Review of Lodox Statscan in the detection of peripheral skeletal fractures in multiple injury patients

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ABSTRACT

Introduction: As part of the primary survey, polytrauma patients in our emergency department are examined using the new ‘Lodox Statscan’ (LS) digital low-radiation imaging device. The LS provides full-body anterior and lateral views based on enhanced linear slot-scanning technology, in accordance with the recommended Advanced Trauma Life Support (ATLS) Guidelines. This study’s objectives were to establish whether LS appropriately rules out peripheral bone injuries and to examine whether LS imaging provides adequate information for the preoperative planning of such lesions.

Methods: A total of 245 consecutive polytrauma patients aged 16 years or more undergoing LS imaging were included in this retrospective chart analysis. The results of the LS scans were reviewed and compared to additional plain radiographs or computed tomography scans, whenever further radiological imaging was required to determine consecutive therapy.

Results: The sensitivity and specificity of the LS scans were 73% and 100%, respectively, for peripheral skeletal injuries. Additional plain radiographs were performed in 50% of cases for (1) superior focussing and more precise resolution of the affected part of the body, (2) additional second or third plane, (3) additional information about fracture type and planning of the surgical approach and (4) for preoperative planning of implant size and positioning on calibrated digitised films, <1% because of the low quality of the LS scan and <1% because the fracture zone had not been fully captured.

Conclusion: The study demonstrates that despite LS’s high sensitivity and specificity in the detection of peripheral skeletal injuries, additional radiological imaging for diagnostic or preoperative reasons was required. Our results imply that LS, although efficient for patient screening in the emergency room, cannot always rule out peripheral skeletal injuries.

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Lodox Statscan’s (LS; Statscan Critical Imaging System, Lodox Systems [Pty] Ltd, Johannesburg, South Africa) use in the management of polytrauma patients in emergency departments as part of the primary survey complies with the recommendations of the 7th edition of the Advanced Trauma Life Support (ATLS) Guidelines (2004) and has been evaluated in previous studies.2–4,6,8 The device provides a full-body anterior and lateral view based on enhanced linear slot-scanning technology in as little as 6.5 min for a full-body scan and uses about 10% of the mean conventional radiation dose.2,3,6 In 2009, our group proposed the Bernese modified ATLS protocol, using LS as a replacement for the time-consuming basic ATLS X-ray protocol, aiming to reduce radiography time before starting the secondary survey.5 This study’s objectives were to establish whether LS appropriately detects peripheral bone injuries in severely injured patients, to review the reasons for additional radiological imaging after initial LS screening and to examine whether LS images provide adequate information for proper preoperative planning of the above-mentioned injuries. Our hypothesis was that full-body radiography is an adequate tool for the detection of all important peripheral bone injuries, obviating the need for additional plain radiographs to assist with management in the majority of cases.

Patients and methods

Consecutive charts of 245 consecutive polytrauma patients aged 16 years or more (Injury Severity Score (ISS) >16), who underwent LS imaging in our emergency department, a European
level I trauma centre, were retrospectively analysed. Patient demographics and injury data were abstracted from our electronic trauma registry.4

The radiological objective consisted of the preliminary diagnostic summary concerning peripheral osseous injuries, recorded electronically by the attending emergency physician (unit policy) and the definitive diagnosis of the attending radiologist. The results of LS images were reviewed and compared with additional radiological imaging (plain radiographs, computed tomography (CT)) performed to assist with further management of bone injuries. Additional plain radiographs (Philips Optimus-Bucky-diagnostic, Hamburg, Germany) were done when requested by the attending physician or the orthopaedic surgeon. CT scans using a 16-slice multidetector row-CT system (Sensation 16, Siemens, Forchheim, Germany) were performed when indicated, for intra-articular and comminuted fractures. We recorded each case where the diagnostic protocol was altered resulting in additional X-rays and compared the clinical impact of the two modalities.

Statistical analysis of sensitivity, specificity and positive and negative predictive value (PPV and NPV) of LS versus further radiography (conventional X-ray or CT) was performed by a consultant statistician, including 95% confidence intervals for all calculations.

