Profile and Use of the ICAM Splint Programme in Zone IV to VII Extensor Tendon Repairs at a Specialised Hand Unit in South Africa

by Nicole Mottay

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ABSTRACT

Background: The ICAM splint programme was developed in the 1980's and is known to produce favourable results in the management of extensor tendon repairs from zone IV to zone VII. It has only become popular in South Africa over the past several years and to the authors knowledge its application in South Africa is not well documented. Aim: To explore the results of using the ICAM splint programme at a specialised hand unit in South Africa. Methods: The study had two phases using a concurrent mixed methods design. In phase one, a retrospective file audit was conducted of patients following the ICAM programme (n=75). Phase two involved individual therapist interviews (n=3), surgeon interviews (n=2) and a focus group with physiotherapists and occupational therapists (n=7) that had experience with the ICAM splint programme. Microsoft excel was used to descriptively analyse phase one data and thematic analysis was used to analyse phase two data. Data were merged and represented in a joint display. Results: Majority of patients (83%) were male with 40% in the age range of 26-35 years old. Majority of the injuries were violence related (69%) in comparison to accidental injuries (31%) with extensor tendon zone V (40%) and VI (47%) being the most commonly involved. Compliance was reportedly influenced by factors namely patients' financial status, education and language barriers affected compliance. Conclusions: The results suggest that the ICAM splint programme is beneficial in managing extensor tendon repairs from zone IV to VII. Therapists should consider factors that affect non-compliance when selecting patients for the ICAM programme to

determine its suitability. Educating patients on the ICAM splint programme is essential to facilitate compliance. Novice therapists to the ICAM programme should receive formal training to improve confidence and skill.
Keywords: ICAM splint programme, extensor tendon repair, zone IV to VII

INTRODUCTION

Tendon injuries of the hand are treated by occupational therapists in South Africa (SA) and can be difficult to manage because they often respond poorly to treatment requiring prolonged rehabilitation1. Extensor tendon injuries can cause significant impairment, yet the assessment and management of these injuries have not been widely reviewed2,3. These injuries may be more challenging to treat because of the complex anatomy of the extensors whereby any minimum discrepancies in tendon length and tension can cause significant functional deficits following injury and repair4. There are various contextual factors within SA that makes hand therapy different to that of developed countries5. SA has a high level of morbidity and mortality resulting from violence and injury6. Moreover, there is the presence of health inequities in the country despite working towards the right to health for all7.

Treatment protocols for extensor tendon repairs can be challenging, making it difficult for occupational therapists striving towards excellence in clinical practice8. Post-operative rehabilitation protocols include immobilisation (IM), early passive motion (EPM) and early active motion (EAM)8,9 and more recently the Immediate Controlled Active Motion (ICAM) splint to manage extensor tendon repairs from zone IV to VII10. A study conducted in the USA showed that the ICAM splint produced 96 percent

excellent and 93 percent good results according to the Miller's criteria10. The first edition of the ICAM splint was proposed in the early 1980's10 however it has only recently become popular in SA.

Use of the ICAM splint programme could be valuable in managing extensor tendon repairs however, to the authors knowledge its application within the SA context is not well documented. The study sought to explore the results of using the ICAM splint programme at a specialised hand unit in SA. Therefore, the study described the profile of patients following the ICAM splint programme after undergoing an extensor tendon repair from zone IV to VII to understand their treatment results. In addition, the experiences of the multidisciplinary team implementing the ICAM splint programme were explored.

LITERATURE REVIEW

Rehabilitation of Extensor Tendon Repairs from Zone IV to VII

The thin overlying skin makes surgical access for extensor tendon repairs easier however it is challenging to maintain its normal length and functioning considering its anatomic complexity hence restoration of movement and gliding post repair is important11. Following a repair, various factors need to be considered when deciding which rehabilitation programme to follow. Implementing a specific programme involves consideration of the severity of injury, quality of the repair, complexity of the regimen and patient compliance12. The extent and zone of the injury as well as the timing and type of repair will determine the rehabilitation technique selected13.

Previously IM was the standard procedure following extensor tendon repairs10, however it had a high risk of complications such as tendon adhesions, joint stiffness14,

extensor lag and prolonged treatment15. As a result decreased composite flexion occurred16,17. Both EPM and EAM protocols have been developed to reduce complications related to the IM protocol15.

