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X Ray in Minor Orthopedic Injuries: Is A Must or There Is Something Else to Trust

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ABSTRACT

***Background and objectives**. The management of minor orthopedic injuries is a routine work at accident & emergency departments, and although many patients undergo radiography. This study aimed to find the best screening test for a fracture in all minor orthopedic injuries with different anatomical sites. **Methods**. The study is a cross-sectional study. The sample was collected randomly from causality room of accident and emergency department from April to September 2006 in Abo Saleem trauma hospital; Sample size was 1000 minor orthopedic injuries with variable sex and limited age from 5-55-year ages. The data was plotted in two software programs SSPS version 10 and MEDCALC version 11.3.3.0. **Results**. Our study found that bone tenderness alone is the most superior screening test for requesting radiographs with any patient had the minor orthopedic injury at knee, ankle, hand, forearm, and foot. Moreover, restriction of movement alone is the most superior screening test for requesting radiographs with any patient had the minor orthopedic injury at wrist and elbow. **Conclusion**. "Blunt trauma or a fall as a mechanism of injury plus either of the following: if there is bone tenderness at knee, ankle, foot, hand, and forearm, or there is a restriction of movement at elbow and wrist". This suggested decision rule for Radiography in all minor orthopedic injuries will reduce (28%) of radiographic requests from all minor orthopedic injuries without missing significant fracture.*

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INTRODUCTION

The primary care physicians often are required to evaluate patients who present with acute skeletal trauma. "Regardless of the experience of the treating physician, accurate detection and evaluation of musculoskeletal trauma is a challenge" [1].

"Plain radiographs remain pivotal in the initial assessment of patients with a suspected fracture or dislocation" [1]. The radiologic studies overuse has become a significant economic problem in the United States [2-4]. Although radiographs are relatively inexpensive, high volume of a low-cost test has the same overall financial impact as low volume of a high-cost procedure [4-6].

There are a lot of trials for attempting judicious use of radiography, but also as a warning to avoid overzealous cost-containment strategies that would reduce x-ray usage to below a safe threshold [7].

This triggers us to develop a new rule for requesting x ray in minor orthopedic injuries. In our practice; there

is no clear guidelines to manage these cases, especially at requesting x-ray to look for the fracture.

Most doctors are considering that if there is any clinical suspicion of a fracture present, they have the right to request x ray. The problem is that suspicion as a term is vague, subjective and variable, so we need a clinical tool to be more specific, objective and constant. From that, we need to find a good screening tool for requesting X-rays in minor orthopedic injuries, which should be more reliable, objective, reproducible, cheap, not consuming time and more convenient to both the patient and the doctor.

Therefore, the current study aimed to find the frequency of the fracture and different anatomical sites' distribution that are affected by minor orthopedic injuries, to know the rate of x-ray of Abo Saleem trauma hospital in minor orthopedic injuries, to find the best screening test for a fracture in all minor orthopedic injuries with different anatomical sites.

METHODS

The study is a cross-sectional study. The sample was collected randomly from causality room of accident and emergency department from April to September 2006 in the Abo Saleem trauma hospital. The sample size was 1000 minor orthopedic injuries with variable sex and limited age from 5-55-year ages. Analysis: The data was plotted in two software programs "SSPS version 10, MEDCALC version 11.3.3.0," comparison of the variable is made by looking to the sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, negative likelihood ratio, and x ray load reduction. The statistic performed by chi-square test; all are considered significant at P value < 0.001.

RESULTS AND DISCUSSION

The frequency of the fracture in minor orthopedic injuries at the Abo Saleem trauma hospital is (22.5%). The wrist has a higher rate of fracture, which is (34.6%); followed by hand is (32%); elbow is (24.5%), foot is (18.5%); ankle is (10%); knee is (7.5%). The frequency of the radiographic requests in minor orthopedic injuries at the Abo Saleem trauma hospital was (66.9%). The distribution of the radiographic requests in different anatomical sites had the same distribution of the fracture in different anatomical sites.

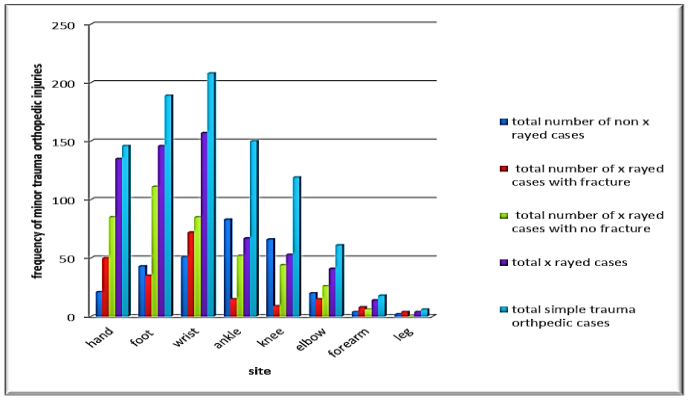

Figure 1 Distribution between non-X rayed and x rayed with or without fracture in different anatomical sites.

