



## Correspondence

### Lodox/Statscan provides benefits in evaluation of gunshot injuries

To the Editor,

Gunshot wounds may result in abdominal or extremity injuries, which have a high rate of mortality [1-8]. Multiple films may be needed to survey the injured sites and localize any residual bullet wounds. Therefore, emergency department (ED) physicians frequently face the challenge of deciding which films to take and how many films are needed because of the presence of multiple wounds and the unpredictable paths of projectiles.

Lodox/Statscan (LODOX™, Johannesburg, Republic of South Africa) is a digital x-ray machine that uses a whole-body scan in 1 integrated film. In our institution, it has been used since November 2007 as a tool for the primary survey of patients with multiple traumas [9]. In a prior case report, we demonstrated the advantages of Lodox/Statscan in evaluating a patient with multiple gunshot injuries [10]. The role of Lodox/Statscan in evaluating gunshot injuries was further investigated in this retrospective case series.

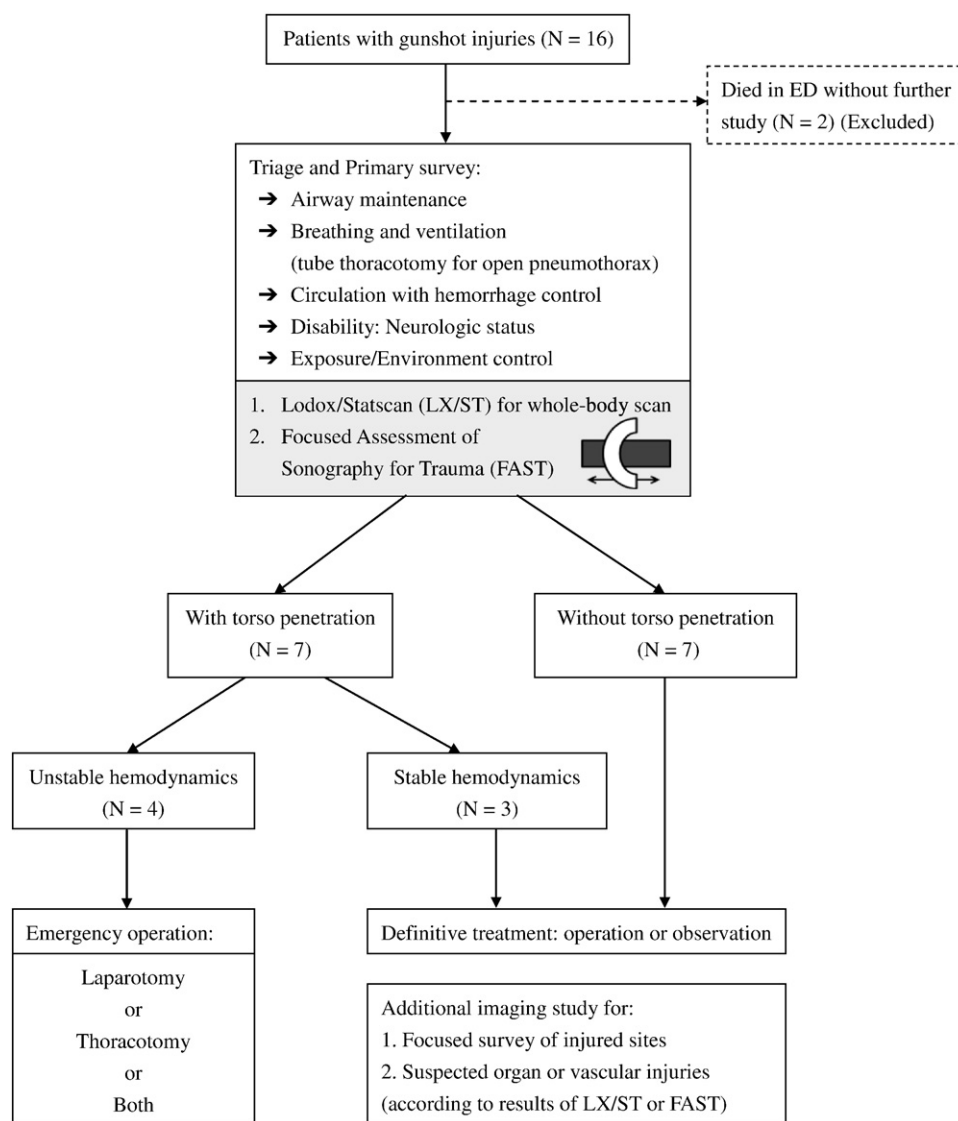
From November 2007 to June 2010, patients with multiple gunshot injuries were screened by the Lodox/Statscan routinely according to our study protocol (Fig. 1). The Lodox/Statscan was used as the primary survey and screening tool to evaluate multiple gunshot injury patients and to determine the necessity of additional imaging studies. Emergency operations (ie, thoracotomy, laparotomy, or both) were performed immediately after this whole-body scan without further imaging in patients with unstable hemodynamics. In contrast, in the hemodynamically stable patients, additional x-rays or computed tomographic scans were performed and focused on the injured sites based on the findings of the Lodox/Statscan.

