may offer a more successful and productive strategy for flexor tendon injury rehabilitation.

Corresponding Author:- Raj Kumar Sharma
Address:- Associate Professor Jyotirao phule Subharti College of physiotherapy Swami vivekanand Subharti university meerut.

……..

Introduction:-

The incidence of flexor tendon injury is estimated to be 7-14 per 100,000 populations. In India such injuries are common and about 5%of these injuries require repair of flexor tendon. A study in a Finnish population puts the figure at 7:100,000 people per year. In a pediatric population (<16 years), 31 flexor tendon injuries were found out of a total of 391 hand injuries [6]. Flexor tendon injuries are traumatic injuries to the flexor digitorum superficialis and flexordigitorum profundus tendons. Flexor tendon injuries are traumatic injuri estothe flexor digitorum superficialis and flexor digitorum pro fundustendons.Itcan be caused by lacerations or trauma (penetrating trauma). Diagnosis is made clinically by observing the resting posture of the hand to assist the digital cascade and the absence of tenodesis effect. Signs and symptoms include unable to bend part of your arm or hand, in ability to move multiple joints in the arm, numbness tingling. Treatment is commonly end to end tendon repair [1]. Flexor tendon injuries are common as the tendons lie close to the skin and so are mostly the result of lacerations such as from knifes or glass, from crush injuries and rarely they can rupture from where they are joined at the bone during contact sports injury such as in football, rugby, and wrestling [5]. Flexor tendon injuries are common and occur mostly by penetrating trauma. The highest incidence is observed in males and those aged 20 to 29 years, with work related injuries accounting for 25% of acute presentations. Tendon injury may be classified as acute or chronic, and as either direct or indirect [7]. The aim of Rehabilitation after tendon repair is to achieve function and gliding but avoiding rupture of the tendon. The two main protocols i.e described for rehabilitation off lexiontendon injury are modified kleinertdmo dified Duran technique. In modified Kleinert technique there is active extension within rubber band flexion, also called the active extension- passive flexion method [5]. The authentic Duran technique visualizes full PIP extension at the PIP joint duringthe exercises and includes rubber band traction which is eliminated in the modified Duran technique [22].

A. Anatomy

Flexortendon sarecord like muscleending running from for earm across the wri stand palm and into the fingers, allowing you to bend your fingers and thumb to grasp and object or make a fist [3]. There are two flexor tendon for each digit- flexor digitorum superficialis (FDS) and flexor digitorum profundus (FDP). In palm, the FDS tendons are located superficially to the FDP but at the level of the MCP joint, the FDS into two slips, allowing the FDP to pass between them and comes superficial to FDS [6].The flexortendon system of the hand consists of the flexor muscles of the forearm, their tendinitis extensions, and the specialized digital flexors heath.These components workincombination toproduce smooth and efficient flexion of the individual digits of the hand [2]. Tendons are strong cords connecting muscles to bone. When muscles contract, tendons pull through their attachments to bone and cause a joint movement. Long tendons run from the end of the muscles through small tunnel sinthewri stand hand to attachtothesmall bones of the finger sand thumb,these tu nnel sarecalled tendon sheath[3].Thetendons that can be involved includes; flexorpollicislongus (FPL) (flexion tip of the thumb), flexordigitorum profundus (FDP) (flexion of fingers), flexor digitorum superficialis (FDS) (flexes themiddle joint of each finger), flexor carpi ulnaris.(FCU) and flexor carpi radialis.(FCR) [3]. The fibrous sheath is thickened at certain places known as pulleys. Based on their appearance pulleys arecalled annular and cruciate .They are named as A1 to A5 for annular pulleys and C1 to C3 for cruciate pulleys. In the thumb, originally three pulleys has been described the yare theA1 pulleyover the MCP joint,A2 pulley over theinterphalangeal(IP)jointand anoblique pulley running across the proximal phalanx . The oblique pulley is an extension of the abduct or pollicis apponeurosisandusconsideredasthemostimportantforFPLfunction.Thetendons are surrounded by synovial sheath and there is synovial fluid in the sheath which covers them and provide them the necessary nutrition. The vascular network reaches them through attachments called vincula. Both thesuperficial and deep tendons haveto vinculaeeach onelongus (long)and onebrevis (short) [6].