Results

A mean ISS of 20 (range 16–86) was calculated for our 245 consecutive trauma patients (172 men and 73 women) aged between 16 and 93 years (mean 44.5 years).5

Peripheral bone injuries

Limbs (excluding hands and feet)

Forty-two patients showed injuries of the shoulder girdle. LS demonstrated 72% sensitivity and 100% specificity in the detection of shoulder lesions (Table 1). Most missed fractures were nonsurgically treated lesions of the scapula or non-dislocated fractured clavicles. Ten patients (24%) required surgical stabilisation.

Ten patients with distal humerus and 14 with radius and ulna fractures were ruled out. The device detected with 90% sensitivity and 100% specificity distal humerus fractures (Table 1). On the other hand, for forearm fractures (radius and ulnar shaft fractures as well as distal radius and ulnar fractures), the sensitivity dropped to 64%, while specificity was 100% (Table 1). Nineteen patients with distal humerus and forearm fractures (79%) required surgery.

Femur fractures occurred in 24 patients. Lodox demonstrated 88% sensitivity and 100% specificity in the detection of femoral fractures (Table 2). As many as 14 patients suffered tibia/fibula fractures. LS values for sensitivity and specificity dropped to 80% and 100%, respectively, for those fractures (Table 2). In general, for femoral and tibial/fibular fractures, surgical treatment was necessary in 33 patients (87%).

Hands and feet

Hand and foot fractures occurred in eight and nine patients, respectively. LS demonstrated 55% sensitivity and 100% specificity in the detection of hand fractures (Table 1). The values for sensitivity and specificity dropped to 45% and 100%, respectively, for foot fractures (Table 2). Seven patients (88%) with hand injuries and all nine patients (100%) with foot injuries required surgery.

An overall sensitivity and specificity of 81% and 100%, respectively, was reached for all fractures of the upper and lower limbs, excluding hands and feet. Including these last two topographical areas sensitivity dropped to 73%.

General additional radiological procedures

Limbs (excluding hands and feet)

A total of 15 (36%) of the 42 patients presenting injuries of the shoulder girdle underwent additional plain radiographs. Of the 24 patients with distal humerus, radius and ulnar fractures, additional plain radiographs were carried out in 17 (71%). In 25 (66%) of the 38 patients suffering from femoral and tibia/fibula fractures, additional plain radiographs were performed.

Hands and feet

Of the 17 patients presenting hand and foot fractures (eight and nine patients, respectively), additional plain radiographs were performed in seven patients in each group (88% and 78%, respectively).

In general, for the 143 peripheral skeletal lesions detected, 121 additional radiological procedures were performed. Of those, 71 were additional plain radiographs and 50 were CT scans of the upper or lower limbs. No clinically relevant fractures were missed throughout this study.

Discussion

Our results demonstrated that Lodox detected upper and lower limb injuries with sensitivity and specificity of 73% and 100%,
respectively. Wei et al., in a systemic analysis of peripheral missed injuries in emergency radiology using conventional AP and lateral X-rays, reported an overall percentage of 3.7% for missed extremities fractures. A total of 23.1% of those injuries were radiographically imperceptible lesions of the foot (7.6%), elbow (6.0%), hand (5.4%) and wrist (4.1%).

In our study, we performed a Lodox AP total body scan for the detection of skeletal injuries. Although the performance of a single fast AP plane scan presented good results in detecting injuries of the long bones (81% sensitivity), detection of fractures of the small bones of the hand and foot was not so successful. One explanation might be the fact that the Swiss Electro Medical Systems (EMS) use vacuum mattresses instead of long spine boards on which alignment and positioning of a patient is much easier compared with the body-adapting mattresses.

Including these last two topographic areas, our findings have led to a drop of the sensitivity to 73%. The performance of a second localised lateral scan on these two regions can improve our sensitivity values with minimum time loss and radiation exposure. The most frequently missed skeletal injuries of the upper and lower limbs were lesions of the hands (45%) and feet (55%), such as carpal and tarsal bone fractures and distal forearm fractures (36%).

Similar results have been reported by other studies on missed injuries with conventional X-rays.

Additional plain radiographs were carried out for: (1) superior focussing and more precise resolution of the affected part of the body, (2) additional second or third plane, (3) additional information about fracture type and planning of the surgical approach and (4) for preoperative planning of implants and surgical approach.

