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Original Research Article

Overview of Outpatient Fracture Cases at Cut Nyak Dhien Hospital for the Period January - June 2023

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Abstract

Introduction:
Fracture is one of the most common problems in the community and requires serious treatment because it will have an impact on all aspects of life. The purpose of this study was to see the description of fracture cases in outpatients at Cut Nyak Dhien Hospital. So that in the future it can be a lesson and also an assessment for the field of orthopedic science in Indonesia, especially West Aceh.

Method:
This research uses a descriptive method. Where data is taken based on data in the SIMRS application at Cut Nyak Dhien Hospital. Data taken in the form of name, place of birth, address, diagnosis, and date of visit. Thenthe sample was separated according to the inclusion and exclusion criteria by the researcher.

Result:
Out of the 5,780 individuals who went to the general surgery clinic at Cut Nyak Dhien Hospital between January and June 2023. 138 fracture instances were reported, or around 23.8 cases per 1,000 clinic visits.

Conclusion:
Men accounted for 81 fractures or 58.6% of all fractures. 58 individuals, or 42% of all fracture cases, were aged 30 to 60 or older when they had a fracture. Among 24 patients (17.4%), femur fractures were the most frequent diagnosis. Four patients (24.5%) in the most often mentioned case suffered metacarpal fractures.

Introduction

Fracture is a break in a bone's structural continuity. It could be as little as a fracture, crumpling, or splintering of the cortex, but more frequently than not, the break is total. The resulting bone pieces could be displaced or not. It is a closed fracture if the overlying skin stays intact; if the skin or one of the bodily cavities is breached, it is an open fracture (also known as a compound fracture), which is susceptible to contamination and infection.[1]

It is acknowledged that peopleunder the age of 65 are more likely to experience fractures, but little is known about the specific fractures that are developing in this patient population. Although the majority of studies have focused on the traditional fragility fractures of the proximal femur, proximal humerus, pelvis, spine, and distal radius, other fractures are likely becoming more frequent.[2]

The fragility fracture occurs every three seconds due to osteoporosis, which causes more than 9 million fractures annually worldwide. First-time osteoporotic fracture sufferers are more vulnerable to subsequent fractures. As people live longer on average around the world, the risk of fracture also grows with age, and more people are anticipated to have fragility fractures.[3] Fragility fractures have a monetary cost of €37 billion in the 27 EU member states (EU27) as of 2010, with

26,300 life years lost and 1.16 million quality-adjusted life years (QALYs) lost each year. 2030 these costs are anticipated to significantly increase due to changing demography.[4]

In females, fractures of the spine (clinical vertebral), hip (proximal femoral), and distal forearm showed a pattern of steady incidence into early adulthood. Fractures of the forearm and spine, on the other hand, began to grow exponentially after menopause. The pelvis, humerus, femur, and patella showed a similar pattern. Childhood and adolescence were the years with the highest incidence of distal forearm, humerus, other forearm,and ankle fractures. Age-related alterations for fractures of the spine, hip, ribs, pelvis, and humerus in males resembled the female pattern.[5]

Male incidence was typically lower at these locales, especially among the elderly. For the distal forearm and humerus, a peak corresponding to childhood and adolescence was observed. In contrast to females, there were no further age-related increases in ankle fractures during infancy and adolescence, but this rise persisted into early adulthood. For fractures of the face, clavicle, carpal bones, hand, fingers, foot, and toe, an adolescent- young adult peak incidence was noted, with no further age-related increases. The evidence for tracking temporal changes in fracture burden is provided by examining fracture patterns.[5]

Patients with spine fractures are frequently seen by emergency room doctors, orthopedic surgeons, and neurosurgeons. According to reports, there are between 24 and 90 spine fractures for every 100,000 people. Modern treatment methods may be used, however prolonged rehabilitation, extended time away from work, or permanent disability may still occur. Due to the frequent negative effects on daily activities that spine fractures have, there is a high main and indirect socioeconomic cost burden.[6]

In a private secondary care hospital in Jeddah, 32,792 patients visited the orthopedic outpatient department (OPD) from April 2013 to March 2017. The number of visits was dominated bymales compared to females. About 2567 (11%) patients visited the OPD with fracture complaints. This indicates that fractures were among the top 3 most common cases experienced by patients during orthopedic clinic visits.[7]

Epidemiology of orthopedic trauma is an interdisciplinary field that combines epidemiologyand orthopedic trauma. Its purpose is to study the incidence, prevalence, and primary components of orthopedic trauma as well as to produce scientific data that can be used as a basis for its prevention and management. Orthopedic trauma epidemiology research can precisely define the distribution of gender, age, location, time, categorization, and causeof trauma in order to produce scientific data that can be helpful for the prevention and management of trauma in the population.[8]

This study is anticipated to provide a source of scientific information on the prevalence and evolution of trauma/fracture management in Indonesia, particularly in West Aceh. There are no orthopedic experts anywhere along Aceh's west-to-south coast, which runs across 7 districts and cities. For the population to receive orthopedic specialist treatments that can be equally accessible inAceh in the future.

Method

Starting from January - June 2023, this descriptive study will observe fracture cases in outpatients at the surgical specialist clinic of Cut Nyak Dhien Hospital (CND). All patients with fractures who had received a diagnosis from generalsurgeons made up the study's population. The general surgery clinic at RSUD CND's computerized databases and medical records were searched to find the data for this study. The data were sorted before being further examined according to age, gender, and the kind of incident that took place.

The following criteria were used to choose the study sample: (1) patients with a fracture diagnosis who visited the general surgery department at Cut Nyak Dhien Hospital; and (2) patients with a West Aceh address. Patients with diagnoses other than fracture and those whose addresses were outside of West Aceh were excluded.

Results

A total of 5,780 people registered for treatment at Cut Nyak Dien Hospital's general surgery clinic between January and June 2023. A total of 138 fractures, or 23.8 cases per 1,000 clinic visits, were diagnosed during this period. For this investigation, 138 people with fracture problems met the inclusion criteria.

Discussion

Fracture is a term that means partial or complete loss of bone continuity. Fractures can occur due to direct or indirect trauma.[9] Research conducted by Hove in 2014 stated his research that traffic accidents are more common in males than females. Men also have a large proportion of high-energy trauma including falls from height and sports injuries. Whereas in the elderly it is often caused by low-energy trauma, this happens because in the elderly bone mineral density (BMD) joint problems are due to degenerative factors.[10] Research in 2021 stated that the number of new fractures was experienced by 102 million people in men and 76 million people in women.[11] A study conducted in 2016 at Meuraxa Hospital and Zainoel Abidin Hospital in Banda Aceh stated that most traffic

Table 1. Cases by Gender

Gender	N (%)
Male	81 (58,6)
Female	57 (41,4)
Total	**138 (100)**

Table 2. Cases by Age

Age	N (%)
0-2 years	2 (1,7)
2 years 1 months - 17 years	28 (20,2)
17 years 1 months - 30 years	32 (23,1)
30 years 1 months - 60 years	58 (42)
>60 years	18 (13)
Total	**138 (100)**

Table 3. Cases by Diagnosis

Diagnosis	N (%); M=Male, F=Female
Femur	24 (17,4); 16M, 8F
Tibial	23 (16,7); 13M, 10F
Humerus	17 (12,3); 7M, 10 F
Radial	15 (10,8); 10M, 5F
Clavicle	14 (10,1); 5M, 9F
Ulna	9 (6,5); 6M, 3F
Metacarpal	7 (5,0); 5M, 2F
Lumbar Spine	5 (3,7); 4M, 1F
Schapoid	5 (3,7); 3M, 2F
Pelvis	4 (2,9); 3M, 1F
Rib	3 (2,1); 2M, 1F
Fibula	3 (2,1); 2M, 1F
Patella	2 (1,5); F
Metatarsal	2 (1,5); M
Phalanx	2 (1,5); M
Mandible	2 (1,5); 1M, 1F
Maxila	1 (0,7); F
Total	**138 (100)**

Table 4. Cases Referred to Orthopedic Specialist at The Provincial Hospital

Diagnosis	N (%)
Metacarpal	4 (24,5)
Tibia	3 (18,5)
Metatarsal	2 (12,5)
Humerus	2 (12,5)
Pelvis	1 (6,4)
Femur	1 (6,4)
Lumbar spine	1 (6,4)
Clavicle	1 (6,4)
Ulna	1 (6,4)
Total	**16 (100)**

accident cases were experienced by men compared to women. The incidence rate was 135 men and 39 women.[12] Even a 2017 study at Soetoemo Surabaya Hospital noted that automobile accidents frequently result in femur fractures.[13] This is consistent with the findings of this study, which found that of the 138 fracture cases shown inTable 1, men encountered 81 fracture cases,, compared to women's 57 cases.

The majority of fracture incidences, according to research done in Sweden in 2020, occur in people between the ages of 16 and 105.[14] The majority of instances in Table 2 of this study are found to be between the ages of 30 and 60. Thisis hardly at all different.

Femur fracture diagnosis was made in 6410 individuals under the age of 17 in research conducted in 2013. In Finland and Sweden, the overall incidence per 100,000 femur fractures was 13.3 and 11.0, respectively. In all age groups older than one year, a male preponderance was found.[15] While in this study there are similarities, where femur fractures were found in 16 men and 8 women. Table 3 clearly shows that femur fractures were more common among males than females.

A 2012 study stated that flexor tendon injuries are common, yet treatment protocols are still widely debated. Advances in suturing techniques and a better understanding of tendon morphology and biomechanics have led to improved outcomes. Thus, problems in the metacarpal region, especially zone 2, require at least an orthopedic surgeon.[16] So in Table 4 we can see that fractures in the metacarpal region are the highest cases referred to orthopedic specialists.

Conclusion

Results showed that Men experience fractures more frequently than women. The mobility of men, who are more active than women, may have an impact on this. In a similar vein, it is evident that age groups between 30 and 60 years are those that have fracture instances most frequently. In contrast, the femur is the bone that fractures more frequently based on the current diagnosis.

The results of the study attached in Table 4, can be seen that as many as 16 (11.5%) patients out of a total of 138 patients who experienced fractures had to be referred to hospitals in the province. This is due to limited equipment and orthopedic specialists who are better able to handle these cases.

The author previously stated that no orthopedic doctors are available in the western and southern regions of Aceh. This causes patients to be referred to the hospital in the provincial capital by traveling 4 hours. Even if the patient comes from the southern region, it can take between 8 - 10 hours to travel. For this reason, West Aceh is currently building a regional

hospital for Aceh's western and southern regions.[17] We hope that in the future services for patients in the West and South of Aceh can be improved. In this case, the provision of orthopedic specialists in the future will be one of the prioritized specialists. Researchers also hope that the Indonesian government, especially Aceh, can make better policies in the future.