During the 32-month study period, a total of 14 patients with gunshot injuries who received a Lodox/Statscan for screening were enrolled. The mean duration for the whole-body scan using the Lodox/Statscan was  $153.4 \pm 21.8$  seconds, including the time to integrate the images.

For patients with life-threatening abdominal gunshot injuries, emergency operations are usually required with no time for further imaging surveys [6,11]. Decisions about the patient's further treatment can be assessed in accordance with the results of this rapid whole-body scan. In patients with isolated chest gunshot wounds, the high-energy projectiles have been shown to penetrate through the diaphragm into the abdominal cavity, resulting in diaphragm or intra-abdominal organ injuries [5]. On the contrary, bullets may also penetrate the thoracic cavity from an abdominal wound. The advantage of using the Lodox/Statscan is clear under such situations because this technology scans the entire body and quickly provides the precise locations for bullets in the body.

The patients with unstable hemodynamics are listed in Table 1. The treatment plan for 3 of these 4 patients was altered after the Lodox/Statscan (cases 1, 2, and 3). In 1 of these 4 patients, who was shot by a shotgun (case 1, Fig. 2), there was only 1 open wound that existed over his anterior chest wall. An emergency thoracotomy was indicated because of the presence of massive hemothorax after chest tube placement. However, the integrated chest and abdominal images provided by the Lodox/Statscan revealed multiple projectiles in the thoracic and abdominal cavities. Hence, the treatment plan was changed from performing only a thoracotomy to performing an exploratory thoracotomy as well as a laparotomy to investigate possible diaphragmatic and intra-abdominal injuries. In this case, the Lodox/Statscan proved to be superior to conventional x-rays because it rapidly provided the surgeons with enough information to make critical decisions about the patient's treatment.

In contrast, the conventional trauma series x-ray only evaluates the critical torso injuries; however, it has been reported that most gunshot wounds are peripheral and musculoskeletal in location [12-14]. Before the Lodox/Statscan, gunshot injury patients with unstable hemodynamics received an emergency operation after the primary survey and conventional trauma series x-rays (CXR, PXR). Therefore, the extremity injuries might be overlooked in patients with life-threatening abdominal injuries [15]. After the Lodox/Statscan, an integrated film provided a whole-body image, including an abdominal and extremity