In the mid 1980's post-operative care for repaired extensor tendons in zones IV to VII began to move from IM to controlled EPM by using a dynamic extension splint17. While EPM prevents adhesions and preserves flexion, the bulkiness of the splint interferes with daily function, are costly to fabricate and cumbersome to use17,18. Controlled EAM protocols have been advocated by surgeons from the 1990's as these protocols were designed to limit tendon adhesion, maintain joint mobility and are easy to fabricate14. EAM protocols encourage active mobilisation of the repaired tendon during the early post-surgical phase12,19. They however risk weakening the repaired tendon and there is possibility of tendon rupture16. Patients need to be carefully selected as non-compliant patients are not good candidates4. However, when conducted successfully it helps patients regain full range of motion (ROM) earlier with improved grip strength and earlier return to work16.

Immediate Controlled Active Mobilisation (ICAM)

In the 1980's an advancement in the rehabilitation of extensor tendon repairs has been the Merritt relative motion splint also known as an ICAM splint10. This technique protects the repaired tendon by decreasing tension on it positioning the injured digit in relative hyperextension to the uninjured digits through the use of a yoke splint15. There are two components to the splint with a wrist extension splint positioning the wrist in 20°-25° extension and a yoke positioning the MCPJ's in 15°-20° of relative

hyperextension15. The splints low profile makes it easy and less cumbersome to use and provides protected functional use which can increase patient compliance17. The ICAM splint programme can be divided into three phases15. During phase one (0-21 days post-operative) the patient is required to wear the yoke and wrist extension splint10. In phase two (22-35 days post-operative) the patient must wear the yoke at all times however if they engage in heavy duty tasks they must wear the yoke and wrist extension splint10. In phase three (36-49 days post-operative) the wrist splint is discarded and the finger yoke is worn10. The patient must adhere to wearing the yoke constantly for the initial 6-weeks20 and follows specific exercises at each phase. According to Howell and colleagues10 the average time of discharge post repair was seven weeks. In comparison to other extensor tendon programmes, the ICAM splint programme also produces favourable results and the splint design is less restrictive for patients.

Outcome Measures post-Extensor Tendon Repair

In order to determine outcomes in hand therapy, therapists need to use objective assessments. Miller's21 guidelines use active composite finger extension to determine the results of extensor tendon repairs10.

Table I. Miller's21 criteria for assessing extensor tendon function Miller

Results	Total extensor lag (degrees)	Total flexion loss (degrees)
Excellent	0	0
Good	< 10	< 20
Fair	11-45	21-45

Poor	> 45	> 45

Total active motion (TAM) is used to describe the full arc of motion of the digits22. This can be compared to the TAM of the contralateral digit or it can be compared to the norm of 260 degrees23. A study conducted by Kadah24 that evaluated the results of acute extensor tendon repairs used the Miller's21 classification based on TAM. Objective assessments in hand therapy allows therapists to evaluate the progress of the patient and plan effective intervention25.

Hand Therapy in the SA Context

Implementation of hand therapy can be influenced by contextual factors in SA. Occupational therapists in SA provide hand therapy in both the public and private sector. Health care services in the public sector are provided at different levels of care (levels one to four) to meet the needs of a diverse SA population. The context in which occupational therapists practice, limit potential for the provision of routine occupational therapy services5. De Klerk and colleagues5 are of the opinion that the unique context of SA imposes obstacles in the implementation of occupation-based hand therapy by occupational therapists. Perceived barriers to occupation-based hand therapy in SA were identified as time, perceptions from colleagues, expectations from doctors, client follow-up, physical environment, language and knowledge5. These perceived barriers can be expected to affect other hand therapy practices within the South African context.

As discussed the surgical intervention of extensor tendon repairs and post rehabilitation can be challenging for the multidisciplinary team (MDT) to treat. In first world countries the ICAM splint programme has documented to produce excellent to good results according to Miller's21 criteria. While it is noted to be successfully implemented in other countries, we have limited knowledge of its application within the South African context.

METHOD

Study Design

The study adopted a concurrent mixed methods design with two phases of data collection conducted concomitantly. This design allowed the researcher to use both qualitative and quantitative data to accurately define relationships among the variables of interest26 and to broaden and strengthen the study's conclusion27. The two phases included, (i) Phase one: Retrospective file audit and (ii) Phase two: Therapist focus group/ interviews and surgeon interviews.