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Original Research Article

Clinical Outcome of Medial Meniscus Root Reconstruction Versus Root Repair in Managing Medial Meniscus Posterior Root Tear

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Abstract

Introduction:
Optimal treatment of a medial meniscus posterior root tear (MMPRT) is essential for restoring joint kinematics, and contact pressures, and preventing the progression of knee osteoarthritis (OA). Recently, transtibial pull-out repair has been the preferred treatment for MMPR tear. However, the repair techniques do not provide any biological structure to enhance biological healing. Reconstruction of the meniscus root with gracilis autograft may reproduce the ligamentous structure resembling the original root. The objective of this study is to assess and compare the clinical effectiveness of medial meniscus root reconstruction and root repair.

Method:
Patients who received arthroscopic surgical treatment for MMPRT were included in this study. Twenty patients who had been diagnosed with MMPR tear were divided into two groups: those who underwent transtibial pull-out repair (10 cases) and those who underwent meniscus root reconstruction with gracilis autograft (10 cases). Each patient then underwent a surgical procedure according to their respective group. Clinical outcomes were assessed using visual analog score (VAS) and KOOS score in 3 months follow-up.

Result:
Both groups had no significant differences in the baseline characteristics. Compared to the repair group, the reconstruction group demonstrated significant mean VAS reduction (p= 0,001) at 3 months. However, there was no significant difference in the mean KOOS score at 3 months (p=0.481).

Conclusion:
The meniscus root reconstruction using gracilis autograft offers significant benefits with superior outcomes in VAS score compared to transtibial pull-out repair, however, there were no differences on clinical outcome at 3 months follow-up

Introduction

The meniscus root is an essential component that plays a crucial role in maintaining the normal function of the meniscus as both a shock absorber and a secondary stabilizer.[1] Medial meniscus posterior root tear (MMPRT) may cause meniscus extrusion (ME), which leads to the rapid development of joint space narrowing and disrupts the ability of the knee to withstand hoop strain, thereby resulting in increased contact pressure, kinematic alterations, and subchondral bone edema.[2,3] These consequences were indistinguishable from total meniscectomy.[2] In the end, the notable reduction in the area of contact and the rise in pressure on the weight-bearing part result in a faster deterioration of the joint; hence, optimal treatment of MMPRT is essential for restoring joint kinematics and contact pressures and preventing the progression of knee OA.

A range of surgical interventions are utilized in the management of meniscus root injuries, such as meniscectomy, meniscal repair, and reconstruction of the meniscus root.[4] Recently, transtibial pull-out repair has been the preferred treatment for MMPRT, and it has been reported to have favorable clinical outcomes. However, the repair techniques do not provide any biological structure to enhance biological healing since the medial meniscus root attachment to the tibial plateau comprises a ligamentous structure.[5,6] The poor healing outcome may have occurred due to the restricted suture fixation within the area between the anterior tibia cortex and degenerative tissue. It has been reported that this structure is considerably weaker than the native root.[7]

Therefore, Lee *et al*.[8] developed the arthroscopy technique using gracilis autograft to reconstruct the MMPRT focused on using the ligament structure to recreate the native root. The purpose of this study is to compare the clinical effectiveness of medial meniscus posterior root reconstruction and repair.

Materials & Methods

Patient selection

Prior to enrollment in this study, all patients were required to submit written informed consent. This study protocol received approval from the Hospital Ethics Committee. Clinical findings and non-contrast knee magnetic resonance imaging (MRI) findings, including the cleft sign, ghost sign, and giraffe neck sign, were utilized to diagnose MMPRT in patients.[9] Based on line characteristics, age, gender, and body mass index (BMI) were acquired. Criteria for inclusion include: Patients (1) who have been diagnosed with MMPRT, (2) who do not have knee osteoarthritis, or grade I-II based on Kellgren Lawrence. The study excluded participants who met the following exclusion criteria: (1) those with concurrent injuries such as anterior cruciate ligament (ACL) or multi-ligamentous injuries; and (2) those with obvious knee deformities.

Twenty MMPRT patients who underwent tibial tunnel-based posterior root reattachment treatment were included in this study. The patients were categorized into two groups: ten patients received arthroscopic surgical reconstruction utilizing a gracilis tendon autograft, while the other ten patients underwent arthroscopic surgical repair accompanied by double tunnel transtibial pull-out repair. One orthopedic surgeon performs all surgical procedures.

Data collection

Age, gender, body mass index (BMI), comorbidities, Kellgren and Lawrence grade of OA knee (K-L), treatment for MMPRT, pre-operative and follow-up VAS score, and KOOS score of the affected knee were collected as baseline characteristics. Three months following the operation, clinical examinations were conducted, including a knee functional assessment using the VAS score and KOOS score. The visual analog scale (VAS) was initially developed by Hayes and Patterson in 1921 as a pain rating scale. The scores are determined by self-reported assessments of symptoms ranging from "no pain" (score = 0) at the left end to "worst pain" (score = 10) at the right end of the scale. The VAS score is an accurate and reliable instrument for quantifying pain at a specific moment in time. (α= 0.88).[10,11]

For young, middle-aged, and elderly adults with knee injury and/or knee osteoarthritis (OA), the Knee Injury and Osteoarthritis Outcome Score (KOOS) is a PROM that can be used to track disease progression and outcomes after surgical, pharmacological, and other interventions. (1) Pain (comprising nine items); (2) Additional Symptoms (comprising seven items); (3) Activities of Daily Living (ADL), comprising seventeen items; (4) Sport and Recreation function (comprising five items); and (5) Quality of life associated with the knee (QoL), comprising four items. A distinct score is assigned to each subscale, ranging from zero (indicating severe knee problems) to one hundred (indicating no knee problems). A recent meta-analysis has determined that the KOOS exhibits sufficient levels of construct validity, responsiveness, content validity, internal consistency, and test-retest reliability for subscales that are pertinent to age and condition. This is supported by a pooled overall alpha of 0.86.[12]

Surgical techniques

Standard anterolateral and anteromedial arthroscopic portals are established, and an arthroscopic visualization is conducted to confirm the existence of a rupture in the posterior root of the medial meniscus. (Figure 1). To enhance the visibility of the medial posterior compartment during arthroscopy, the medial collateral ligament is released using an inside-out technique utilizing an 18-gauge needle. In the transtibial pull-out techniques, following confirmation of the MMPRT by arthroscopic examination, the ruptured margin of the meniscus root is refreshed with a shaver. To create the tibial tunnel, a standard tip-to-tip anterior cruciate ligament reconstruction tibial tunnel guide is utilized. A small incision over the anteromedial proximal tibial tibia is made and a 2.0 mm guide pin is drilled from that incision to the posterior horn root of the knee. The tip edge of the detached portion of the meniscus is sutured using a No.2 Fiber wire (Rejoin) and the tail of the suture is shut down to the tibial tunnel. The tail of the sutures is then fixated using either the ET button (Rejoin) or anchor screw with the washer to the tibial. (Figure 2).

To perform the meniscus root reconstruction techniques, a 2-cm longitudinal skin incision is made medial to the tibial tuberosity to harvest the gracilis

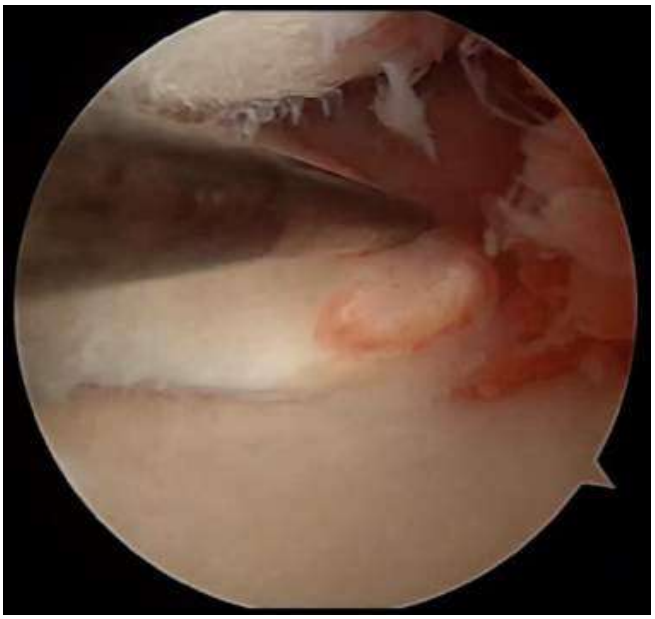

Figure 1. Arthroscopic evaluation of medial meniscus posterior root tear

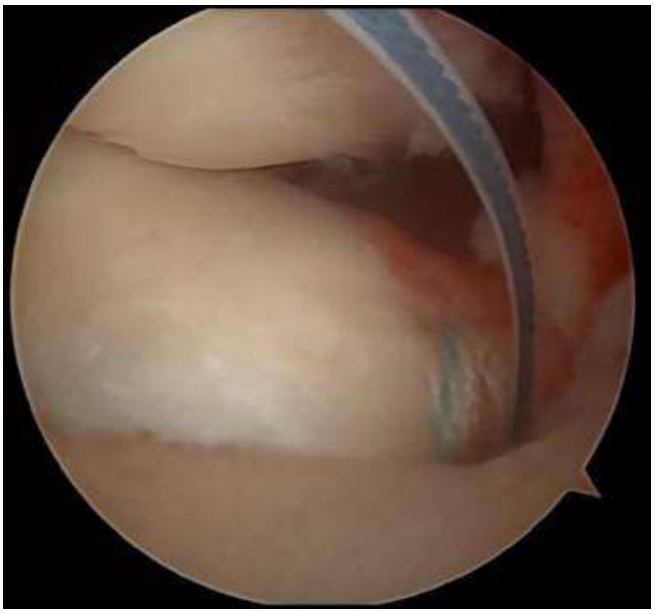

Figure 2. Transtibial pull-out techniques for MMPRT, the tail of suture was shuttle into the tibial tunnel

tendon. The graft is extracted using a tendon stripper after the gracilis is dissected in its entirety. The graft is tapered to fit through the tunnel and had a final length of approximately 6 cm and a diameter of 3 mm. Through the incision used for graft harvest, a 2.0-mm guide pin is inserted and advanced to the meniscus root attachment site of the knee. Following that, a 6-mm cannulated drill is utilized to excessively drill the guide pins. A suture hook or mini-scorpion may be utilized to create a hole in the posterior portion of the medial meniscus. (Figure 3). After suturing the posterior meniscus with a suture lasso, the meniscus is dilated using two no. 2 Ethibond sutures in a back-and-forth jigsaw motion until the desired diameter is achieved, allowing the graft to pass through the meniscus. Then, using a shuttle suture, the graft of the gracilis tendon is passed through the meniscus hole (Figure 4). The posterior horn displacement is subsequently reduced, and stabilization is achieved by applying adequate tension into the tibial tunnel (Figure 5). A 6 mm PEEK interference screw (Rejoin) is utilized to firmly fasten the graft in place to the tibial while the knee is flexed at an angle ranging from 30 to 45 degrees. A final arthroscopic assessment is conducted to validate the tension of the entire medial meniscus and the integrity of the reconstructed posterior root.