Numerous studies had done in knee, ankle and elbow to reduce x-ray rate for economic purpose, but as we notice that the higher rate of x-ray in our study was in wrist, foot and hand respectively. Ankle, knee and elbow had lower rate of x-ray. From that, we need to reduce the x-ray load in all minor trauma orthopedic injuries and not only concern on ankle, knee and elbow as the studies in the past concern on, and why we not find a screening test for all minor trauma orthopedic injuries to reduce the x-ray load. In those studies, the reasons to find screening test in the knee and ankle is that the rate of fracture in these cases is low that make the screening test is logistic as cost effective. But we believe even if the rate of fracture is little high does not mean we cannot try to find screening test that helps to reduce the x- ray load.

Furthermore, we need to know if there is a difference in the best screening test in different anatomical sites. The ankle injury is one of the most common

musculoskeletal injuries in athletes and sedentary persons; 20% of all sport injuries in The United States [8]. All ankle injuries evaluated in emergency department only 15% have fracture [9-14]. But our study shows only 10% of ankle injuries had been fractured. Radiography in children and adult can be reduced by Ottawa ankle & foot rule; this rule correctly ruled out fracture without using radiography in 299 out of 300 [8]. Our study in acute ankle injuries shows that both doctor certainty and bone tenderness have same sensitivity (100%), negative predictive value (100%), reduction of x-ray load (70%), and reduce the radiographic request by (33%) with no statistically significant difference in both.

Table 2 The results of different screening tests of fracture at the ankle.

value of the ankle	Doctor certainty	swelling	Bone tenderness	Restriction of movement
sensitivity	100%	86.7%	100%	60%
specificity	56.6%	9.6%	40.38%	51.92%
Positive predictive value	53.6%	21.7%	32.6%	26.47%
Negative predictive value	100%	71.4%	100%	81.81%
Likelihood ratio	2.30	0.95	1.67	1.25
X ray load reduction	70%	10.66%	70%	66%

Ottawa Ankle and Foot Rules

Ankle radiography is indicated only if a patient has pain in the malleolar zone and any of the following findings: bone tenderness at A or B or the inability to bear weight (four steps) immediately after injury and in the emergency department or physician's office [8].

Foot radiography is indicated only if a patient has pain in the midfoot zone and any of the following findings: bone tenderness at C or D or the inability to bear weight (four steps) immediately after injury and in the emergency department or physician's office [8].

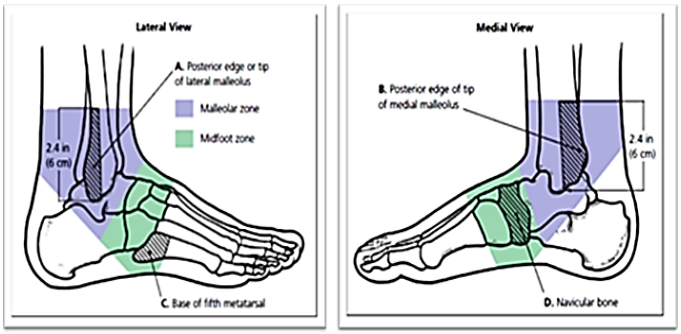

Figure 5 Ottawa ankle and foot rules.

The Ottawa Ankle and Foot Rules were established and serve as reliable guidelines to determine when an ankle or foot series is warranted in patients who have sustained minor ankle and/or foot injury [15]. The Ottawa ankle & foot rules as an accurate test for excluding fractures of the ankle and mid-foot, these studies show the test has a sensitivity of almost (100%) & reduce unnecessary X ray load by 30-40% [16].

Our study, Acute foot injuries shows that swelling, bone tenderness & restriction of movement have same sensitivity (100%), negative predictive value (100%); but bone tenderness has highest reduction x-ray load (42.85%), reduce the radiographic request by (25.7%) & specificity (47.74%). Both bone tenderness & doctor certainty show statistical significance as the screening test for requesting x-rays in acute foot injuries and there is no statistically significant difference in between.

Table 3 The results of different screening tests of fracture at the foot.