Selection and Sampling

Purposive sampling was used for both phases as it is a practical and efficient method28 that allows a deliberate selection of participants based on the qualities the participant possesses29. Saturation sampling was achieved for the file audit as all patient files that recorded the ICAM splint programme was retrieved. The setting for both phases was at a specialised hand unit at a central public hospital in SA. The hospital is located in an urban settlement in the city of Johannesburg.

Phase 1: File Audit (Quantitative phase)

Pilot study: A pilot study was conducted accessing five patient files to formulate and trial the data extraction tool. Shortcomings of the tool were refined to ensure that only pertinent information was retrieved.

Following, the pilot study duplicate occupational therapy files from the Hand Unit of the central public hospital was accessed from January 2015 until December 2018 as the ICAM splint programme was introduced during that period. A total of 473 files were identified and screened of which 75 files were included as they met the inclusion criteria (Figure 1).

Figure 1 Patient file selection based on PRISMA four- phased flow diagram30

Data Collection: Information from day one post-theatre until twelve weeks was retrieved using the data extraction tool. At each week, variables that covered a description of the wound, compliance, oedema, pain and splint remoulding was recorded. ROM measurements and dynamometer readings were included. Results were established using the Miller's21 criteria based on TAM. The information was transferred onto an excel sheet using Microsoft Excel 2016 for data analysis.

Data Analysis: Data was cleaned and coded for descriptive analysis. The categorical variables were analysed of which the frequency and proportions were represented on bar graphs or pie charts.

Reliability and Validity: To increase reliability, measurement error was controlled, by conducting a pilot study. This reduced threats of validity by improving the data extraction tool and ensuring that it measured what it purports to measure. Construct validity was increased by using the data extraction tool ensuring that information yielded was consistent with each audit. The researcher was the constant individual extracting data to ensure no variances occurred in the method of data extraction.

Phase 2: Interviews and Focus Groups with therapists and surgeons (Qualitative Phase)

Data Collection: A one-hour focus group was conducted with four occupational therapists and three physiotherapists who work/ worked in the hand unit and have experience with the ICAM splint programme. A total of three semi-structured individual face-to-face interviews were conducted with occupational therapists that have experience in the ICAM splint programme and two surgeons from the hand unit that have experience in extensor tendon repairs.

Data Analysis: Audio-records of the focus group and interviews were transcribed verbatim. Thematic analysis was used for identifying, analysing, and reporting themes within the data31. A deductive approach was adopted reading each transcript individually and codes generated to compile themes.

Trustworthiness: Credibility of the study was enhanced by using purposeful sampling techniques as participants with experience in the ICAM splint programme and extensor tendon repairs were recruited32. The audio-records were transcribed verbatim and findings reported using verbatim quotes. To ensure dependability the researcher

provided a clear exposition of data collection and data analysis methods. Confirmability and dependability was achieved through a reflexive journal which allowed the identification of biases of the researcher. Data was collected from two sources to triangulate findings. Transferability was achieved by providing a thick description on the study participants and the context of the study33.

Merging of analysed data from Phase one and Phase two

Following analysis of data from phase one and phase two, the "point of integration"27 occurred at the results stage (Figure 2) at which the analysed qualitative and quantitative data were merged to corroborate and triangulate findings. A joint display was used, with the quantitative findings represented on bar graphs and pie charts and the qualitative findings listed beside it organised into themes and sub-themes27. This allowed side-by-side comparison to corroborate findings. Findings were listed below the joint display in a narrative form.

Figure 2. Overview of the data analysis process

Ethical Clearance and Considerations

Ethical clearance was obtained from the Biomedical Research Ethics Committee of the University of Kwa Zulu-Natal (BE661/18) and gatekeeper permission received from the Medical Advisory Committee at the central public hospital.

RESULTS

Demographics of Therapists and Surgeons

Therapists in phase two (n=10) comprised of 30% (n=3) physiotherapists and 70% (n=7) occupational therapists. The mean age of therapists was 29 years old with majority of them with less than two years (70%; n=7) experience in hand therapy. All

therapists reported treating less than five patients with the ICAM splint programme per month. The physiotherapists (30%; n=3) reported receiving no formal training on the programme and the occupational therapists (70%; n=7) reported learning about the programme through peer learnings and observation. The mean age of the surgeons (n=2) was 35 years old. All participants worked in the public sector.