B. Healingprocessoftendon

The 2 process involved in the healing of tendon are the extrinsic healing mechanism involving the surroundingtissue, and the intrinsichealingmechanism that involves thetendon itself and its synovial sheaths. Vascular and cellular in growth from the surrounding tissues enhance the extrinsic healing. The callus formation allows the cicatrization of the tendon but restricts its mobility,commonly in zone 2. To prevent adhesion formation agents like steroids, anti- inflammatory drugs, hyaluronic acidand antihistamines are used. For decreasing the risk of adhesion formation microsurgical techniques and new suture materials in a combination with a non-traumatic approach has been very useful. Though many factors as associated lesions (skin loss, vascular, nerve injury or fracture) and the nature of the trauma (avulsion, crush injuries l, Bluntinjury)playamain roleindenotingchances ofadhesionsformation.Studiesshowthatthe tendon cells (tenocytes) themselves are potential for healing [20].

C. **Zoneofclassificationofflexortendoninjury**

D. The zone Classification of flexor tendon divides into five zones based on anatomical location. Flexor tendoninjurywasclassifiedinto5zonesbyKleinertandVerdenin1983(Figure2.1)Zone2hasbeen known as "no man's land" due to historical high complication rate [4].

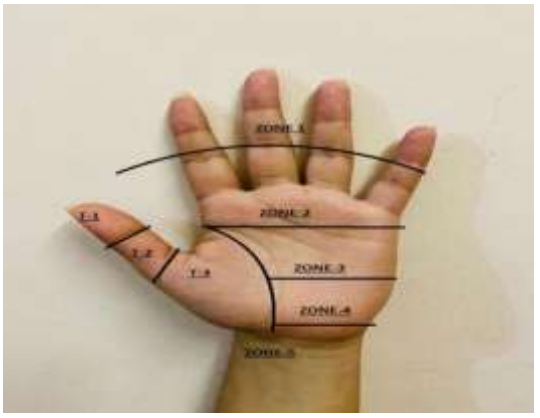


Fig.1.2zoneofclassification offlexortendon injury

ZONEOFCLASSIFICATIONOFFTIINFINGERS	
Zone1	StartsfromtheinsertionofflexorFDStotheinsertionofFDP on the distal phalanx. Contain FDPbelow eg. Jersey finger
Zone2	Startfromtheevenpulleyproximaledgetothedistalinsertionof FDS.
Zone3	Fromthedistaledgeofthecarpaltunneltotheproximalendof theA1pulley.Containstheoriginoflumbricalmusclethatstarts from the FDP tendon.
Zone4	Withinthecarpaltunnel.
Zone5	Fromthemusculotendinousjunctionintheforearmtothe proximal aspect of carpal tunnel.

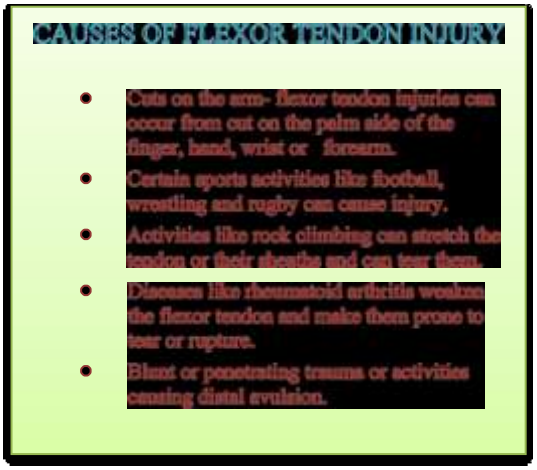
a) *Table1.*1ZoneofclassificationofFTI

ZONEOFCLASSIFICATIONOFFTI IN THUMB	
ZoneT1	FromFPLinsertionto A2 pulley.
ZoneT2	FromA2pulleyto distal A1 pulley.
ZoneT3	FromdistalA1pulley to carpal tunnel

FlexorTendonRepair[29].

