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Brief Report

Can physician and patient gestalt lead to a shared decision to reduce unnecessary radiography in extremity trauma?☆,☆☆,★

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1. Introduction

Minor musculoskeletal injury is one of the most common presentations to the emergency department (ED). The majority (85%-90%) of those presenting for minor injury do not have a fracture [1], and presumably, many others never seek medical attention. The need to image patients with obvious signs of fracture is never in question—but it is much less clear who needs imaging when those signs are absent. This leads to considerable practice variability[1] and, in the United States, is complicated further by the need to address patient satisfaction. The notion that patients might help risk-stratify their own case in the setting of trauma by answering the question "do you think you have anything broken?" has not been formally investigated.

Querying the patient about their perception of the severity of their injury can lead to shared decision making (SDM) regarding the need for imaging and might reduce unnecessary imaging by simplifying the process for physicians and for triage nurses in departments with triage protocols. This investigation was designed to explore the utility of using both the patient's perception of the severity of their injury and the provider's perception of that severity, to help decide whether to obtain imaging. Specifically, we hypothesized that when the patient felt they did not have a fracture or the provider predicted "<10%" likelihood, that the incidence of fracture would be extremely low.

2. Methods

This was a prospective, observational study. It was approved by the hospital's institutional review board, and written informed consent was obtained from all subjects. The study was conducted from November 2011 to January 2015 at a single inner city regional trauma center with 70 000 annual visits. The criteria for inclusion were age 18 years or older, radiograph ordered for blunt extremity injury, English speaking, and time elapsed since injury less than 4 weeks. Patients were excluded if they had (1) clinically obvious fracture (eg, open fracture, "anatomically incorrect" deformity); (2) arrival via emergency medical services transport; (3) nontraumatic pain or chronic pain; (4) injury to the torso; (5) provider concern for foreign body; or (6) if the patient was a victim of an assault (as required by our institutional review board).

2.1. Study protocol

All patients presenting with isolated extremity injury underwent routine triage by a nurse and evaluation by an ED physician or midlevel provider. The triage process did not include imaging ordered by nurses. The treating provider's imaging order was placed before enrollment in the study based solely on their existing practice. Once the imaging order was placed, a radiology (skeleton) icon appeared on the Cerner Compass FirstNet departmental tracking board. Research associates prescreened subjects by chief complaint on the tracking board and approached them once the icon appeared. After eligibility screening, subjects were enrolled once they gave consent. Research associates administered the questionnaire to consenting subjects and placed completed questionnaires in a private area for collection. Availability of research associate staffing determined the enrollment periods, which included all 7 days of the week from 7:00 AM to midnight. Subjects were queried regarding pretest probability after imaging was ordered, but before it was obtained.

Providers estimating pretest probability were attending physician faculty or experienced midlevel providers who were caring for the patient. Providers were queried regarding their pretest probability after patient examination and placement of the order, but before results were known. The multiple-choice data collection form (Appendix A) included mechanism of injury, location of injury, time elapsed since injury, and patient and provider pretest estimation of the likelihood of fracture or dislocation:

5) Patient: Do you think you have any bones broken or joints dislocated? (circle only one)

   a) Yes, definitely
   b) Probably: more likely than not
   c) Probably not
   d) Definitely not

☆ Author contributions: MM originated the concept and initial study design, supervised database management, and wrote the manuscript. TVB assisted with institutional review board submission, recruitment and supervision of research associates, and database management. LB assisted with statistical methodology and analysis and editorial review of the manuscript.

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[1] In our group of 38 physicians, the plain films ordered for the calendar year 2010 varied 300% from a low of 0.33 films per patient, to a high of 0.91 films per patient. The average utilization was 0.57 films per patient, and the SD was 0.13.

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ED Physician: pretest probability for fracture or dislocation:

a) Low (<10%)
b) Moderate (10%-50%)
c) High (>50%)
d) Certain

Subject questionnaires were matched with their radiology reports. Reponses were coded as positive if a fracture or dislocation was noted. Soft tissue findings and joint effusions were not considered positive.

The primary outcome was determination of the sensitivity and negative predictive value (NPV) of both physician and patient prediction of no abnormality. We anticipated that physician preimaging estimation of the likelihood of fracture being less than 10% would have sensitivity and NPV of 95% and determined that a sample of 80 subjects would allow the calculation of a 95% confidence interval with lower limit of the confidence interval of 90%. We estimated that physicians would assess the likelihood of fracture as less than 10% in approximately 40% of the subjects enrolled in the study (Fig. 1). Thus, a total sample size of 200 subjects was planned ($40\% \times 200 = 80$).

A secondary outcome was the clinical significance of any "missed" bony injuries, as assessed by a panel of 4 actively practicing physicians (2 orthopedists and 2 emergency physicians).