Demographics of Patients following the ICAM Splint Programme (n= 75)

Patients following the ICAM splint programme comprised 83% (n=62) male and 17% (n=13) female. Forty percent (n=30) of patients were between the age range of 26-35 years old, followed by 27% (n=20) between 18-25 years old, 23% (n=17) between 36-45 years old, 9% (n=7) between 46-55 years and 1% (n=1) above 56 years old. Only unilateral injuries were noted, of which 53% (n=40) of patients had right hand involvement and 47% (n=35) with left hand involvement. Of these, 57% (n=28) of patients had their dominant hand affected.

Details of the Injury

Of the total patients profiled, 69% (n=49) sustained their injury due to violent related incidences and 31% (n=22) were associated with accidental injury. The mechanism of injury revealed 35% (n=24) were due to stab injuries with a knife, bottle and glass injuries were noted as a result of violence (21%; n=14) and accidental injuries (15%; n=10) respectively. In terms of digits involved, 63% (n=47) of patients had one digit involved and 37% (n=28) with two digits. The extensor tendons injured included extensor digitorum communis (71%; n=68)), extensor indicis proprius (15%; n=14)), extensor digiti minimi (11%; n=11)) and extensor carpi ulnaris (3%; n=3).

Patient Compliance with the ICAM Splint Programme

Improved Compliance

Figure 3. Patient compliance with the ICAM splint programme

As reported by therapists in the focus group and individual therapist interviews, patients were more compliant following the ICAM splint programme in terms of splint compliance, exercise compliance and attending follow-up appointments. This information corroborated with the file audit as illustrated in Figure 3.

"…they are pretty compliant even though they might not come on their day, they walk in and say I couldn't pay to come this day but I am here today." (Focus group-physiotherapist)

Therapists proposed that patients were more compliant with the ICAM programme in comparison to the immobilisation programme because they could monitor and track their progress. The patients' perception of improvement motivated them to comply with exercises.

"It also motivates the patient because they can see more progress, how much they can flex and extend each week whereas in the extended wrist extension they only have PIP flexion and they can't see the hand actually moving." (Focus group-Occupational Therapist)

Factors affecting Non-Compliance

Compliance with the splint and the exercise programme was higher in comparison to follow-up appointments. The highest rate of appointments defaulted was at week 4 (40%), week 6 (47%) and week 8 (55%). One of the influencers mentioned by the

participants was limited finances and the patient's perception of the hand being fully functional.

"The patients will tell you that they don't have money to come to hospital for an extensive rehabilitation programme…" (Surgeon interview-Registrar)

"…they might just think that my hand is working and I don't need to return to the hospital so then they not necessarily defaulting, the hand is fully functional, they are just not coming back to pay for another appointment." (Focus group-Occupational Therapist)

The level of education of the patient and their insight into the importance of rehabilitation identified as a determining factor in compliance. Therapists and surgeons expressed the responsibility of the MDT to educate the patient at every session on the importance of complying with the ICAM programme. Therapist recordings of patient education in the hospital file is highest day one post theatre (76%; n=57) and decreases by week 12 (31%; n=23).

"…it is very dependent on understanding, the patient's compliance and also how we stress the importance of it as well to try and educate as much as possible every single session…" (Focus group-Occupational Therapist)

Surgeons also identified the importance of education on the surgical procedure to promote compliance with therapy post theatre.

"…informing the patient is important…you can't blame the patients if they haven't been explained by the surgeons and therapists…" (Surgeon interview-registrar)

Language and understanding was recognized influencing non-compliance. Therapists expressed that although the ICAM programme is explained to patients there can be miscommunication due to a language barrier.

"…a language barrier where they don't understand what you are saying and sometimes that affects their compliance" (Focus group-Physiotherapist)

According to therapists, patients easily removed the finger yoke due to the splint design. Non-compliance with the finger yoke was highest after discontinuation with the wrist extension splint.