Fig. 1. Anteroposterior Lodox scan of a polytrauma patient showing a left distal femur fracture and a left midshaft tibial fracture (a). Anteroposterior and lateral plain radiograph of the comminuted fracture of the distal femoral metaphysis with intra-articular extension of the fracture line (b) (AO Type 33 C2). This patient also had a CT of the knee (not shown) for superior estimation of the comminuted distal femur metaphysis and femoral condyles and for preoperative planning of implants and surgical approach. Anteroposterior and lateral plain radiograph of the tibial diaphyseal fracture (c) (AO Type 42 B2).

Table 3

<table>
<thead>
<tr>
<th>Anatomical region</th>
<th>Additional X-rays + CTs</th>
<th>Out of screen</th>
<th>Not seen</th>
<th>Bad quality</th>
<th>Superior focussing, additional plane, preoperative planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requested by</td>
<td>Attending emergency physician: 31%</td>
<td>Orthopaedic surgeon: 69%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder girdle</td>
<td>43</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>Humerus</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Forearm</td>
<td>17</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Hand</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Thigh</td>
<td>18</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Calf</td>
<td>12</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Foot</td>
<td>11</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>121 (100%)</td>
<td>8 (7%)</td>
<td>26 (&lt;22%)</td>
<td>3 (&lt;3%)</td>
<td>84 (69%)</td>
</tr>
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plain radiographs: preoperative planning of implant size and positioning, comparison of preoperative dislocation and postoperative reduction and three-dimensional appraisal of specific features of fractures. In diaphyseal fractures of the upper and lower limbs, digitised plain radiographs allow measurement of the bone's intramedullary diameter for nail sizing and measurement of the length of broken and intact bone for plate sizing and positioning. It is very likely that CT imaging reduced the number of additional plain radiographs as many clinically suspected fractures were ruled out, or were detected but did not require additional plain radiographs. As a beneficial effect of CT imaging, early CT scans other than head, thorax, abdomen and pelvis may be taken in haemodynamically stable patients that is, for intra-articular fractures.

Limitations

The performance of conventional imaging according to established clinical criteria (plain radiography and CT as current gold standards) plus Lodox scanning on all patients would have been a more appropriate methodology. However, our concern has been that, since Lodox represents a Food and Drug Administration (FDA)-approved and established diagnostic device, the comparison of Lodox versus conventional radiographs would have been difficult because our ethical committee would not have allowed both imaging techniques in the same patient.

Conclusion

The new ‘Lodox Statscan’ (LS) digital low-radiation imaging device is a valuable adjunct in the emergency department that allows rapid detection of bone injuries in polytrauma patients, significantly reducing the median whole-body scanning time and the overall radiation dose. Additional radiological imaging for peripheral skeletal injuries was required in 50% of cases reviewed. Only 31% of additional X-rays were requested by the emergency medicine physician. In 69% of the cases, additional imaging was requested by the orthopaedic surgeon on duty. The number of additional radiographs would probably be greater if our patients had not performed routine CT scans for intra-articular and comminuted fractures.

Our results for peripheral skeletal injuries demonstrate that LS, although extremely useful as a diagnostic tool in the emergency department, was not as effective as in spinal, truncal and pelvic injuries. Lodox should therefore be interpreted with caution when actual management decisions are made. Future engineering should anticipate this problem to further reduce extra imaging and radiation and to develop Lodox Statscan as a truly all-in-one diagnostic tool.

Conflict of interest statement

The authors declare that they have no conflict of interests.

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References


Fig. 2. (a) Anteroposterior Lodox scan of a polytrauma patient. The right upper limb as well as the left upper limb distally to the level of the elbow is not included in Lodox's picture. Apart from the obvious left distal femoral (AO Type 33 C3) and tibial fractures (AO Type 43 C3), a possible dislocation of the left elbow joint can be suspected due to the peculiar alignment of the humerus with the proximal ulna. (b) Lateral digital X-ray demonstrating left elbow dislocation. (c) Anteroposterior X-ray demonstrating fractures of IIIrd, IVth and Vth metacarpal bones.