3. Results

We enrolled 213 consenting patients with 219 injuries. Seven patients were inappropriately enrolled after arriving by emergency medical services, 7 had torso injuries, and 4 had incomplete questionnaires. Of the remaining 195 patients with 201 injuries, 4 had multiple injuries, and it was unclear to which injury the data applied. These cases were excluded. The final data set included 191 patients with 195 distinct injuries. Most (67.7%) of the subjects presented within 24 hours of injury, with presentation times from 30 minutes to 28 days (median, 22 hours). There were 45.6% upper extremity and 54.4% lower extremity injuries. Table 1 shows characteristics of study subjects (see Fig. 2).

Fifty-four (27.7%) of the injuries had positive radiographic findings (Figs. 3-7). There were 51 fractures and 3 finger dislocations. Median pain scale did not differ significantly for patients with and without positive radiographic findings (7.5 vs 7.0; $P = .070$). In cases where treating providers estimated a fracture risk of less than 10%, there were 6% with fracture. This comprised 45% of patients who underwent imaging. No case in which the patient predicted "definitely not" ($n = 14$) had a fracture or bony injury, for a sensitivity of 100% and an NPV of 100%. Table 2 shows test characteristics of provider and patient predictions of bony injury.

Table 1
Characteristics of included cases

Characteristic	n (range)
Age	32 (25-46)
Pain scale (1-10), median (IQR)	7 (6-9)
Delay to presentation (h), median (IQR)	22 (3-48)
Presentation on day 1, n (%)	132 (67.7)
ED visits last 12 mo, median (IQR)	1 (1-2)
Mechanism of injury	
Fall from standing, n (%)	49 (25.1)
Fall 2′ to 8′, n (%)	20 (10.3)
Fall onto hands, n (%)	11 (5.6)
Motor vehicle crash, n (%)	18 (9.2)
Bicycle/skateboard, n (%)	14 (7.2)
Direct blow/crush, n (%)	22 (11.3)
Sports, n (%)	12 (6.2)
Other, n (%)	49 (25.1)
Upper extremity injuries, n (%)	89 (45.6)
Shoulder, n (%)	11 (5.6)
Upper arm, n (%)	1 (0.5)
Elbow, n (%)	5 (2.6)
Forearm, n (%)	5 (2.6)
Wrist/hand, n (%)	67 (34.4)
Lower extremity injuries, n (%)	106 (54.4)
Hip, n (%)	2 (1.0)
Thigh, n (%)	2 (1.0)
Knee, n (%)	29 (14.9)
Lower leg, n (%)	2 (1.0)
Ankle/foot, n (%)	71 (36.4)

Abbreviation: IQR, interquartile range.

4. Discussion

4.1. Factors influencing the imaging decision

In the United States, when a patient presents with a minor mechanism and minimal clinical findings, multiple factors influence the decision whether to obtain imaging: (1) desire to meet patient expectations; (2) lack of established bond of trust with the ED physician; (3) fear of litigation; (4) engrained habit; (5) the relatively low-cost, noninvasive nature of plain radiography; (6) reimbursement incentive; and (7) use of existing decision rules. The desire to meet expectations and avoid a missed finding undoubtedly plays prominent roles in this decision. In the United States, the low threshold for obtaining imaging in extremity trauma presents opportunity for significant cost savings—the "less than 10%" physician pretest probability group comprised 45% of the radiographs obtained in this cohort.

4.2. Existing clinical decision aids for radiography

A number of clinical decision rules, clinical decision instruments, and clinical prediction instruments for skeletal radiography exist [2-6], but

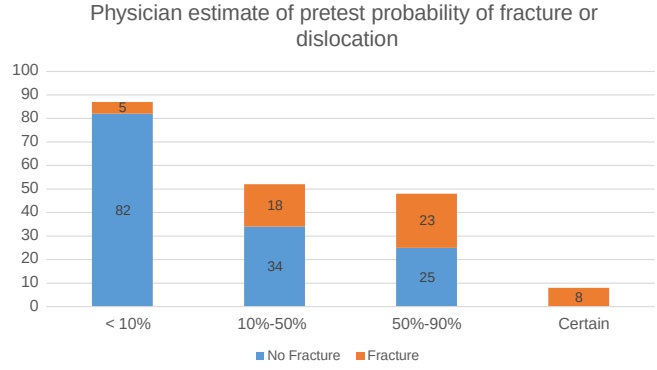

Fig. 1. Physician pretest probability estimate.

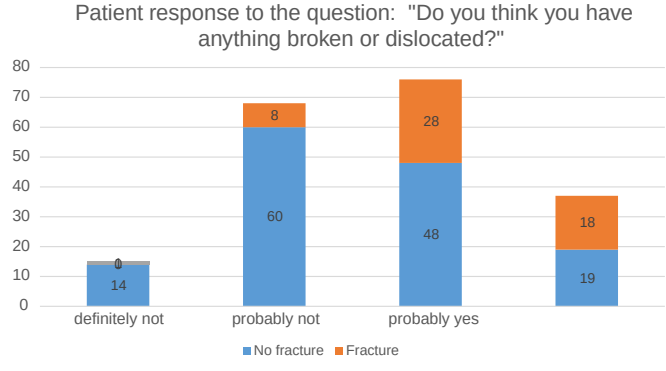

Fig. 2. Patient estimate of pretest probability.