"…because they can remove the finger yoke and sometimes it isn't completely immobilised like you would want…" (Focus group-Occupational Therapist)

Enablers of the ICAM splint programme

Preference for the ICAM splint programme

Figure 4. Miller's total extensor lag classification

Figure 5. Miller's total flexion loss classification

Therapists shared their experiences with the immobilisation programme in comparison to the ICAM programme. The ICAM programme was favoured as therapists expressed that patients presented with better ROM at the metacarpal phalangeal joints (MPJ), shorter therapy time and less tendon adhesions. The physiotherapists agreed that it was easier to mobilise the patient at four weeks, as there was less stiffness compared to patients immobilised.

"We find there is less stiffness in the MCP's than in the extended wrist extension splint because they can mobilise a lot sooner." (Individual therapist interview-Occupational Therapist)

"…getting that tendon glide early on, you notice that it is a lot more successful to prevent tendon adhesions." (Focus group-Occupational Therapist)

"…it is easier for us to rehab them sooner because they are already used to moving their hand but as soon as you take an immobilisation splint off they haven't moved in four weeks." (Focus group-Physiotherapist)

According to Miller's total extensor lag classification, at week 12 patients' presented with 71% (n=12) excellent, 6% (n=1) good and 0% poor results (Figure 4). At week 12, according to Miller's total flexion loss classification patients' presented with 29% (n=4) excellent and 35% (n=6) poor results (Figure 5).

The ICAM programme allowed patients to engage in light duty activities of daily living while in the splint and in some instances earlier return to work.

"…the fingers are free so you can do lighter duty type of things…admin duties so they could either be put in a lighter role or light duty at work…" (Focus group-Occupational Therapist)

Barriers to implementing the ICAM Splint Programme

Therapists identified training on the ICAM splint programme as being insufficient. Occupational therapists attended peer learnings or learnt the programme through observation. The physiotherapists reported receiving no formal training. Therapists expressed that confidence using the programme improved over time. Newly qualified therapists were thought to experience more difficulties in implementing the

programme. Due to regular rotation of physiotherapists within the unit, they expressed concerns that therapists had to be frequently orientated to the ICAM programme and there was limited knowledge.

"…now I feel confident for the amount of time that I had to practice but initially I wasn't as confident." (Focus group-Occupational Therapist)

"…as physio sometimes we get confused because we rotate often…we always like need constant reminding what the process is and then you have to remind different people..." (Focus group-Physiotherapist)

Figure 6. Remoulding the finger yoke

Occupational therapists recognised difficulties with fabricating the finger yoke. Achieving the correct degree of relative hyperextension to the uninjured digit was challenging. Ease of fabrication was dependent on which digits were involved. The middle finger was most commonly involved with (33%; n=34), index finger (31%; n=32), ringer finger (19%; n=20) and little finger (17%; n=17). Therapists experienced difficulty correctly positioning an affected little finger in the yoke in comparison to other digits. Remoulding of the finger yoke on follow-up visits was common but this decreased over time. As recorded in the patients' files, the top three reasons for remoulding was discomfort (42%; n=19), the yoke fitting too tightly (18%; n=4) and splinting in the incorrect position (13%; n=3). Therapists expressed that difficulties with yoke fabrication was further influenced by oedema and patients pain tolerance. Physiotherapists reported using the dynamometer to assess grip strength and the goniometer to assess ROM to monitor progress of the patient. The occupational

therapists reported using clinical observation and recognised the need to use more objective assessments to better monitor progress and functional outcomes.

"…if I see a patient this week and somebody else sees the patient my improvement and their improvement is not the same so you can see improvement but you can't objectify that improvement." (Focus group-Occupational Therapist)

Surgeon Practices in Extensor Tendon Repairs

Elements affecting Results of Extensor Tendon Repairs

Figure 7. Mechanism of injury

Surgeons reported that the mechanism of injury can influence the surgical repair. Knife injuries was the highest at 35% (n=24) (Figure 7). Injuries with sharp objects as such made surgery easier in comparison to bottle injuries (21%; n=14) whereby patients presents with multiple jagged cuts. Majority of extensor tendon injuries treated by the surgeons was related to interpersonal violence which they reported as easier to manage because the weapon was often sharp resulting in less complicated cuts.