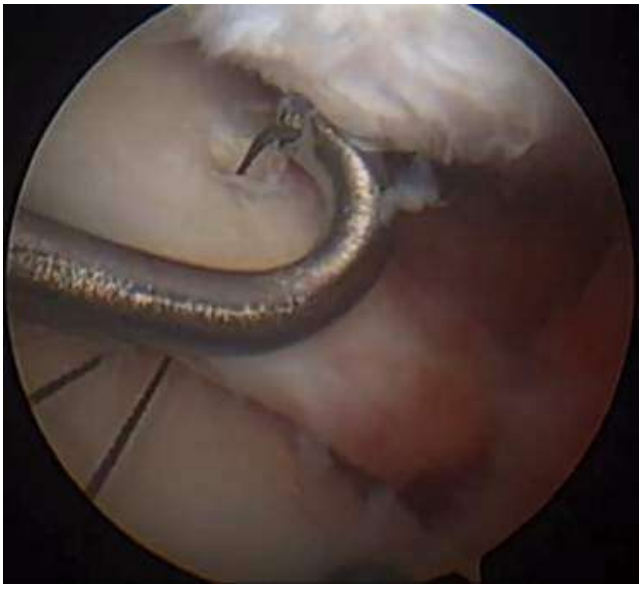

Figure 3. Suture hook is use to create a hole in the posterior portion of the medial meniscus

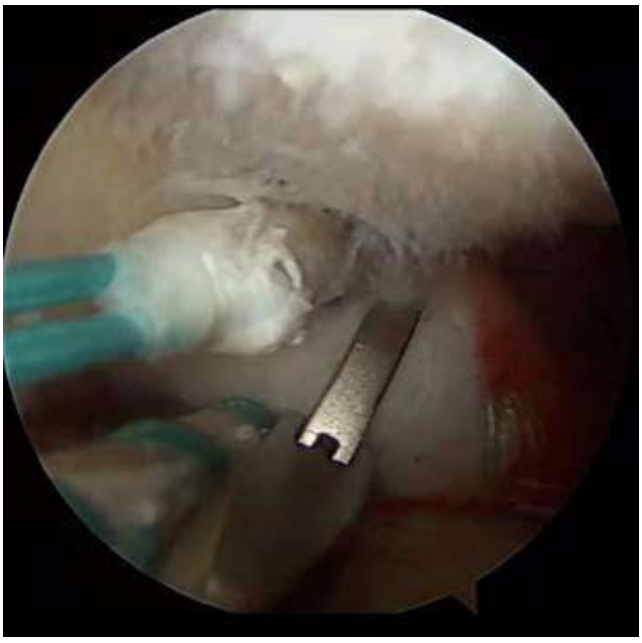

Figure 4. The graft of gracilis tendon is passed through the dilated meniscus hole

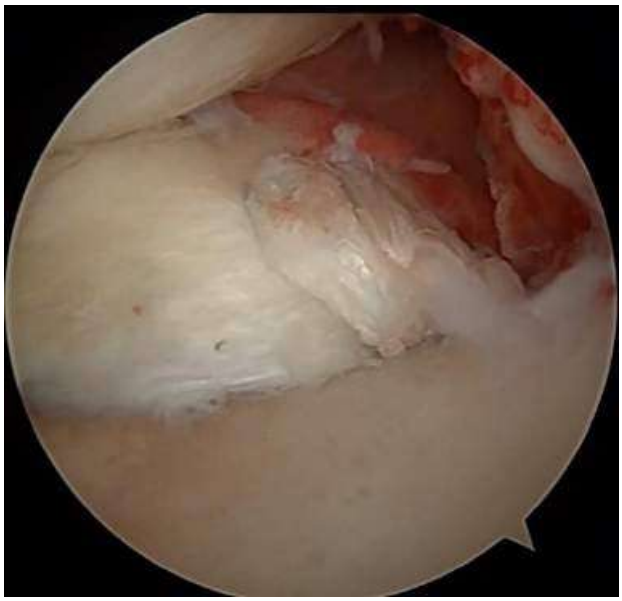

Figure 5. The gracilis tendon graft is passed through the tibial tunnel to reconstruct the medial

Statistical Analysis

Windows IBM SPSS V25 software (IBM, Armonk, New York, USA) was used for statistical analysis. Baseline characteristics between the two groups were compared. Non-parametric numerical data and nominal data were assessed using the Mann-Whitney U test and the Chi-square test, respectively (if the expected count <5 more than 20% is continued with the Fisher-exact test). The normality of the data was assessed using the Saphiro-Wilk test, and the mean score of PROs was compared between both groups using an independent t-test if the data is normally distributed. In case of non-normally distributed data Mann-Whitney U test were utilized. $P < 0.05$ was considered statistically significant.

Results

Patient Demographics

As presented in Table 1, ten patients were included in both reconstruction groups (mean 57.6±9.2 age years) and repair groups (mean 59±9.1 age years). A Mean BMI of the reconstruction group is (27.3±3.3) and the repair group is (27±2.9) respectively. The mean preoperative VAS scores for the reconstruction and repair group were (7.5±0.5) and (8 ±0.7) respectively. Mean preoperative KOOS scores were (35.5±5.2) and (36±5.1). There was no statistical difference in baseline characteristics between both groups.

Clinical Outcome

The range of postoperative VAS scores for the reconstruction group is 1 to 2 with a mean VAS score (1.6 ±0.51) while the repair group is 2 to 4 with mean (3.2 ±0.79). The mean post-operative VAS score showed statistically significant improvement at 3 month (p=0.001). The range of postoperative KOOS score is 70 to 79 in the reconstruction group and 80 to 88 in the repair group, mean KOOS score at 3 months showed no difference in both groups (p=0.481).

Discussion

This present study involved a comparison of VAS score and KOOS score at 3 months follow up. The findings (Table 2.) show that compared to the repair group, the reconstruction group demonstrated a significant reduction in the mean VAS score (p=0.001), however, there was no difference in the mean KOOS score (p=0.481). Furthermore, no significant differences were observed in the initial characteristics of the two groups. Two distinct suture configurations were utilized to suture the meniscus in the transtibial pull-

Table 1. Patient demographics between two groups

	Reconstruction group (n=10)	Repair group (n=10)	p value
Age (Mean ± SD)	57.6 ± 9.2	59 ± 9.1	0.631¶
BMI (Mean ± SD)	27.3 ± 3.3	27 ± 2.9	0.912#
Sex (M/F)	4/6	1/9	0.303¶
KL grade	Grade 0 (n= 3) Grade 1 (n= 3) Grade 2 (n= 4)	Grade 0 (n= 3) Grade 1 (n= 5) Grade 2 (n= 2)	-
Comorbidities	Hypertension (n= 3) DM 2 (n= 2) Obesity (n= 3)	Hypertension (n= 4) DM 2 (n= 2 Obesity (n= 1)	-
Suture configuration		Horizontal mattress suture (n= 3) Cinch suture (n=7)	-
Pre VAS score (Mean ± SD)	7.5 ± 0.5	8 ± 0.7	0.143#
Pre KOOS score (Mean ± SD)	35.5 ± 5.2	36 ± 5.1	0.739#

M: Male ; F: Female ; KL: Kellgren Lawrence ; SD : Standard Deviation ; BMI : Body Mass Index ;VAS: Visual Analog Scale; KOOS: Knee Osteoarthritis Score ; DM 2 : Diabetes Mellitus type 2.
*Chi-square test # Mann-whitney U test ¶Continuity correction of Chi-square test with Fisher-exact test.

Table 2. Clinical outcome of the study groups

	Reconstruction group (n=10)	Repair group (n=10)	P value
Post VAS score (Mean ± SD)	1.6 ± 0.51	3.2 ± 0.79	0.001[€]
Post KOOS score (Mean ± SD)	81.5 ± 5.9	8.37 ± 3.2	0.481[#]

Visual Analog Scale; KOOS: Knee Osteoarthritis Score; SD: Standard Deviation
[#]Mann-whitney U test
[€]Independent t-test

out repair group. Seven patients underwent a cinch suture, whereas three patients received a horizontal mattress suture. Nevertheless, Jackson et al.[13] conducted a study on the clinical results of medial meniscus posterior root repairs utilizing different suture configurations. They found that all participants showed improvement in clinical outcomes, and no significant differences were noted. Thus, it may not emerge as a significant factor that can influence the clinical result.