Clinical tool of the foot	Doctor certainty	Swelling	Bone tenderness	Restriction of movement
sensitivity	82.85%	100%	100%	100%
specificity	40%	17.11%	47.74%	31.53%
Positive predictive value	32.58%	27.55%	26.88%	31.53%
Negative predictive value	86.97%	100%	100%	100%
Likelihood ratio	1.38	1.2	1.91	1.46
X ray load reduction	28.57%	18.51%	42.85%	37.03%

Acute knee injuries are responsible for about 1.3 million visits to the emergency department in USA [17]. Only (6%) of acute knee injuries had fracture [17]. There is thought that emergency physicians can be usually discriminate clinically between fracture and non-fracture in acute knee injuries, but they were requesting x-ray for most the patients [18-20].

Pittsburgh decision rules

Blunt trauma or a fall as the mechanism of injury plus either of the following:

1-Age is younger than 12 years or older than 50 years.

2- Inability to walk four weight-bearing steps in the emergency department.

The Pittsburgh rule has sensitivity (99%), reduce the x-ray load by (52%), negative predictive value is (99.8%), and positive predictive value is (24.1%) [21].

Ottawa's knee rules

1-Age is 55 years or older.

2-Tenderness is at the head of a fibula.

3-Isolated tenderness is at a patella.

4-Inability to flex knee to 90 degrees

5-Inability to walk four weight-bearing steps immediately after the injury and in the emergency department

The Ottawa knee rule is a clinical decision aid that helps rule out fractures and avoid unnecessary radiography [22]. Ottawa's rules allowed decreasing the number of x-ray studies performed after a knee trauma by 35%, with sensitivity for knee fracture detection of 100 % [23]. In addition, Ottawa's knee rules in adult over 12 years have sensitivity (97%), reduce x-ray load by (23%), negative predictive value (98.5%) and positive predictive value (14.8%) [21]. On other hand, Ottawa's knee rules in children older than five years have sensitivity (100%), reduce X ray load by (38.7%) and specificity (42.8%) [24]. Furthermore, by properly applying the Pittsburgh rule, approximately 30% fewer radiographs could have been ordered without missing any fractures [25].

Our study shows Only (7.5%) of acute knee injuries has fracture and shows that doctor certainty, bone tenderness and restriction of movement have same sensitivity (100%) and negative predictive value (100%) with superiority to bone tenderness in reducing x-ray load by (74.78%), reduce the radiographic request by (43.95%), and specificity (59.1%). Both doctor certainty and bone tenderness show statistical significance for requesting x-ray to exclude fracture with no clear statistically difference in between.

Table 4 The results of different screening tests of fracture at the knee.

Clinical tool of the knee	Doctor certainty	swelling	Bone tenderness	Restriction of movement
sensitivity	100%	44.44%	100%	100%
specificity	64.3%	11.36%	59.09%	45.45%
Positive predictive value	47.36%	9.3%	33.33%	27.27%
Negative predictive value	100%	50%	100%	100%
Likelihood ratio	2.80	0.5	2.44	1.83
X ray load reduction	68.9%	35.29%	74.78%	52.1%

At 2002 Docherty and colleagues study the elbow injuries to find the best screening test for requesting x-ray; they found that the ability of elbow extension test to screen for clinically significant injury requesting radiograph. The sensitivity of the test is (97%), negative predictive value is (98%), positive predictive value is (63%), specificity is (69%) and reduce x-ray load by (50%) [26]. Our study in acute elbow injuries shows that swelling, bone tenderness and restriction of movement have same sensitivity (100%) & negative

predictive value (100%), but only restriction of movement show statistical significance as the screening test for requesting X-rays in acute elbow injury and there is no clear difference between restriction of movement and doctor certainty, bone tenderness, and swelling. The restriction of movement specificity is (53.84%), positive predictive value is (55.56) and reduces X- ray load by (50.81%), and reduce the radiographic request by (25.37%). The restriction of movement shows superiority as the screening test for requesting X-rays in acute elbow injuries.

Table 5 The results of different screening tests of fracture at the elbow.

Clinical tool of the elbow	**Doctor certainty**	**swelling**	**Bone tenderness**	**Restriction of movement**
sensitivity	66.7%	100%	100%	100%
specificity	39.1%	53.84%	26.92%	53.84%
Positive predictive value	41.67%	55.56%	44.11%	55.56%
Negative predictive value	64.3%	100%	100%	100%
Likelihood ratio	1.09	2.16	1.36	2.16
X ray load reduction	60.65%	27.86%	26.22%	50.81 %

Our study in acute wrist injuries shows that both bone tenderness and restriction of movement have same sensitivity (91.66%) with superiority to a restriction of movement at negative predictive value (84.21%), positive predictive value (55.46%) and reducing X ray load by (40.38%), and reduce the radiographic request by (20%). Doctor certainty, bone tenderness, and restriction of movement show statistical significance for requesting x-ray to exclude fracture with no clear statistical difference between each other but all the three-show clear statistical difference between swelling and each of them.