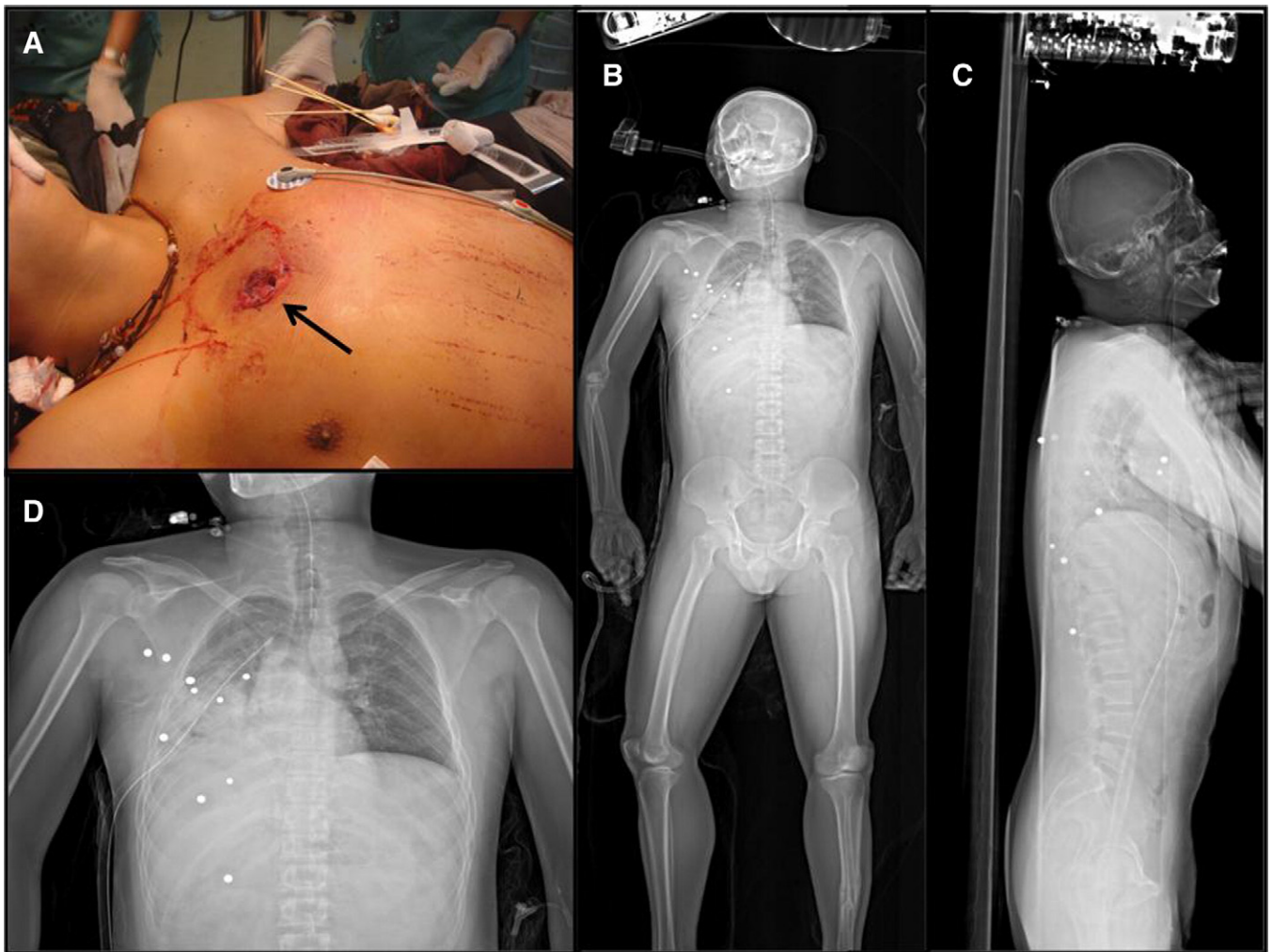
**Fig. 1** The study protocol for the management of gunshot injury patients and patient distribution in the study.