Studies have established a significant correlation between meniscal root tears, which result in the cessation of circumferential hoop stresses, and the progressive development of symptomatic joint arthritis.[14] Consequently, the majority of studies have shown that surgery is advisable for individuals with substantial needs and mild osteoarthritis.[15,16] The transtibial pull-out technique for the meniscus root procedure facilitates anatomic reduction and fixation of the meniscus root. By restoring the meniscus to its initial anatomical position, meniscus root repair has been associated with encouraging functional improvements in the knee.[17] While the pull-out technique has been previously regarded as the recommended repair method for managing MMPRT, it is linked to relatively low rates of healing. In a comprehensive investigation conducted by Feucht et al [18], it was discovered that only 62% of patients achieved a state of 'complete' healing, while 34% experienced 'partial' healing, and 4% were classified as having 'failed' healing. This unfavorable healing outcome might be the result of a fixation involving only a non-absorbable high-tension suture attached to the anterior tibia cortex. Furthermore, the utilization of a pulling suture to repair the meniscus may result in excessive stress on the meniscus, which differs from its natural origin. It may be the cause responsible for the lower improvement of the VAS score in the transtibial pullout repair group compared to the meniscus reconstruction group. In an animal model, Feutch et al.[7] documented a displacement of the meniscus root after root repair utilizing the trans-tibial pull-out technique while subjecting the root to cyclic loading. A substantial distance may exist between the footprint, the site of the tear, and the tibial fixation points, which increases the susceptibility to the "bungee effect," which has the potential to hinder the healing of the meniscus. Several studies have also documented the inability of numerous repairs to halt the progression of symptomatic knee arthritis and the inadequacy of meniscal healing rate outcomes.[19–21]

Over the last decade, there has been a surge of interest in MMPRT reconstruction techniques. Lee *et al*.[8] developed the arthroscopy technique using gracilis autograft to reconstruct the MMPRT. The utilization of the graft serves to establish a connective tissue link between the original meniscus root attachment site and the grafted meniscus root footprint, hence facilitating an accelerated healing process and improving the clinical outcome. This method also involves the utilization of an interference screw or button to anchor the graft to the bone, therefore improving control over tension to prevent micro-motion or the bungee effect compared to the repair technique. The study conducted by Li et al.[6] demonstrated that meniscus root reconstruction using a gracilis autograft is beneficial for treating patients, as it results in higher rates of meniscus healing. Specifically, 51% of patients in the repair group achieved complete healing, while 82.7% of patients in the meniscus root reconstruction using gracilis autograft group achieved complete healing. Wendel et al.[5] have provided evidence that meniscus root reconstruction can facilitate optimal healing by reattaching to the anatomic footprint with a cartilaginous graft that resembles the native root. Reconstruction of the MMPRT was likely an option that is expected to overcome the limitation of the arthroscopic transtibial pull-out repair. In this study we found that significant reduction of the mean VAS score in the meniscus root reconstruction group; however, the mean postoperative KOOS score between both groups was not any significant, this may be attributed to short follow-up time, as meniscus root needed more time to heal. Furthermore, as previously stated, the act of pulling the suture of the meniscus during transtibial pullout repair may result in increased stress on the meniscus, which might potentially diminish the significance of the improvement in VAS scores.

This study has also identified several limitations. First, our current study is limited to a single center, which means it was conducted in a single facility. Additionally, the study included a very small number of patients and had a short follow-up duration. These factors may introduce bias into the results. Second, there is a discrepancy in the fixation technique employed in the transtibial pull-out group. However, studies have demonstrated that there was no significant difference was discovered among those techniques. Third, there is no randomization in this study. To resolve this problem, further observational studies are recommended to conduct with a larger sample size and a longer duration of follow-up.

Conclusion

In comparison to transtibial pull-out repair, meniscus root reconstruction with gracilis yields superior outcomes as measured by the VAS score; however, at the three-month follow-up, there was not a significant difference in clinical outcome. Additional research incorporating a more extended follow-up period is required to comprehensively assess the advantages between these two procedures.

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Case Report

Neglected Infection of Supracondylar Humerus with Non-Prosthetic Peri-Implant Fractures (NPPIF): Case Report

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Abstract

Introduction:
Proximal humerus fractures in adults are one of the most common fractures with an incidence of approximately 6%. However, a non-prosthetic peri-implant fracture combined with neglected infection is still underreported. So far, no journal has been concerned about this topic, and we want to discuss our comprehensive management in this case.

Case Presentation:
A 70-year-old female complained of pain in her right elbow after falling on her house. Fractures got infected after a week of being neglected by the patient. She had a history of open reduction and internal fixation with plate and screws seventeen years ago. She was diagnosed with neglected infection peri-implant fracture right supracondylar humerus Non-prosthetic Peri-Implant Fractures (NPPIF) Classification P1B and scheduled for debridement, removal implant, external fixation with hinged bar. Infection was treated according to the wound culture result.

Conclusion:
Comprehensive management is needed in this kind of case. Our goal in this case is to stabilize the fracture and heal the infection. This patient has a good prognosis and make a functional return.

Introduction

Proximal humerus fractures (PHF) in adults are one of the most common fractures with the incidence approximately 6%.[1] PHFs most commonly occur in patients over 65 years of age.[2] In the setting of osteoporosis or osteopenia, a low-energy fall may result in PHF. Non-prosthetic peri-implant fracture (NPPIF) is a fracture in a bone with an existing non-prosthetic implant such as an extramedullary plate and screws or an intramedullary nail. The term peri prosthesis fracture and peri-implant fracture is overlapped with NPPIF. Since first introduced in 2018, NPPIF is still underreported especially combined with neglected infection.[3] So far, there has not been a journal discussed about this topic and we want to discuss our comprehensive management of neglected infection peri-implant fracture right supracondylar humerus with Non-prosthetic Peri-Implant Fractures (NPPIF) Classification P1B.

Case Report

A 70-year-old female referred from Balimed Hospital Karangasem complained pain in her right elbow after slipping and falling into her house 8 days ago. The patient fell to the right side and used her right elbow as the weight support. Patient had a history of open reduction and internal fixation with a plate and screw seventeen years ago which made her unable to bend and straighten her right elbow even before the accident. History of fever was denied. The patient had

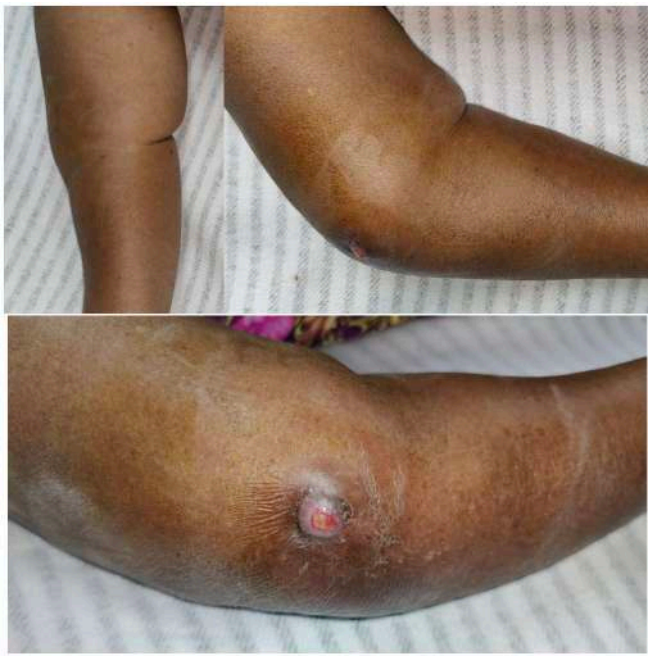

Figure 1. Clinical examination of the patient

no history of other systemic disease. The patient was no longer working and was a right-handed person.

On her right elbow (Figure 1), there was a 1x1 cm wound at the lateral side surrounded with swelling and erythema. From the wound, we could see the pus oozing out but there was not any active bleeding. Deformity and angulation were also seen. When palpated, tenderness was felt around the elbow. The patient was still able to feel sensation and her radial artery was still palpable. However, she could not move her elbow due to pain. Her wrist and metacarpal joints' movement was normal. She was able to extend her thumb and wrist.

Laboratory results showed normal white blood cell 4.56 x $10^3/\mu$L, but a high Erythrocyte sedimentation rate (112mm/hour) and C-reactive protein (31.2 mg/dL). Radiographic examination (Figure 2) showed deformity on the right distal third humerus with plate and screw internal fixation. Placement and apposition were not precise; seemed malunion old fracture.

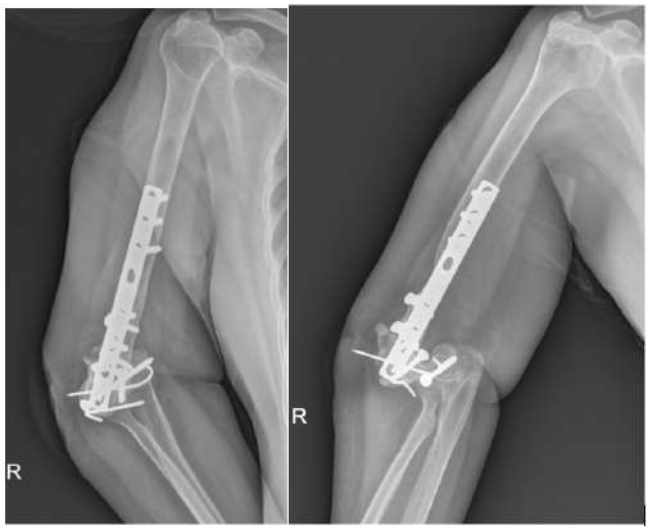

Figure 2. X-ray of humerus anteroposterior and lateral view before the surgery

The patient was diagnosed with neglected infection peri-implant fracture right supracondylar humerus Non-prosthetic Peri-Implant Fractures (NPPIF) Classification P1B and scheduled for debridement, removal implant, external fixation with hinged bar. The incision was made through posterior approach with a triceps fascial tongue approach. Debridement was done including the fibrotic tissue. Cultured was done and showed Methicillin susceptible to Staphylococcus aureus (MSSA). Soft tissue was released and the implant was removed. Fracture was reduced and external fixation with a hinged bar was applied (Figure 3). We did a c-arm to make sure of the position and stabilization. The wound was sutured in each layer. A post-operative x-ray (Figure 4) was done to re-assess the implants.

As operative post-operative management, the patient was given fentanyl 300 mcg 50cc normal saline with the speed of 2,1cc/hour and paracetamol 500mg every 6 hours intra oral. Ceftriaxone 1 g was given twice daily intravenous for 3 days then exchanged for Cefixime 200 mg twice daily intraoral for 5 days. Wound care was done every 3 days. The patient was sent home after being hospitalized for 10 days.

On follow-up; three days after her discharge, the patient only complained of minimal pain (Numerical Rating Scale 3/10). The dressing was dry with minimal seepage. Hypoesthesia still occurred on the dorsum and palmar of the manus. Thumb extension was limited due to pain and the OK sign was positive. A sign of infection was not found. The patient was prescribed with Cefixime 200mg twice daily intraoral and paracetamol 400mg four times a day intraoral. She was then scheduled for another follow-up next week.