"Bottle injuries are the ones where we struggle because there are multiple cutting surfaces you get jagged edges which makes their soft tissue compromised…"

(Surgeon interview-registrar)

Delayed repairs identified as a challenge in managing extensor tendon repairs. Surgeons reported that this was attributed to large patient loads resulting in delays in theatre, patients presenting late to hospital and late referrals from satellite hospitals.

"…a delay in theatre sometimes there is shortening of the tendon so excursion becomes an issue so you have to do a tenolysis in addition to getting the tendon orientated."

From the file audit (n=74) it was identified that 26% (n=19) of patients underwent surgery between day 0-2 of the injury, 51% (n=38) between day 3-7, 23 % (n=17) between day 8-14 and 0% above 14 days.

Surgeons recognised the zone of injury as a factor that influenced surgical results. From the file audit majority of the injuries occurred over zone V (40%; n=24) and zone VI (47%; n=28) and 13% (n=8) over zone VII. Surgeons considered the anatomy of the different zones as a factor that affected outcomes post repair.

"…I think zone IV, V, VI are okay once you start going towards zone VII and muscle belly and the muscular tendinous junction then it becomes tricky…" (Surgeon interview- registrar)

Surgeons acknowledged wound healing as a determinant that affected extensor tendon repairs. Acutely infected wounds post repair sometimes requires a debridement which risks rupturing the repair. Patients may then require tendon reconstruction or a tendon transfer at a later stage. Furthermore, surgeons noted that infection causes scar tissue formation often resulting in patients requiring a tenolysis. From the file audit at week 4, therapists described 48% (n=19) of the wounds as healed, 28% (n=11) clean, 20% (n=8) dry, 3% (n=2) septic and macerated and 0% with slough. There was record of only one patient requiring debridement due to infection.

"…we need to debride the tendon and end up losing our repair…" (Surgeon interview-registrar)

"…infection causes scarification around the area and it also causes adhesions which forces the surgeons…going back to theatre excising the scar and tenolyse the tendons…" (Surgeon interview-registrar)

DISCUSSION AND IMPLICATIONS

The use of ICAM splint programme is not well documented in SA. This study, which may be the first to the author's knowledge, aimed to profile and describe the intervention of the ICAM programme at a specialised hand unit in SA. From this study, compliance emerged as a dominant theme. Compliance with exercises and use of the splint improved however, appointment follow-ups were identified as an area of concern. Appointments were defaulted due to limited finances, a sense of having a fully functional hand and following removal of the wrist extension splint. In a study conducted by Howell and colleagues10 on the ICAM, patients were non-compliant to treatment due to insurance issues, self-discharge when doing well, within ten days or after discontinuation of the wrist extension splint. When following the ICAM splint programme it is recommended that patients follow-up at least once a week to check the fit of the splint, progress the programme and individualise instructions10. Non-compliance with appointment follow-ups may affect the results post rehabilitation, as the programme is not closely monitored.

Patient education provided by the MDT helps improve insight into the condition and the effects of non-compliance. Education at each follow-up visit reinforces patient

understanding. Patients' ability to recall medical information may be poor but deeper insight into the risks and consequences are said to improve knowledge9. Patient education from the MDT was deemed essential when following the ICAM programme. For EAM programmes to be successful, patients need to have good insight into the programme and the consequences of non-compliance. Patient education can however be challenging in the SA context. SA is a diverse country with 11 official languages. Although therapists try to educate patients on the importance of therapy, language barriers result in poor understanding influencing compliance with therapy. The MDT needs to develop novel ways in which to educate patients on the surgical procedure and effects of non-compliance with the ICAM programme. Improved understanding with the use of a translator may influence patient compliance resulting in better outcomes.

Therapists favoured the ICAM programme over other extensor tendon programmes due to their experience of achieving better ROM, shorter therapy time and functionality of the splint. According to Miller's21 criteria majority of patients had excellent extension and poor total flexion loss by week 12. While extensor tendon function was favourable, flexion may have been limited due to stiff joints or tendon adhesions. The limitation of flexion after an extensor tendon repair is a prominent difficulty with patients losing more flexion than extension2,34. However, in a systematic review by Ng and colleagues12 that considered five studies, patients following EAM extensor tendon protocols still gained significantly better TAM than those following immobilisation protocols.