The aim of FTR is to achieve a balance between repair strengthandtendonglide.Theidealcharacteristicsofa primary FTR have been outlined:

- Sutureseasilyandsecurelyplacedinthetendon
- Smoothjunctureoftendonends
- Minimalgappingattherepairsite(lessthan3mm).
- Minimalinterferencewithtendonvascularity
- SufficientstrengthtopermitEAM



ZONE1REPAIR–themostlyusedrepairtechniqueisthe "button-over-nail" repair,but it has limited range of motion at distal DIP joint. "Shepherd's Crook" repairs I as light variation using a k- wire as an external strut in the place of classic button, it has benefits of avoiding skin pressure

necrosis and damage to the nail structure and there are drawbacks like high risk of infection, k-wires and difficulty in patient compliance. Use of micro bone suture anchors is used alternatively to avoid morbidity causedbypull-outsuturerepair.Themaindisadvantageofboneanchorisitshighcost,sutureanchorsmaybe contraindicated in patients above 75 years.

ZONE 2 REPAIR- "No man's land, repair. Two strand repairs have very high rupture rates and is not favoredbysurgeon.It isasuturerepairwithatleastfourstrands.Fourstrandrepair-most commonlyused repair for zone 2. It is a suture repair with at least four strands.

ZONE 3 REPAIR- Using a two and three "figure of eight core suture configuration in combination with a continuousepitendinoussuturetorepairFDSandFDPinjuries.AgoodoutcomewithsafeEAMcanbeseen if there is no neurovascular compromise.

ZONE4REPAIR-Tendoninjuriesarerareinzone4duetoprotectionofflexorretinaculum.Its management include direct tendon repair and releases the transverse carpal ligament.

Z**ONE5REPAIR**-Zone5injuriesareconnectedwithneurovascularcompromiseandrequiresurgicalrepair and rehabilitation. Kessler repair have good functional and technical outcomes on zone 5 injuries.

THUMB INJURIES REPAIR- Using a six strand M Tang repair, excellent results can be achieved with minimaldeficitinIPjointextension.Endtoendrepairalsohasanexcellentgoodoutcome.Repairtechniques as motion stable Mantero technique and the Kessler 4 strand repair results ininadequate IP joint mobilityand bad overall functional result and not used practically routinely.

Postoperativemanagement

MostoftheminvolveActivemotionexercises.Thenthesuturestrengthhastoincrease:

1. Activeextension-rubber bandflexionmethod e.g.-KleinertProtocol
2. Immobilization
3. Controlledpassivemotionmethodse.g.Duranprotocol
4. EarlyActive ROM

FlexorRehabilitation

- AnidealRehabilitationpromotesintrinsictendonhealing,minimizes adhesions formation and optimizes tendon glide to restore a functional Romwithout compromising the repair.[7]

Timeline	Splint	Therapeuticexercise	Precautions	Other
Week0-3	Dorsal blockingsplint 1.neutralwrist 2.50flexionof MCP 3.fullextensionofIP Note-ifFDPof MF,RF or SF repaired, shouldinclude all 3 digits in splint.	Homeexerciseprogram 1. passivefull fist 2. passiveDIPinextensionwith MCP and PIP in flexion 3. activelyextendIpsandblock MCP in full flexion 4. activeextensionandpassive flexion of DIP 5. activeextensionandpassive flexion of PIP 6. unaffectedfingersisolatedFDs glide 7. gravityassistedwristflexion followed by active extension limited to splints Therapistprocedureinclinic: 1. removalofsplint:fingersflexed with passive wrist extension 2. passive wrist flexion with passivehookfistingtoprevent intrinsic tightness Earlyactivemotionprotocol *clearingofsutureofadequate strength by MD Note-severe edema increases chances of tendon drag and rupturesoinitiateROMpost-op after 48 to 72 hrs Tensile strength of tendon decreasesfromday5to 15. Hold flexion of fingers with wrist extendedinhook,fullfistposition	Early active flexion only if noactiveflexion of involved finger Nopassivewrist extension No passive fingerextension Involved hand has no functional use	Care of wound Control of edema Massageof scar Note-may need pulley ring fabricationif pulley is repaired

Table1.2-Zone2-5FlexorTendonRepairProtocol

Week3	At night if needed initiateserialstaticPIP extension splint.	IfnotdoneviaEAM, add: 1. placed\hold for hook,fullandstraight fist with wrist extended. 2. place hold for isolatedFDSglideof involved digits.	Sameasweek1and3 Gentle tension exercises should be done. Avoidmuscle contraction.	
Week4	Progresssplinttohand based dorsal splint	In all three fist position with wrist extended initiate active,nonresistive digitalflexionand extension.		Light prehensile activitesinclinic
Week5	Dischargesplint	InPIPandDIPflexion if needed add gentle blocking exercises		Light prehensile activitiesathome
Week6	IfneededinitiatePIP and DIP extension splint			If needed initiate NMES,therapeutic heating viaultrasound
Week8		Tohomeprograms graduallyaddresistive exercise.		Functionaluseof hands.