Discussion

Non-prosthetic implant per-implant fractures (NPPIF) is a term to call fracture in a bone with a non-prosthetic implant such as an extramedullary plate and screws or an intramedullary nail. The term peri prosthesis fracture and peri-implant fracture is overlapped with NPPIF. A study showed that NPPIF is commonly located in the femur followed by radius/ulna, humerus, tibia, and clavicle. Classification of NPPIF was according to the type of implant (nail or plate), the location of the new fracture (type 1: at the tip, type 2: distant from the implant), and the condition of the original fracture's healing status. Surgical management techniques vary depending on the area. The classification was utilized to determine the appropriate management approaches.[3]

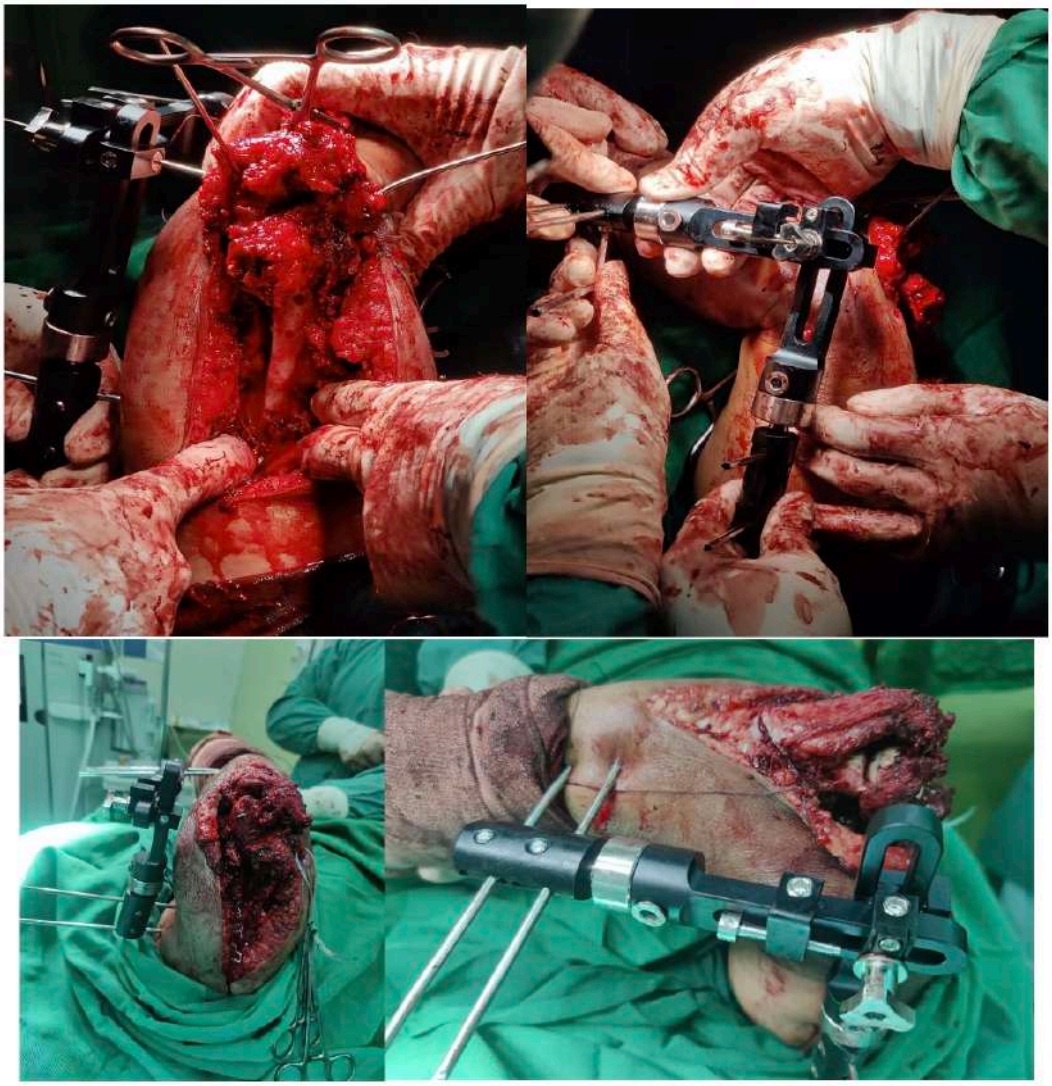

Figure 3. Intraoperative surgery procedure of applying hinged bar external fixation

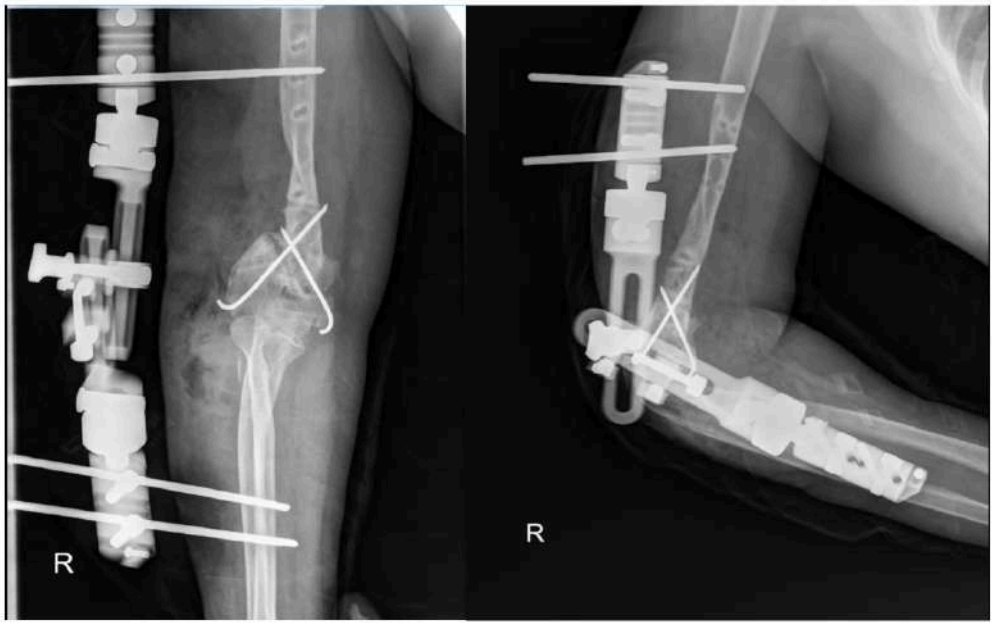

Figure 4. X-ray of humerus anteroposterior and lateral view after the surgery.

Figure 5. Clinical examination on the first follow-up.

However, this case was complicated by neglected infection in the fracture. Our goal of treatment in this case is to stabilize the fracture and manage the neglected infection due to the fracture. All infections that take place in conjunction with a fracture are now referred to as fracture-related infections (FRI).[4] Damage to soft tissues and compromised blood vessels promote microbial infiltration, which interferes the normal bone healing. Fracture instability causes decreased neovascularization together with continuous osteolysis and soft tissue injury results. This event promotes microbial growth and weakens the host's immune response. Further biomechanical instability results from this cycle. A patient's quality of life may be severely and permanently impacted by FRI because this condition delayed healing, increased functional loss, or amputation. According to recent epidemiological research, the infection rate is 1.8% after closed fractures and 27% after open fractures. FRI also burdens the healthcare system because it costs 6.5 times more than non-infected cases, with a reported 70% treatment success rate, 9% recurrence rate, and 3% amputation rate.[5]

A literature review revealed that certain diagnostic tests (confirmatory criteria) are quite specific for the presence of infection. Leukocyte count, C-reactive protein, and erythrocyte sedimentation rate are examples of common serum inflammatory indicators that have been examined in the diagnosis of FRI. However, these markers can be elevated in many other inflammatory disorders as well as after trauma without infection. After an injury, C-reactive protein (CRP) levels increase, peaking at day 2 and then declining to normal during the following one to two weeks. In this case, CRP was slightly increasing. The other important diagnostic approach of the FRI is microbiological diagnostic. Microbial diagnostic is important to confirm infection, evaluate their patterns of antimicrobial susceptibility, and choose the targeted antimicrobial therapy for the patient. Local antimicrobials should be taken into consideration. After the tissue sample, empiric broad-spectrum antibiotic therapy for FRI should be initiated and then modified as quickly as feasible following culture results. In this case, the patient is still susceptible to methicillin. Therefore, Ceftriaxone is still chosen as the first-line therapy based on our mapping of the hospital microbiome.[5]

The fundamental paradigm for FRI management includes identification of the pathogen, irrigation, debridement, soft tissue management, osseous stability, and tailored antibiotic therapy. Then, the surgeon also needs to decide whether the implant needs to be removed or not based on the healed fracture. Thorough debridement, irrigation with normal saline, fracture stability, dead space control, and sufficient soft tissue coverage are crucial elements of surgical care of FRI. In this case, we had done debridement to remove all the necrotic tissue and also exchanged the implant with hinged bar external fixation.[6]

The original indication of external fixation was for the treatment of open fractures. Today, external fixations are well established for the therapy of chronic disorders such as infected nonunion of fractures, correction of deformity caused by malunion, or management of bone gaps via distraction osteogenesis. External fixations are not only used in acute situations.[7] Hinged bar external fixation was chosen because of several advantages such as stabilizing the joint and enabling early mobilization. Hinged external fixation is usually applied for six to eight weeks. It is also crucial to prevent joint stiffness in elbow disease. By applying a hinged external, it improves the range of motion because it protects elbow protection from valgus and

varus stress and makes the elbow able to bend and extend whereby the ligaments can heal without additional reconstruction.[8] A study showed that using hinged bar external fixation in severe injury of the elbow resulted in the excellent range of motion with the median arcs of flexion-extension and pronation-supination respectively 125° and 170°. The hinged elbow fixator is also used for revision surgery to correct joint incongruency or a stiff elbow as well as for acute therapy of elbow pain.[9]

Conclusion

Comprehensive management is needed in this kind of case. Our goal in this case is stabilize the fracture and heal the infection. This patient has good prognosis and make a functional return.

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Case Report

Crush Injury of Upper Extremity Leading to Bywater's Syndrome: A Case Report

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Abstract

Introduction:
A male came to the ER with wounds on his left arm after a vehicle incident. He was run over by the truck's wheels on his left upper extremity until his whole arms were crushed. He had a massive crush injury on his whole left arm, no movement or pulse was detected. MESS Scoring resulted in a score of 11, thus an indication for amputation. Blood examination showed an increase of ureum and creatinine without previous kidney disease history. The patient was diagnosed with a crush injury of the upper extremity and Bywater's Syndrome based on kidney involvement. He was consulted by the orthopedic department and was given fluid resuscitation, injections of analgesics, antibiotics, and Human Tetanus Immunoglobulin (HTIG). Proximal humerus amputation was performed. A second surgery later was performed to debride the wound due to contaminated necrotic tissues.

Introduction

Crush injury can lead to many complications, one such uncommon consequence is known as Bywater's Syndrome.[1] It is characterized by the sudden and excessive destruction of red blood cells (hemolysis) due to mechanical trauma.[2] It is a relatively rare condition, Mangled Extremity Severity Score (MESS) should be performed on patients with crush injuries as diagnostic tools and to determine if the patient needs amputation.[3]

Case Report

A 57-year-old male came to the ER with a massive wound on his left arm after a motor vehicle incident on the street. The patient was riding his bike and then collided with a truck. The patient got run over by the truck's wheels on his left upper extremity until his whole arms were crushed.