Our study in acute forearm injuries shows that swelling, and bone tenderness has same sensitivity (100%) and negative predictive value (100%) with superiority to bone tenderness in reducing X ray load (44.44%), reduce the radiographic request by (14.5%), and positive predictive value (66.67%). Both bone tenderness & doctor certainty show statistical significance as the screening test for requesting x-rays in acute forearm injuries with no clear statistically significant difference in between.

Table 6 The results of different screening tests of fracture at the wrist.

Clinical tool of the wrist	Doctor certainty	swelling	Bone tenderness	Restriction of movement
sensitivity	84.72%	86.11%	91.66%	91.66%
specificity	44.45%	21.17%	30.58%	37.64%
Positive predictive value	60.39%	48.06%	52.8%	55.46%
Negative predictive value	74.41%	64.28%	81.25%	84.21%
Likelihood ratio	1.52	1.09	1.32	1.47
X ray load reduction	30.76%	25%	38.94%	40.38%

Table 7 The results of different screening tests of fracture at the forearm

Clinical tool of the forearm	Doctor certainty	Swelling	Bone tenderness	Restriction of movement
sensitivity	75%	100%	100%	75%
specificity	66.67%	66.67%	33.33%	33.33%
Positive predictive value	75%	80%	66.67%	60%
Negative predictive value	66.67%	100%	100%	50%
Likelihood ratio	2.25	3	1.5	1.12
X ray load reduction	22.22%	33.33%	44.44%	44.44%

Our study in acute hand injuries shows that bone tenderness has highest sensitivity (100%), negative predictive value (100%), positive predictive value (45.21%); the bone tenderness is reducing x ray load

by (27.27%), and reduce the radiographic request by (20%). Both bone tenderness & doctor certainty show statistical significance as the screening test for requesting x-rays in acute hand injuries with no clear statistically significant difference in between.

Table 8 The results of different screening tests of fracture at the hand.

Clinical tool of the hand	Doctor certainty	Swelling	Bone tenderness	Restriction of movement
sensitivity	84.6%	96.15%	100%	80.76%
specificity	38.6%	22.72%	28.41%	25%
Positive predictive value	44.9%	42.3%	45.21%	38.88%
Negative predictive value	80.95%	90.9%	100%	68.75%
Likelihood ratio	1.37	1.24	1.39	1.07
X ray load reduction	15.15%	18.18%	27.27%	30.3%

All studies which had done before are concentrating on simple ideas, which make the possibility of the fracture increases if present, and make the doctors request x-ray. These ideas like age of the patients, bone tenderness, and restriction of movement. For example, Ottawa rules in the knee; ankle and mid-foot are concentrating on the three ideas which mentioned above; Pittsburgh rule concentrates on age of the patients and restriction of movement in the knee; Docherty and colleague concentrate on restriction of movement in the elbow only. In our study, we are concentrating on the same ideas in addition to the swelling and the doctor certainty but not only in the specific anatomical site like other studies did. However, we concentrate to find the screening test for the fracture in order to request X ray in different anatomical sites. Our study shows that bone tenderness considered competitive with superiority as the screening test for requesting X-rays in acute ankle, knee, foot, forearm, and hand injuries. In comparison to acute wrist and elbow injuries, the study shows restriction of movement is considered competitive with superiority as the screening test for requesting x rays. If we are using these rules in all cases of minor trauma orthopedic injuries at age of 5 to be 55 years old, we will be reducing X ray load by (48.72%) and reducing X ray request by (28%).

CONCLUSION

Blunt trauma or a fall as a mechanism of injury plus either of the following: if there is bone tenderness at knee, ankle, foot, hand, and forearm, or there is a restriction of movement at elbow and wrist. This suggested decision rule for Radiography in all minor orthopedic injuries will reduce (28%) of radiographic requests from all minor orthopedic injuries without missing significant fracture. However, also this rule reduces the radiographic request by (20%) in acute hand and wrist injuries, (25.37%) in acute elbow injuries, (25.7%) in acute foot injuries, (14.5%) in acute forearm injuries, (33%) in acute ankle injuries, (43.95%) in acute knee injuries without missing significant fracture. If a general practitioner applies this suggested decision rule in all minor orthopedic injuries, it will reduce the x ray load and the referral load to the hospital by more than (48%) without missing significant fracture.

Recommendations

For general practitioners at primary health care: The general practitioner can apply this suggested decision rule in all minor orthopedic injuries to reduce the X ray load and the referral load to the hospital. At the end, we need more studies in this field to confirm the results which we had got.

Conflict of Interest

The authors declare no conflict of interest.

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