Tableno.1.3flexortendonrepairprotocolaccordingtoweek[19].

KLEINERTANDDURANTECHNIQUES

Kleinert and Duran techniques -Kleinert (active extension,rubber band passive flexion) and Duran(passive extension,passiveflexion)protocolsare2basictypesofearlymotionprogramsforRehabilitationsofflexor tendon injuries. [23]

LEINERTTECHNIQUE

HaroldKleinertin1950proposedactiveandpassivemobilizationwithdorsalblockingplastersplint keeping wrist in flexion of 20°, MP joint in flexion of

70°andallowingcompleteextension offingers.

An elastic traction band is attached to a loop, which is fixed to nail, keeping fingers in flexion but at the same time allowing active extension within the range of dorsal blocking splint[20, 21]. The first 4 weeks patient is said to perform active extension of fingers manytimes for half an hour periods every day at different intervals.For there stof the day andduring the night the rubber band traction is detached in order to prevent development of flexion contracture in interphalangeal joint. In the start the exercise should be keeping

Patients elbow flexed and proratedin ordertorelax Flexor muscles, it should be guided by the hand therapist.

Betweenthe5thand6thpostoperativeweeksactive flexion is begun with Dorsal blocking splint. [20] The original controlled motion protocol recommended by Kleinert has been modified by decreasingflexionatwristandincreasingflexionat MP joints. Almost all modifications of the active

LIMITATIONSOFKLEINERTTECHNIQUE [20,22].

- It's a costly technique and a highlydemanding procedure for thetherapist,surgeonandpatient.
- A proper control at everystep is necessarytopreventaruptureor agap at the tendon repair site.
- Proximal interphalangeal flexioncontracturesareformed.

digitalextensionand rubberband flexionmethodof Kleinert consists a distal palmer bar that allowsthe rubber to have a more direct approach to the terminal digit from the distalpalmerandresultsinnearlycompleteinterdigital flexion during rubber band contraction.[21]
Active extension in limits of dorsal blocking splint, 50 repetitionsperhour.InadditionpassiveflexiontothePIP and DIP joints, followed by composite passive flexion to each digits (5 repetitions per hour). Complication from Kleinert protocol majorly PIP flexion contracture due to holding the injured finger in flexion all the time, lead to the creation ofanother passive motion protocol lcalledthemodifiedDuranprotocol.[22]

ModifiedKleinertTechnique-The Kl einert controlled passive mobilization splint is modified to increase the passive range of motion (ROM) of the PIP and DIP joints to near normal [28]. Modification of Kleinert regimen byadding a palmar pulley can be introduced to improve DIP flexion. This regimen can be called as active extension/ assisted flexion regimen rather than active extension/passive flexion regimen. [27]