The ICAM splint design allows patients to engage in basic activities of daily living and perform light duty work. While the ICAM programme allows more freedom to use the hand in comparison to other programmes, it was noted by therapists that patients were more likely to remove the yoke due to ease of removal. In a systematic review by Wong and colleagues9 it was found that a focus on improvement in patient compliance to EAM splints and rehabilitation protocols are essential. Reasons for splint non-compliance may be attributed to poor appearance, discomfort, interference with function, failure to decrease pain, and hygiene9. Therapists reported initial challenges in fabricating the yoke and the main reason for remoulding was due to discomfort. Formal training and in-services are required to improve therapist confidence when implementing the ICAM programme. This could assist novice therapists with limited experience in splinting in ensuring that comfort and aesthetics are valued to assist with splint compliance.

While the physiotherapists used objective assessments such as ROM and grip strength, occupational therapists used observation to monitor progress. Occupational therapists recognised the need to use validated assessments to determine results of using ICAM programme and functional outcomes. In a systematic review by Ng and colleagues12 five studies that investigated outcomes post extensor tendon rehabilitation used ROM and grip strength as measures but none used validated patient reported functional scores e.g. Disability of Arm, Shoulder and Hand. According to Wong and colleagues9 there are inconsistencies in how outcomes are measured

making comparisons across studies difficult hence it has been suggested that studies investigating tendon rehabilitation should follow the International Classification of Functioning, Disability and Health to describe functioning, disability and health in a standardised way.

External factors such as mechanism of injury, age, occupation and handiness can determine the management of extensor tendon injuries2. Majority of injuries that occurred were violence related and the weapon used was a knife. Based on the information gained from the surgeons in this study, these are easier to manage due to straight cuts with a sharp object. According to Griffin and colleagues2 it is important for surgeons to get background history on the mechanism of injury to determine if the wound needs debridement, if there is risk of infection or the presence of foreign bodies. Infection can delay a primary repair if the patient requires debridement and a debridement post tendon repair can risk rupturing the tendon.

Surgeons in this study reported that delayed extensor tendon repairs are not ideal however, it is not always within the surgeons' control. Majority (51%; n=38) of surgical repairs were conducted within a week. From the literature, a repair that is delayed should be conducted within seven days34, before the tendon retracts or softens, as late hand referrals for extensor tendon repairs present with complications such as joint stiffness, oedema and tendon adhesions8. Apart from delays in surgery, delays in implementing the ICAM splint programme can affect the results as there is an increased likelihood of adhesions and joint stiffness. For this reason, the authors of the ICAM programme10 suggested that the ICAM splint should be initiated within 10 days

of the repair however better results are achieved if it is started immediately or within three days10.

Anatomical structures over the different extensor zones can affect a surgical repair. Majority of the injuries occurred over zone V (40%) and zone VI (47%). Hirth and colleagues18 found that extensor tendon injuries are common in zones V and VI due to the superficial location and minimal soft tissue protection on the dorsum of the hand. Extensor tendon repairs over zone VII lead to greater unsatisfactory results if there is retinaculum involvement as it can result in bowstringing while zone V produced favourably outcomes11. Zone VI repairs can result in poor results due to iatrogenic factors where suture techniques shorten the tendon by 6 mm which can cause an 18 degree loss of motion at the MCP and PIP joint34. Further studies into the zone of injury and its effects on therapy outcomes may be beneficial in guiding therapists during rehabilitation.

LIMITATIONS

Information gathered from the file audit was restricted to what therapists recorded. As a result there was missing data from therapist recordings and defaulted therapy was not always well documented.

CONCLUSION

The results of this mixed methods study suggest that the ICAM splint programme can be used to manage extensor tendon repairs from zone IV to VII within the SA context, however factors that affect non-compliance should be considered when selecting patients. While the ICAM splint has shown to produce favourable results in other

countries there are contextual factors in SA that need to be factored in. Patients' financial status, level of education and language should be considered in the decision as to whether the ICAM programme will be used with a patient as this impacts compliance.

An MDT approach is recommended when educating patients on the ICAM splint programme to reiterate compliance and to ensure patient-centred care. Further training and education for novice therapists is required to build therapist confidence in application of the ICAM programme and the splint fabrication. More studies on the efficacy of the ICAM programme in the current context are required and objective and standardised assessments should be used to monitor progress of patients using the programme.

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