**Table 1** Gunshot injury patients with unstable hemodynamics

Case	Age/sex, BP in the ED	Numbers and locations of the gunshot wounds	Findings of the LX/ST	Associated treatment after the LX/ST
1	36/male, 72/45 mm Hg	Anterior chest wall × 1 (shotgun injury)	Multiple bullets in both thoracic and abdominal cavities	Both thoracotomy and laparotomy <sup>a</sup>
2	24/male, 88/48 mm Hg	Anterior chest wall × 1, anterior abdominal wall × 1, extremity × 1 (left forearm)	Left ulna bone linear fracture, one residual bullet in the abdominal cavity	Splint immobilization of the left forearm, <sup>a</sup> laparotomy
3	32/male, 47/28 mm Hg	Anterior chest wall × 1, extremities × 3 (left upper arm × 2, right lower leg × 1)	Two residual bullets in the left upper arm and a left humerus fracture	Operation for the removal of residual bullets <sup>a</sup>
4	19/male, 64/39 mm Hg	Anterior abdominal wall × 2	One residual bullet in the abdominal cavity	Laparotomy

BP indicates blood pressure; LX/ST, Lodox/Statscan.

<sup>a</sup> The treatment plan was changed after reviewing the findings of the Lodox/Statscan.



**Fig. 2** A shotgun injury patient with 1 entry wound and multiple retained bullets. The shotgun entry wound was over the right-side chest wall (A). The Lodox/Statscan image reveals multiple bullets in the thoracic and abdominal cavities (B and C). A magnified image reveals a right-side hemothorax, multiple bullets, and a positioned chest tube (D).

**Table 2** Gunshot injury patients with stable hemodynamics

Case	Age/sex	Numbers and locations of the gunshot wounds	Additional images performed after the LX/ST	Associated treatment after the LX/ST
5	21/male	Right shoulder × 1, right knee × 1	Right shoulder and right knee x-rays <sup>a</sup>	Splint immobilization
6	33/male	Buttock × 1, right thigh × 1	Femoral CT <sup>b</sup>	Operation for suspected femoral vascular injuries
7	35/male	Anterior abdominal wall × 1	Abdominal CT <sup>c</sup>	Laparotomy
8	27/male	Anterior chest wall × 1, extremity × 1	LX/ST only	Surgical fixation of an extremity fracture
9	29/male	Right upper arm × 1	LX/ST only	Surgical fixation of an extremity fracture
10	22/male	Right forearm × 2	LX/ST only	Observation
11	18/male	Left lower leg × 1	LX/ST only	Observation
12	43/male	Posterior chest wall × 1, left forearm × 1	LX/ST only	Observation
13	26/male	Right forearm × 1	LX/ST only	Observation
14	22/male	Left upper arm × 1, left knee × 1	LX/ST only	Splint immobilization

CT indicates computed tomography.

<sup>a</sup> Further knee x-rays were performed because of unclear Lodox/Statscan images.

<sup>b</sup> A femoral CT scan was performed for suspected vascular injuries.

<sup>c</sup> Laparotomy was performed regardless of the CT scan findings. An abdominal CT seemed unnecessary in this patient.

evaluation in the ED. Table 1 also shows that there were 2 patients whose extremities appeared normal but were found to have fractures or residual bullets by the Lodox/Statscan. Thus, it helped avoid missed injuries during the treatment of patients with life-threatening abdominal injuries (cases 2 and 3).

The patients with stable hemodynamics are listed in Table 2. To determine the courses of the multiple projectiles and to assess potential tissue damage, many films may be required to characterize the multiple injured sites. Out of these 10 stable patients, 7 (70%) patients did not need additional images after the Lodox/Statscan. Furthermore, a total of 11 patients in this study (78.6%, 11/14) received a whole-body scan using the Lodox/Statscan without the need for extra images. All of these patients were followed up for at least 2 weeks, and there was no adverse outcome from forgoing further imaging. The results of this study suggest that residual bullets and skeletal fractures that are related to a projectile's path can be seen clearly and that unnecessary films can be avoided by using this single-image whole-body scan.

A rapid imaging study is important for patients with multiple gunshot injuries. We agree that this retrospective, small-sample-size study cannot estimate the accuracy of the Lodox/Statscan. However, it rapidly scans the entire body and provides enough information for critical decision making about a patient's future treatment. Therefore, we present the Lodox/Statscan as a beneficial alternative to evaluate patients with gunshot injuries.