Vital signs showed blood pressure of 85/51mmHg, body temperature of 36.5°C, heart rate of 128 bpm, respiratory rate of 24 times per minute. Physical examination showed a massive crush injury on his whole left arm, no movement or pulse were detected. MESS Scoring was performed and the patient's score is 11, thus an indication for amputation. The left humerus

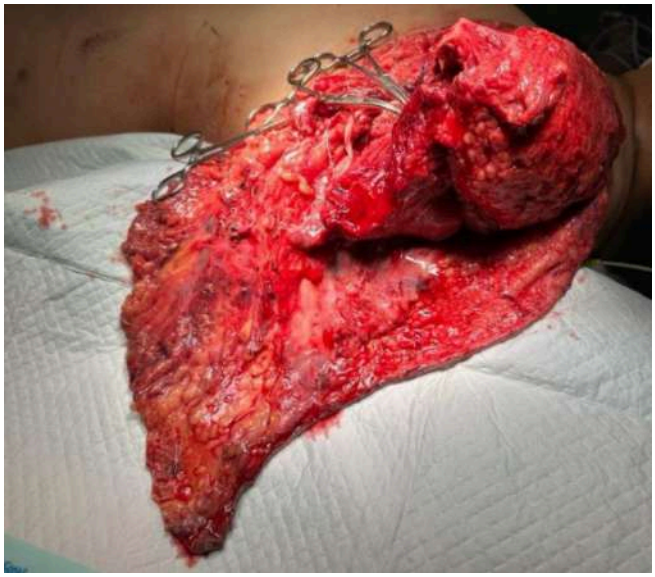

Figure 1. Crushed left arm after injury

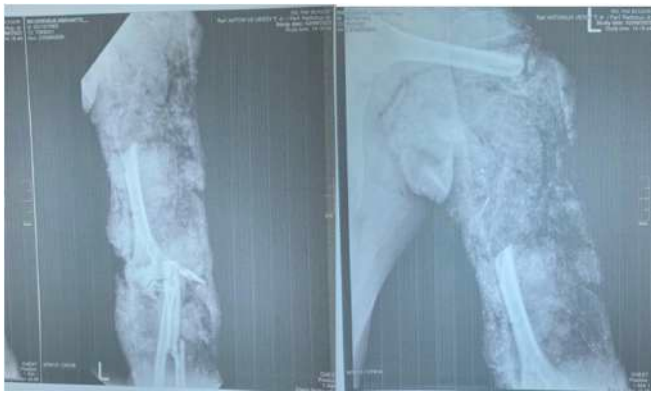

Figure 2. Upper left arm x-ray

x-ray was performed even though the crush injury was already visible. The x-ray showed a one-third mid-left humeral fracture with poor alignment. Blood examination showed lowered hemoglobin of 10.4 g/dl, elevated leukocytes of 34.720/uL, urea and creatinine of 59 mg/dL, and 2.12 mg/dL without previous kidney disease history. The patient was diagnosed with a crush injury of the upper extremity and Bywater's Syndrome due to kidney involvement. The patient was consulted to the orthopedic department and was given 2 liters of ringer lactate fluid, ketorolac injection, ceftriaxone injection, and Human Tetanus Immunoglobulin (HTIG), and proximal humerus amputation was performed. Three days later, he complained about darkened skin around his amputated arm, followed by slight blood and pus. A second surgery was performed to debride the wound due to contaminated necrotic tissues. Five days after the second surgery, the patient showed improvement and there were no signs of infection. The patient was discharged from the hospital and continued the treatment to evaluate post-amputation condition and systemic symptoms.

Discussion

A crush injury is characterized by the extensive damage of a large muscle mass. Bywater's syndrome or crush syndrome is a crush injury with systemic manifestations.[4] Systemic symptoms arise from traumatic rhabdomyolysis, which occurs when there is muscle reperfusion injury following the release of compressive forces on the tissues.[5] The patient showed kidney dysfunction as in elevated creatinine and urea levels upon trauma without prior kidney failure history. Upon arrival, vital signs showed hypotension, tachycardia, and tachypnea, which might be early signs of hypovolemic shock due to massive blood loss. Early resuscitation and treatment were done to prevent further complications. According to literature, early untreated Bywater's syndrome death is caused by hypovolemic shock and hyperkalemia due to kidney dysfunction, and late untreated death is caused by prolonged renal failure, coagulopathy, hemorrhage, and sepsis.[6] Further treatment is determined by using a MESS score to decide whether the patient needs an amputation. MESS score includes skeletal/soft tissue injury, limb ischemia, shock, and age as variables.[7] Score of 7 or above is highly predictive of amputations. As this patient scored 11, amputation surgery was performed. According to the literature, it is reported that 13-40% of infections happen in major limb amputation. The risk factors vary from ischemia, pre-existing limb ulcers, patient co-morbidities, and

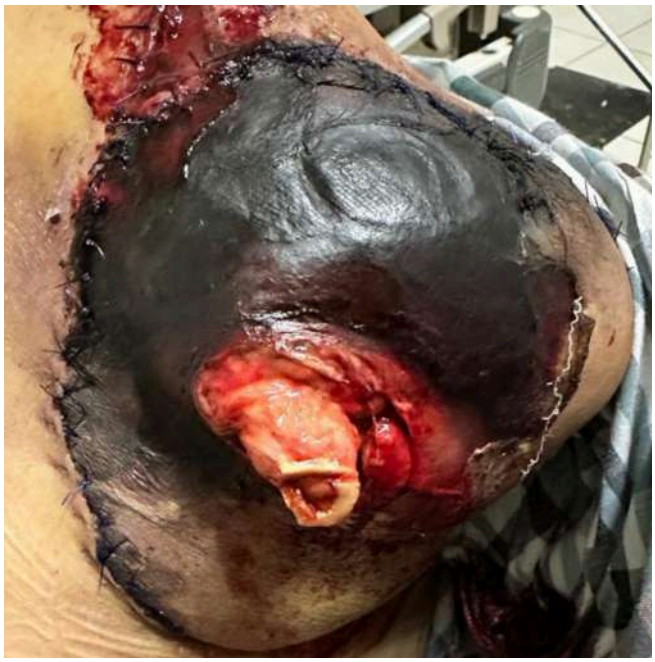

Figure 3. Necrotizing tissue after amputation surgery

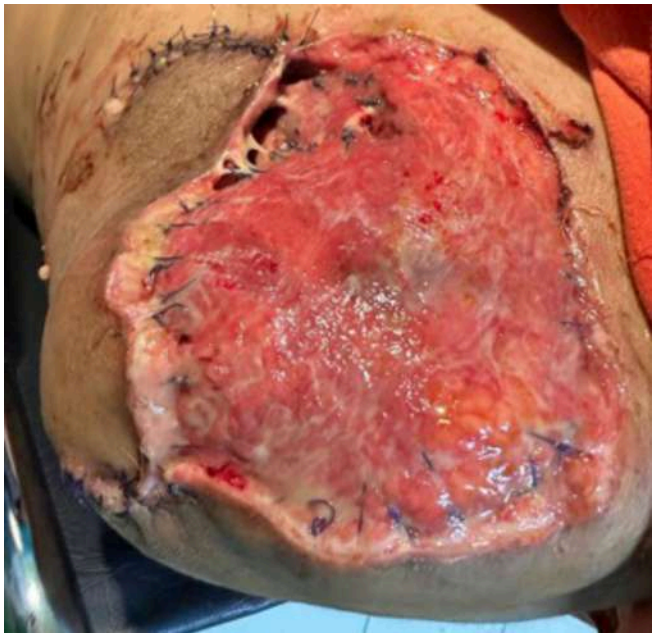

Figure 4. Debridement surgery

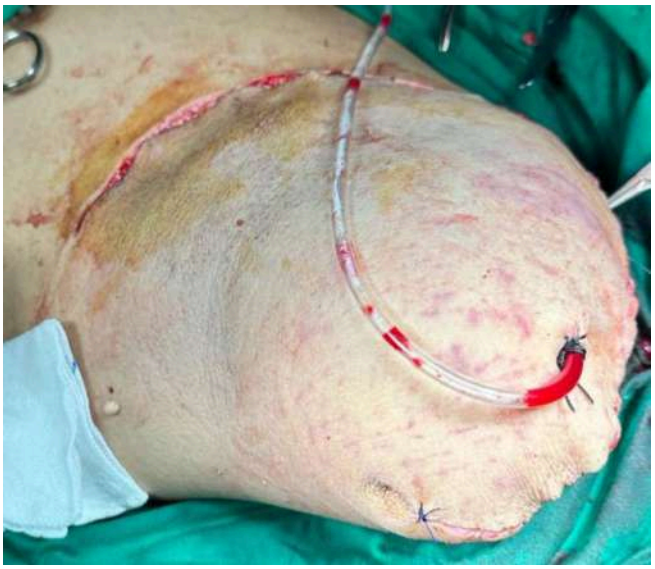

Figure 5. Post debridement surgery

contamination of the wound.[8] In this patient, contamination of the wound is verdict to become the source of infection. The second surgery was performed to debride the contaminated wound. After a total of six days of treatment and two surgeries, the patient showed improvement after the second surgery. Further treatment was still needed to evaluate the wound and systemic signs of kidney involvement. Post-operative pain and psychological factors also need to be issued. We would recommend psychological assessment, kidney function evaluation, and wound hygiene for the next treatment. It is an important case to be reported as early recognition and treatment might result in a notable outcome for the patient.

Conclusion

Urgent and effective medical care is required to reduce the risk of cardiac arrhythmia, kidney damage and death. Decisions may need to be made quickly as postponed therapy might result in worse prognosis. Patients with crush injury present some of the greatest challenges in field medicine, and may need a physician's attention on the site of their injury. Appropriate physiological preparation of the injured is mandatory.