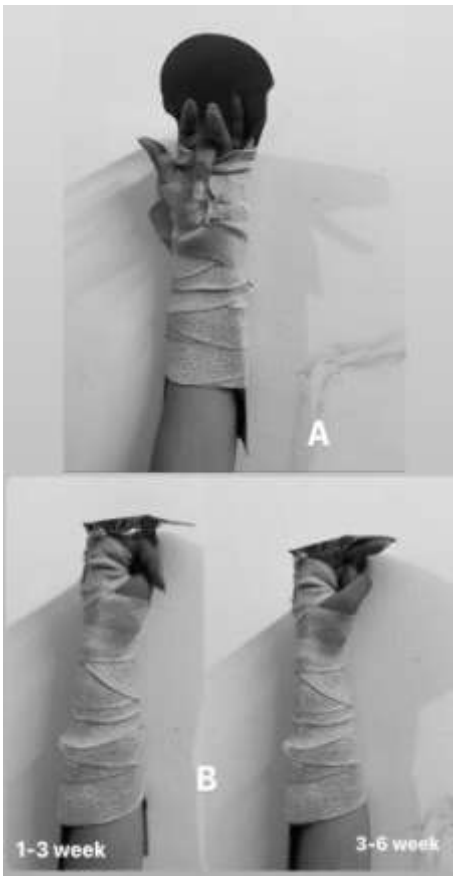


Fig1.5ModifiedKleinerttechnique

Protocol	Completeimmobilization	Passivemotion
Dorsalblockingorthosis Wrist Metacarpaljoint Proximalinterphalangealjointand distal interphalangeal joint	30˚flexionofwrist 40-60˚flexionofMCPjoints PIP and DIP in extension	Kleinert: Wrist 30˚flexion MCPin40-60˚flexion PIP and DIP joint in extension Involved finger immobilized with rubberbandorelasticthreadinfull flexion. Duran: 20˚ flexion of wrist MCPjointsinflexion PIPandDIPjointinextension Fingerspositionedinextensionat night

Duran Techniques-

DuranandHauserproposedcontrolledpassivemotionfor the post-operative flexion tendon repair lesions in zone 2. Wrist is in 20-30°of flexion, MP joint in 60° of flexion while PIP and DIP joints are in extension. For 1st 4weeks controlled passive motion is used, by the hand therapist, twice a day with each session of 6-8 motionsfor each tendon. This method uses 3-5minutes exercise movements at the repair site for preventing any firm adhesion formation. For a week, rubber band traction is connected to the wrist and active exercises are done for 2 weeks with dorsal blocking splint in place [20].

Modifiedduran Protocol:

Duran technique was updated by Strickland. He increased the duration and frequency of daily passive exercises.PIPandDIPjointsareseparatelymobilizedin repeated motions with full passive extension andflexion. An occupational therapist, works with the operating hand surgeon and assist the controlled passive motion protocol during 1st 5 weeks. For initiating the active flexion exercises after 5thweek, block technique advised by Bunnel can be used, PIP joint is actively flexed, MP joint is blocked in extension. After 6weeks, if the extension of the finger is limited, dynamicsplitting may be necessary. 6 months is the minimal period before considering any tenolysis and this is the time period that is required to obtainedcomplete motion [20].The modified version incorporated the full length of the fingers in the orthosis and also addedstrapping of full extension. It decreases the problems with PIP joint contracture [22]. Patients are instructed to perform passive flexion and active extension exercises to eachsingle finger joint andthentheentirefingeronan hourlybasis [22].Passiveexercisesdescribedinthe original protocol for the early stage, protected tenodesis in therapy if appropriate. [23]

Limitations

- Thesmallfinger shouldnotparticipatein theblocking programs.[24]

	DURANSVS.KLEINERTTECHNIQUE[19,23]	
s.no.	Duran protocol	KleinertProtocol
1.	Rubberbandtractionisusedfora week	Dorsal blockingsplintisused
2.	Passiveextension offingers.	Placesthefingerinactive extension
3.	Usesdorsalblockingsplintfor passive flexion of fingers	Fixesthefingerinpassiveflexionbythe use of rubber band
4.	Wristisplacedin20◦offlexion; MCP joint is in looseflexion.	Wristisplacedin30◦offlexion;MCPjoint is in 40-60◦ of flexion

RESULT:

In flexor tendon injury rehab, the success of modified Kleinert protocol and modified Duran protocolwerequitesimilar,butwhentheyareusedinacombinedregimen theyareprovedtobe more efficient and successful.

CONCLUSION:

Flexor tendon injuries are common and occur mostlyby penetrating trauma. Tendon injurymay be classifiedasacuteorchronic,andaseitherdirect orindirect.TheaimofRehabilitationaftertendon repairis to achievefunction and glidingbut avoidingruptureof thetendon. Thetwomain protocols
i.e described for rehabilitation of flexion tendon injuryare modified kleinert and modified Duran technique.Afterourstudy,wecometoaconclusion,combinedregimenofmodifiedKleinertand modified Duran technique was more beneficial in the rehabilitation of flexor tendon injury.