Chih-Yuan Fu MD

Yu-Chun Wang MD

*Trauma and Emergency Center*

*China Medical University Hospital*

*Taichung 404, Taiwan*

*Department of Trauma and Emergency Surgery*

*Taipei Medical University-Wan Fang Hospital*

*Taipei 116, Taiwan*

*E-mail addresses: drfu5564@yahoo.com.tw,*

*traumawang@yahoo.com.tw*

Chi-Hsun Hsieh MD

*Trauma and Emergency Center*

*China Medical University Hospital*

*Taichung 404, Taiwan*

*E-mail address: hsiehchihsun@yahoo.com.tw*

Ray-Jade Chen MD  
*Trauma and Emergency Center*  
*China Medical University Hospital*  
*Taichung 404, Taiwan*  
*Department of Trauma and Emergency Surgery*  
*Taipei Medical University-Wan Fang Hospital*  
*Taipei 116, Taiwan*  
*E-mail address: rayjchen@tmu.edu.tw*

doi:10.1016/j.ajem.2011.04.001

## References

- [1] Butt MU, Zacharias N, Velmahos GC. Penetrating abdominal injuries: management controversies. *Scand J Trauma Resusc Emerg Med* 2009; 17:19.
- [2] Campbell NC, Thomson SR, Muckart DJ, Meumann CM, Van Middelkoop I, Botha JB. Review of 1198 cases of penetrating cardiac trauma. *Br J Surg* 1997;84:1737-40.
- [3] Hull JB. Management of gunshot fractures of the extremities. *J Trauma* 1996;40:S193-7.
- [4] Madiba TE, Thomson SR, Mdlalose N. Penetrating chest injuries in the firearm era. *Injury* 2001;32:13-6.
- [5] Murray JA, Demetriades D, Cornwell III EE. Penetrating left thoracoabdominal trauma: the incidence and clinical presentation of diaphragm injuries. *J Trauma* 1997;43:624-6.
- [6] Pryor JP, Reilly PM, Dabrowski GP, Grossman MD, Schwab CW. Nonoperative management of abdominal gunshot wounds. *Ann Emerg Med* 2004;43:344-53.
- [7] Velmahos GC, Constantinou C, Tillou A, Brown CV, Salim A, Demetriades D. Abdominal computed tomographic scan for patients with gunshot wounds to the abdomen selected for nonoperative management. *J Trauma* 2005;59:1155-60.
- [8] Volgas DA, Stannard JP, Alonso JE. Current orthopaedic treatment of ballistic injuries. *Injury* 2005;36:380-6.
- [9] Chen RJ, Fu CY, Wu SC, et al. Diagnostic accuracy, biohazard safety, and cost effectiveness-the Lodox/Statscan provides a beneficial alternative for the primary evaluation of patients with multiple injuries. *J Trauma* 2010;69:826-30.
- [10] Fu CY, Wu SC, Chen RJ. Lodox/Statscan provides rapid identification of bullets in multiple gunshot wounds. *Am J Emerg Med* 2008;26:965.e5-7.
- [11] Cowey A, Mitchell P, Gregory J, MacLennan I, Pearson R, et al. A review of 187 gunshot wound admissions to a teaching hospital over a 54-month period: training and service implications. *Ann R Coll Surg Engl* 2004;86:104-7.
- [12] Geissler WB, Teasedall RD, Tomasin JD, Hughes JL. Management of low velocity gunshot-induced fractures. *J Orthop Trauma* 1990;4:39-41.
- [13] Woloszyn JT, Uitvlugt GM, Castle ME. Management of civilian gunshot fractures of the extremities. *Clin Orthop* 1988;226:247-51.
- [14] Juhl M, Moller-Madsen B, Jensen J. Missed injuries in an orthopaedic department. *Injury* 1990;21:110-2.
- [15] Olson SA, Rhorer AS. Orthopaedic trauma for the general orthopaedist: avoiding problems and pitfalls in treatment. *Clin Orthop* 2005;433:30-7.