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Literature Review

Shoulder Injury Related to Vaccine Administration Following COVID-19 Vaccination

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Abstract

Shoulder Injury Related to Vaccine Administration (SIRVA) is a general term that describes a complaint of shoulder pain and limited range of movement within 48 hours after vaccination. With mass vaccination due to the COVID-19 pandemic, the incidence of SIRVA is expected to increase. Symptoms include pain, stiff shoulders, limited movement, and weakness. The pathophysiology of SIRVA is not fully understood, but it is believed to occur due to an excessive immune response due to inappropriate injections. Earlier studies on SIRVA have highlighted a significant gender gap, indicating a higher prevalence among females. To date, there is no established standard method for assessing SIRVA, but magnetic resonance imaging (MRI) is the imaging of choice for detecting SIRVA-related abnormalities, such as hematoma, infection, intraosseous edema, subacromial bursitis, joint synovitis, adhesive capsulitis, tendonitis, and rotator cuff injuries. The first line pharmacological therapy that can be given is nonsteroidal anti-inflammatory drugs (NSAIDs). If there is no improvement, an intra-articular corticosteroid injection can be given. It can also be supported by physiotherapy to increase muscle strength in the area of the injured part. SIRVA can be prevented by understanding the anatomy of the shoulder and the appropriate injection technique.

Introduction

Shoulder Injury Related to Vaccine Administration (SIRVA) is a general term that describes a complaint of shoulder pain especially in the deltoid muscle, where the vaccine is injected intramuscularly.[1] The National Vaccine Injury Compensation Program stated that SIRVA is defined as pain in the shoulder accompanied by a limited range of movement within a minimum of 48 hours after vaccination, where there is no previous history of pain or inflammation in the shoulder. If left untreated it can lead to permanent disability.[2] The most common cause of SIRVA is a method of administering the vaccine that does not comply with protocol, which could be in the form of an injection site that is too high or deep, thereby triggering an inflammatory or immune response at the injection site and injuring the surrounding muscles or blood vessels.[3] SIRVA is not only caused by certain vaccines but varies. Atanasoff et al reported the largest contributor to SIRVA was the influenza vaccine (62%), followed by the Tetanus vaccine (15%), Tetanus, Diphtheria, Pertussis vaccine (15%), and Human Papillomavirus (HPV) vaccine (8%).[2] In addition, due to Corona Virus Disease 2019 (COVID-19) pandemic in 2020, there was an increase in reports of SIRVA. The first case of SIRVA after COVID-19 vaccination was reported by Tatiane et al. in April 2021, where the patient reportedly suffered from subdeltoid bursitis and rotator cuff tendinopathy after vaccination.[4]

The coronavirus disease 2019 (COVID-19) pandemic is a worldwide occurrence of a viral outbreak caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It was first identified in China in December 2019 and quickly spread worldwide.[5] Several efforts have been made to provide

acquired immunity against COVID-19, including implementing a mandatory vaccination policy.[6] Although it has been proven to reduce COVID-19 incidence, hospitalization, and mortality rate, such mass vaccination can increase the incidence of SIRVA.[7,8] The estimated incidence of SIRVA according to a previous study performed by Hibbs et al. in 2020 is 1.5-2.5% and it is estimated to increase after mass COVID-19 vaccination. However, SIRVA is often underestimated so reported incidents are inaccurate.[9] SIRVA can be an extremely painful condition and can decrease patients' range of motion which can last for weeks to months or as long as years.[3] It can interfere with daily activities, reduce patients' quality of life, and result in long-term impacts on biological, psychological, and social well-being. Therefore, this literature review aimed to describe the SIRVA following COVID-19 vaccination.[10]

Results

Definition

Shoulder Injury Related to Vaccine Administration (SIRVA) is a term to describe complaints of shoulder pain that occur due to vaccination injection techniques that do not comply with the protocol. This term was first introduced in 2010 by the Vaccine Injury Compensation Program (VICP) and was officially added to the Vaccine Injury Table in 2017. SIRVA can actually be prevented if medical personnel can understand the correct vaccine injection technique and recognize the anatomy of the shoulder itself. In certain conditions, the place where the vaccine is injected is too high into the glenohumeral joint so that it is not placed in the deltoid muscle but rather in the shoulder capsule. If the injection location is too low or to the side, it can cause damage to the axillary and radial nerves and lead to less common symptoms such as neuropathic pain and paralysis. Symptoms that arise in SIRVA include stiff shoulders, pain, limited movement, and weakness.[9]

Several pharmacovigilance institutions discuss the criteria for SIRVA. Surveillance of Adverse Events Following Vaccination in the Community (SAEFVIC) states that SIRVA occurs at onset 24-48 hours after vaccination, and there is suspicion of an error in the vaccine injection technique, causing a group of clinical manifestations such as pain when moving the shoulder, limitations in ROM, and the presence of abnormalities on imaging such as connective tissue and joint capsule injury which includes deltoid muscle bursitis, tendonitis, rotator cuff tear, or adhesive capsulitis.[11] In addition, the Vaccine Adverse Event Reporting Scheme (VAERS) and the Vaccine Injury Compensation Program (VICP) define SIRVA as complaints of pain in the shoulder within 48 days after vaccination, accompanied by limitations in ROM, provided there is no nerve damage or history of pain and inflammation.[12] However, it turns out that there are several articles that discuss the criteria for SIRVA which include the presence of nerve damage.[13] This is in accordance with the previous explanation that the wrong vaccination injection location can injure the axillary and radial nerves and lead to other complications such as bursitis, radial nerve injury, and axillary nerve injury.

When it comes to patients with underlying chronic shoulder pathologies, it can be difficult to determine if an acute exacerbation of pain after vaccination is caused by SIRVA, or if it is simply a natural progression of the existing condition. Patients with chronic shoulder pathologies often experience pain and limited range of motion, which complicates the diagnosis of SIRVA. However, patients with pre-existing shoulder injuries or conditions may be at a higher risk of developing SIRVA due to the increased sensitivity or vulnerability of the shoulder joint. The injection of the vaccine into an already compromised shoulder can exacerbate symptoms and lead to a more pronounced inflammatory response. Currently, there is limited literature discussing SIRVA in patients with chronic shoulder injury, but a prospective study conducted by Servet Igrek et al. found that patients with pre-existing chronic pathologies experienced a significant increase in Visual Analog Scale (VAS) scores before and after vaccination. In contrast, patients without any shoulder injury or condition did not experience a significant difference in VAS scores.[14]

Epidemiology

SIRVA is reported to increase every year, the following is the prevalence of SIRVA caused by certain types of vaccines.

Pathophysiology

The pathophysiology of SIRVA is not fully understood, but it is believed to occur due to an excessively strong immune response to the vaccine antigen.[16,17] A study on SIRVA following influenza vaccination conducted by Hirsiger et al. has indicated that vaccine application in an inappropriate tissue compartment is associated with chronic immune activation. In that study, it was observed that patients with vaccine-associated tissue damage, especially those with bone erosions, displayed a significantly higher occurrence of CD19+CD27+CD38+ plasmablasts and CD4+CD45RO+CXCR5+ Tfh-like T cells in their peripheral blood. The frequencies of plasmablasts (PB) and Tfh-like T cells were correlated and fell within the range typically observed only transiently 1–2 weeks after influenza vaccination. These findings suggest a potential pathological immune dysregulation in cases of SIRVA. The persistence of plasmablasts and Tfh-like T cells in the peripheral blood of SIRVA cases several months after vaccination may indicate ongoing

Table 1. Epidemiology of SIRVA

Author	Year	Sample	Prevalence
Hesse EM, et al.[15]	2010 - 2016	489	• Inactivated influenza = 400 (84.0%) • Tetanus, diphtheria, pertussis = 57 (12.0%) • Pneumococcal conjugate = 11 (2.3%) • Tetanus, diphtheria = 6 (1.3%) • Pneumococcal polysaccharide 4 (0.8%) • Hepatitis A = 3 (0.6%) • Hepatitis B = 2 (0.4%) • Meningococcal conjugate = 2 (0.4%) • Measles, mumps, rubella = 1 (0.2%) • Human papillomavirus = 1 (0.2%) • Other / unspecified = 2 (0.4%)
Mackenzie LJ et al.[9]	2017 - 2021	505	• Unknown = 208 • COVID-19 AstraZeneca = 95 • Influenza = 68 • COVID-19 Pfizer = 52 • COVID-19 Moderna = 31 • Pneumococcal = 17 • DTaP, Tdap, DTaP + polio = 12 • COVID-19 unknown = 11 • Herpes zoster = 6 • MMR = 3 • HPV = 3 • Hep A = 2 • COVID-19 Janssen = 1 • HIB + meningococcal = 1 • Polio = 1 • Varicella = 1 • Meningococcal = 1

immune activation. In fact, SIRVA was associated with an activated T cell phenotype characterized by CD69+ and CD154+ expression, particularly in Tfh-like T cells, and this activation was correlated with the frequency of plasmablasts.[18]

Furthermore, improper intramuscular injection into anatomic structures near the deltoid muscle may result in chemical and/or mechanical trauma. Injection into less vascularized subcutaneous tissue or adjacent bursae, tendons, and nerves can potentially lead to the development of SIRVA because it can reduce immunogenicity, therefore reducing the effectiveness of the vaccine and causing pain.[17,19] The injection that is placed too deep into the shoulder capsule can result in inflammation of the shoulder joint or its surrounding bursa (synovitis), or it may lead to an infection like septic arthritis or bursitis. An injection placed into the rotator cuff area can cause injuries to the rotator cuff, such as tendonitis or a tear. Placing an injection into the subacromial or subdeltoid space can cause painful inflammation (bursitis) and potentially lead to a condition known as frozen shoulder (adhesive capsulitis). If the injection is administered into or near the axillary nerve, it may cause nerve irritation, resulting in numbness and tingling (paresthesia), and in some cases, it may cause temporary weakness in the arm due to anterior or middle deltoid paralysis.[1,3]

Risk Factors

The risk factors for SIRVA include female gender, thin habitus, having small deltoid muscle bulk, and improper injection techniques.[9,20] Earlier studies on SIRVA have highlighted a significant gender gap, indicating a higher prevalence among females, with some research reporting rates as high as 82.5% of cases being female.[12,15,21] The higher incidence of SIRVA in females is caused by several factors including a low body mass index, reduced thickness of the deltoid fat pad and/or muscle bulk, higher vaccination participation among females, increased rates of reported adverse events, or greater tendency for females to seek medical care. Modesty could potentially be another contributing factor, as females might be more inclined to roll up their sleeves or pull down their shirts to expose the deltoid, as opposed to males who might be more likely to remove their shirts entirely. However, it's important to note that there is currently no primary research available in this specific area. Further research is necessary to better understand the reasons behind these gender disparities in SIRVA cases.[(9)] In a recent report conducted by Atanasoff et al., the patient was also an elderly female with a thin body habitus. The authors suggest that inadequate technique, combined with smaller body habitus, may increase the risk of unintentional injection into the subacromial bursa or underlying bone.[22]