REFERENCES

:

1. Tylerparas.Flexortendoninjuries.Orthobullets.com.8October2022.
2. StevenBates,JamesChang,CatoTLaurencin,FranciscoTalavera,ThomasRHuntIII, Harris Gellman,et al. Flexor tendon anatomy. January 2022.
3. TylerStevenPidgeon,ThomasWardThrockmorton,CharlesD.Jennings,ColinF. Moseley.Flexor tendon anatomy.Medscape.Orthoinfo.January 2022.
4. RasuliB,Henryknipe.ZoneClassificationofflexortendoninjury.Radiopaedia.org.7April 2020.
5. Mgriffin,SHindocha,DJordan,MSaleh,Wkhan.Anoverviewofmanagementofflexor tendon injury. Pubmed.27 October 2014.
6. HariVenkatramani,VigneswaranVaradharajan,Praveen Bhardwaj,AashishVallurupalli, and S. Raja Sabapathy. Flexor tendon injuries.J Clin Orthop Trauma. 2019 Sep-Oct; 10(5): 853–861.
7. OliverPearce,Matthew TBrown,KatrinaFraser, LucaLancerotto.Flexortendoninjuries: repair and Rehabilitation. Sciencedirect. 8 August 2021.
8. AmericansocietyforsurgeryofthehandFlexortendoninjurywww.assh.org.2019
9. UniversityofMichiganhealth. Flexortendoninjury. UOFMhealth.org.January2018.
10. Dr.Johnknight.Flexortendoninjuries andrepair.Pubmed.July2020.
11. PinnacleOrthopedics.Flexortendoninjuries.www.pinnacleorthopaedics.com.December 2019.
12. GlisterHandClin.Pitfallsandcomplicationsofflexortendonsurgery.Pubmed.February 1985.
13. SomaILily,TerryMMesser.Complicationaftertreatmentofflexortendoninjury. Pubmed. July 2006.
14. JohnStaras,RichardMgray,RandallWCulp.Complicationsofflexortendoninjuries. Sciencedirectjournals.lwww.com. February 1984.
15. Myhealthalbertaprofessionals.Tendoninjury.https://myhealthalberta.ca.25Jan2021.
16. StephenWLinderman,RichardHgelberman,StavrosThomopoulos,Huashel.Celland biologic based treatment of flexor tendon injury. Ncbi.in. September 2016.
17. Alireza Rouhani, Alitabrizi and Ehsan ghavidal. Effects of non-steroidal anti-inflammatorydrugsonflexortendonRehabilitation afterrepair.Pubmed.15September2013
18. YiqinZhou,JamesHCWong.PRPtreatmentefficacyfortendinopathy:AReviewof basic science studies. Pubmed. 20 July 2016.
19. KevinFlutsky,EricLgiang,Jonas Lmetzon.FlexortendoninjuryRepairand Rehabilitation. Pubmed. January 2015.
20. TawheenAhmad,SummairaJan,SaimaRashid. Managementofflexortendoninjuryin hand. intechopen.com. March 29,2019.
21. CharlesL.Puckett,VaghanH.Meyer,Chow,ClarkEN,etal.Evaluationofmodified Kleinert's traction early mobilisation regimen for flexor tendon injuries in zone V.www.semanticschlor.org. February 2006.
22. Henry,SL,Howell,Higgins,Lalonde,etal.Thedorsalblockingorthosisforflexor tendon rehabilitation.www.orfit.com. January 15, 2021.
23. Alp Cetin, Fitnat Dincer, Abdullah Kecik, Meral Cetin. Rehabilitation of flexor tendon injuriesbyuseofacombinedregimenofmodified kleinertandmodifieddurantechniques. Pubmed. November 2001.
24. SeanPClancy, Danieal PMass.Current flexorandextensortendonmotionregimens:A summary. Hand.theclinics.com. March 2013.
25. RoxanneWentzel.Acomparisonoftheoutcomesoftworehabilitationprotocolsafter flexor tendon repair of the hand at Christ Hani Baragwanath Academic Hospital. Researchgate. 31 january 2017.
26. VikrantRanjan,MillandMehta,MugdhaMehta, ParijatMishra,Tulikajoshi,etal.The outcomes of flexor tendon injury repair of the hand: A clinico epidemiological study. Cureus.com. January 18 2023.
27. MirzaMujadzic,MiguelPirelaCruz,EnesKanlic.Updatesinflexortendonrepairinzone II.www.bjpms.org.August2005
28. PGSlattery.ThemodifiedklienertsplintinzoneIIflexortendoninjuries.Pubmed. August 2008.

29. AthanasiusIshak,AkshayaRajangam,AnkurKhajuria.Theevidence-baseforthemanagement of flexor tendon injuries of the hand: Review. Sciencedirect. 2019.