Clinical Evaluation

For patients experiencing persistent or worsening shoulder pain for more than 48 hours after vaccination, further clinical evaluation is necessary. The initial assessment should include gathering medical history to understand the correlation between the symptoms and the injection, as well as to rule out potential comorbidities or preexisting shoulder pathology.[1] The symptomatic hallmark of SIRVA is shoulder pain emerging within 1 to 2 days of vaccination in a shoulder that was previously asymptomatic and limitations in range of motion. In contrast to the typical post-vaccination shoulder pain, SIRVA-related pain persists beyond 1 week and does not resolve within that time frame.[23] In research conducted by Atanasoff et al., every patient reported experiencing shoulder pain. The initiation of pain was noted in 93% of cases within less than 24 hours after vaccination, and 54% reported pain immediately following the injection.[22] Hesse et al. found that 31.1% of patients report limited shoulder ROM after injection.[15] Due to pain and restricted movement, patients may encounter challenges in carrying out their daily activities.[23]

After obtaining a medical history, a physical examination, especially in the shoulder area, is done. The physical examination of the shoulder begins with an inspection of the injection site, palpation, assessment of range of motion (ROM), muscle strength tests, and neurovascular examination.[24] It is recommended to expose both shoulders entirely, without clothing, to enhance visibility and facilitate the assessment of any asymmetry, skin changes, or swelling. Subsequently, gentle palpation of the site is conducted to detect any potential hematoma, fluctuance, abscess, or crepitus. Evaluation of shoulder range of motion should encompass both active (unassisted) and passive (assisted by the examiner) movements. The typical range of motion of the shoulder includes forward flexion of 150° to 180°, extension of 40° to 60°, abduction of 150° to 180°, internal rotation to the thoracic spine, and external rotation of 60° to 90°.[1] Additionally, ROM on the affected side should be compared with that of the unaffected side. Following that, strength testing can be conducted, focusing on assessing the integrity of the deltoid function. This involves testing the arm against resisted abduction (middle deltoid) and forward flexion (anterior deltoid). Nevertheless, distinguishing reduced strength from pain can be challenging and may necessitate additional evaluation through imaging.[24] Lastly, it is essential to conduct a comprehensive neurovascular examination. Vascular injuries are not acknowledged as a complication of SIRVA, and they can be promptly ruled out by palpating the brachial artery at the mid-arm medially or the radial artery at the volar-radial wrist.[1]

Diagnostic Studies

To date, there is no established standard method for assessing SIRVA. Although X-rays are widely accessible, they are unlikely to produce positive or diagnostic outcomes in the early stages of the clinical course. Plain radiographs may be beneficial for examining arthritic changes in the glenohumeral joint to eliminate other potential causes of shoulder pain.[(1)] Nevertheless, findings from other studies suggest that X-rays are not effective in evaluating SIRVA. If available, magnetic resonance imaging (MRI) is the imaging of choice for detecting SIRVA-related abnormalities. It allows for the assessment of hematoma, infection, intraosseous edema, subacromial bursitis, joint synovitis, adhesive capsulitis, tendonitis, and rotator cuff injuries.[25] On MRI, the predominant observation is a fluid signal in the deep muscular or tendinous structures, often linked to inflammatory changes in the subacromial-subdeltoid bursa and focal bone marrow edema of the humeral head.[26] The use of contrast-enhanced MRI is recommended when an infection is suspected, as it provides clearer insights into osseous and non-osseous involvement and confirms the presence of tissue necrosis.[1] Currently, there is no specific guideline for the optimal timing of MRI; however, 63% of MRIs are typically conducted within three months of symptom onset.[27] In cases where an MRI is unavailable, ultrasound evaluation can be considered, offering clinical data for diagnoses related to SIRVA. Ultrasound can assist in identifying bursa abnormalities in individuals with bursitis.[(1)] Given that SIRVA is not a neurological injury, normal results are expected in nerve conduction, electromyographic studies, and neurological evaluations.[27] Nevertheless, for optimal results, it is recommended to do these evaluations at least 2-3 weeks after vaccination. This time frame facilitates the initiation of any potential nerve injury's sequence of changes in myelin sheath and axonal sheath, allowing the study to accurately identify such alterations.[1]

Treatment

SIRVA is capable of causing a series of effects if the vaccination injection is misplaced. One condition that commonly occurs in SIRVA is subacromial-subdeltoid bursitis, which is the result of inflammation of the shoulder joint or its surrounding bursa (synovitis), or it may lead to an infection like septic arthritis or bursitis.[28] Thus, the first line of pharmacological therapy that can be given to SIRVA patients is nonsteroidal anti-inflammatory drugs (NSAIDs). If there is no improvement, an intra-articular corticosteroid injection can be given. Administration of NSAIDs or corticosteroid injections can be supported by physiotherapy to increase muscle strength in the area of the injured part. This is important because in certain conditions where there is immobilization of the

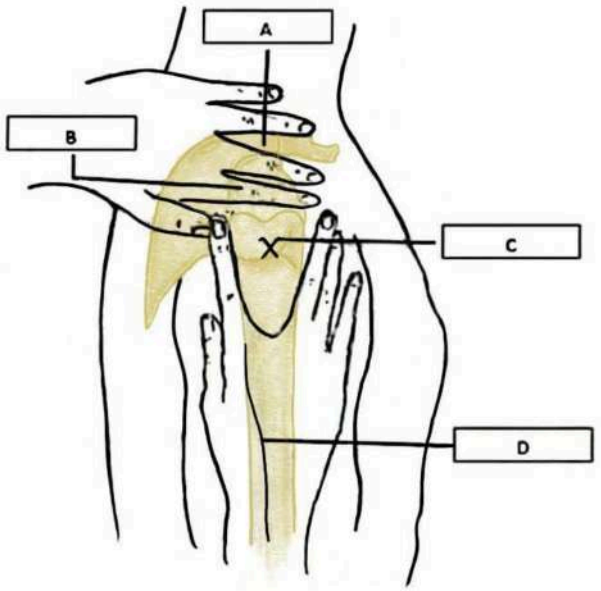

Figure 1. Injection Technique to the Deltoid Muscle **a**. Acromion, **b.** Bursa, **c.** Axillary nerve, **d.** Radial nerve

shoulder, it can lead to muscle atrophy and a frozen shoulder, which involves stiffness and pain in the shoulder joint.[2] In the case report conducted by Mackenzie LJ et al, the physiotherapy exercises carried out, including practicing flexion, external rotation, and abduction movements, were proven to reduce the pain scale and improve the range of movement.[29] several other pharmacological drugs can be given, such as topical diclofenac ointment and serratiopeptidase tablets. Sukhija S, et al. reported that the application of diclofenac ointment 3–4 times a day for 8–10 days was proven to reduce the local tenderness. In addition, if there is damage to the joint, surgery can be carried out in the form of reconstruction.[28] Arthrographic distension was also performed and showed significant results in the form of pain relief and increased range of movement. Recovery can take several weeks to several months, depending on each individual and how the therapy is carried out.[30]

Prevention

SIRVA is a condition that can be prevented if the vaccine is administered according to a predetermined protocol. This can be supported by the ability to understand the anatomy of the shoulder which includes the deltoid muscle, axillary and radial nerves, bursa, and acromion. Not only that, it is also necessary to understand the appropriate injection technique so that it is not too deep or too shallow on the skin.[3]

Several things that medical personnel need to pay attention to when injecting vaccines:

- Determine the injection zone in the deltoid muscle by determining the upper and lower limits of a safe injection site. The upper limit is determined by placing 2-3 fingers from the acromion. Two fingers are used for medical personnel who have larger fingers, while three fingers are used for those who have slimmer or smaller fingers. Meanwhile, the lower limit of this safe zone is the axilla. When you want to inject, the thumb and forefinger form a V-shape to keep the injection zone visible (Figure 1).[3]
- The appropriate shooting angle on the deltoid muscle is an angle of 90°.[3]
- The specific needle length is selected based on the patient's body shape and weight. A needle that is too long can penetrate the deltoid muscle and reach the bone. This can cause the vaccine not to be completely absorbed. On the other hand, if the needle is too short, the vaccine will be administered subcutaneously, resulting in the possibility of developing nodules or cellulitis.[3]

The following are CDC recommendations regarding appropriate needle sizes for vaccination. In addition, clinical judgment should be used when selecting needles.[31]

Table 2. Needle Length for Intramuscular Injections in Deltoid Muscle by Age

Age	Needle Gauge	Needle Length (mm)	Colors
Toddlers, 1-2 years	22-25	16-25	Blue, Purple, Orange
Children, 3-10 years	22-25	16-25	Blue, Purple, Orange
Children, 11-18 years	22-25	16-25	Blue, Purple, Orange
Adults, 19 years and older			
– 60 kg (130 lbs) or less		25	Blue
– 60-70 kg (130-152 lbs)		25	Blue
– Men 70-118 kg (152-260 lbs)		25-38	Blue, Black
– Women 70-90 kg (152-200 lbs)		25-38	Blue, Black
– Men 118 kg (260 lbs) or more		38	Black
– Women 90 kg (200 lbs) or more		38	Black

In patients with a history of chronic shoulder pathologies, it is essential to take extra precautions to minimize the risk of exacerbating the existing condition or causing SIRVA. In such cases, contraindications for administering injections in the shoulder area should be carefully considered. Exploring alternative sites like the ventrogluteal area for intramuscular injections may be beneficial, aiming to decrease potential discomfort and mitigate the risk of aggravating symptoms related to the shoulder. The ventrogluteal region is preferred due to its substantial muscle mass. It is considered both safer and less painful, given its distance from the superior and inferior gluteal arteries, as well as the sciatic and superior gluteal nerves.[32] This site is also suitable for all ages including infants since the muscle

in the ventrogluteal site is sufficiently developed, even in infants aged 1 to 12 months. Particularly, in children aged 12 to 36 months, the ventrogluteal site exhibits greater thickness compared to the anterolateral site.[33]

Conclusion

Shoulder Injury Related to Vaccine Administration (SIRVA) is a general term used to describe the occurrence of shoulder pain and restricted range of motion within 48 hours following vaccination. With mass vaccination due to the COVID-19 pandemic, its incidence is expected to rise. As of now, there is no universally accepted standard for assessing SIRVA, but MRI is the preferred imaging modality for identifying abnormalities. NSAIDs serve as the initial pharmacological therapy, and if no improvement is seen, intra-articular corticosteroid injections may be administered. Additionally, physiotherapy is recommended to enhance muscle strength in the affected area. Preventing SIRVA involves a comprehensive understanding of shoulder anatomy and the application of correct injection techniques.

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