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Israeli Experience of Treating Syrian Civil War Patients: Analysis of the Role of Computerized Tomography in the Management of War Injuries

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Abstract

Purpose: In this study we seek to evaluate the use of computerized tomography (CT) and the impact on diagnosis, management and prognosis in patients injured in the Syrian civil war treated in Ziv Medical Center in 2014.

Methods and Materials: Retrospective analysis of indications, timing, and number of CT scans performed was correlated with clinic management, progress and outcome.

Results: Of 220 patients, one patient with massive limb injury and hemorrhage was taken directly to the operating room without CT. Contrast CT was performed in 132 patients at the ER. Ninety-five patients underwent CT within 1 hour of arrival. Of these patients 33 had abdominal, 46 chest, 24 pelvic, and 46 limb injuries. Fifty-six patients were operated within 24 hours. Thirty-seven patients underwent CT after 1 hour (11 abdominal, 12 chest, 8 pelvic, 6 limb injuries). Mean time to surgery was 12 hours. 48 patients with orthopedic injuries underwent CT. Associated vascular injuries were found in 8 (all of which required surgical intervention). The average waiting time to the first surgery was shorter in those who have had a CT exam upon admission, compared to those who didn't (9.2 hours *vs.* 16.2 hours $p<0.05$). Hospital staying duration was also shown to be significantly longer in those who have had more than one CT scan (average 44 days) compared to those who had only one CT scan (average 14 days) $p<0.01$.

Discussion and Conclusion: CT scan revealed more than 50% additional injuries in the: Head, neck, Chest, and abdomen and pelvis when compared to physical exam alone. However, in the extremity injuries there was no additional effect of the CT exam compared to physical exam. CT scan helped shorten the time interval to surgery and had a prognostic value by helping estimation of total duration of hospital staying.

Keywords: Syrian civil war; Computerized tomography; War injuries; Israel; Prognosis; Hospital stay

Introduction

Since the beginning of the Syrian civil war, almost seven years ago, there were thousands of Syrians citizens [1], who have made their way to the Israeli border, in order to get medical treatment, firstly by the Israeli Defense Force (IDF), and later on, at one of the Israeli hospitals. Ziv medical center in Safed has treated more than 900 Syrian patients, since the year of 2012.

Radiographic imaging as a mean for evaluation of foreign bodies and injuries in patients is dated back to World War I [2], whereas the usage of computed tomography (CT) has gained its popularity during the 1980's, for example in the Israeli-Lebanon War in 1982 [3]. Modern CT scanners now provide physicians with the option of safely observing selected hemodynamically-stable patients, instead of taking them to the operating room immediately [4]. In many cases, the use of CT is integral to the care of these patients, and is a part of in-theatre trauma protocol [5]. Its benefits compared to other diagnostic modalities are noninvasiveness, high sensitivity and specificity in localization and visualization of foreign bodies, assessment of damage extent and trajectory of trauma wounds, and hemorrhage visualization in soft and solid organs and tissues [6].

In a series of combat casualties, a combination of physical examination (PE) and CT/CT-Angiography resulted in a sensitivity of 96.3% and a specificity of 97.2% in diagnosing cervical vascular wound, leading to a decreased rate of negative neck explorations from 39% to 17% [7].

Beekley et al. [4] retrospectively studied 145 hemodynamically stable combat casualties with penetrating fragmentation wounds to the torso. They reported that CT scan for intra-peritoneal or retroperitoneal penetration that disclosed nothing abnormal was 99% predictive of successful non-operative management.

Splavski et al. [8] evaluated fourteen patients with war missile injuries to the spine and spinal cord, who underwent

CT scan to evaluate the bone destruction, spinal cord compression and lesions, as well as dural lesion with possible cerebrospinal fluid (CSF) fistulae, and epidural traumatic hematomas, with detection of 12 out of 13 penetrating injuries with dural lesions, 6 of them had spinal cord lesion, and also detection of spinal cord compression in 9.1% of all patient who underwent CT scan. These results had a great importance to the neurosurgeons in planning the operative procedures to the wounded patients.

CT imaging of craniofacial injuries in both civilians and combat soldiers were reported by Statler et al. [9]. Most craniofacial injuries of the local Afghan civilians were due to land mine incidents (44%) with penetrating wound sand blasts injuries. Some of them had injuries that were impossible to diagnose without cross-sectional imaging.

A postmortem CT (PMCT) done for Israeli soldiers who were killed in military action in small scale conflicts in Lebanon, were reviewed by Farkash et al. [10] with different mechanisms of injury –missile penetration, artillery shells, and mine blasting. The different affected body parts were also reviewed, with the most common parts were head and neck (86%), and followed by chest (77%) and face (50%). Interesting finding from their report was of gas presentation in various circulatory systems and in relatively high percentages, including heart (45%), aorta (27%) and other large vessels, a finding that may suggest air embolism and may have implications over the prehospital care.

In our study we aim to analyze the types of injuries of Syrian citizens, as reflected from the CT scans done at the triage and later during the hospitalization and to evaluate the use of computerized tomography (CT) and the impact on diagnosis, management and prognosis in patients injured in the Syrian civil war treated in Ziv Medical Center in 2014.

Materials and Methods

A retrospective analysis was conducted, by using the hospital's computerized systems. All patients' names were anonymized, and no personal information was detected, other than their main complaint and treatment. The study was approved by the hospital's Helsinki committee.

Statistical analysis was performed by Pearson Correlation (2 tailed) and Chi square test. We used Toshiba Aquillone one CT scanner: 320 slices, 16 cm coverage with 0.5 mm. thickness.

Our total body trauma protocol consisted of acquisition from vertex to lesser trochanters, starting with a non-enhanced CT of the head and neck (cervical spine) with arms alongside the trunk. The second scan covered the chest, abdomen, and pelvis. The preferred technique for the second scan was CT angiography of the chest and abdomen immediately after raising the arms alongside the head, with additional scans of the abdomen and pelvis in the portal and late nephrographic phases.

The type of the CT scan (total body CT scan, or focused MDCT scan) was determined according to the clinical judgment on admission.

Results

Patient population

Out of 220 Syrian patients who were treated at Ziv Medical Center during the year 2014, 88% were males; mean age was 26.1 years (range 0-80 years old, mode – 20 years old).

Physical exam and CT statistics

When considering the rate of injuries, as described per physical exam, it appears that the extremities were the most common to be affected, with 83 (38.1%) lower extremities, 58 (26.6%) upper extremities and followed by head 48 (22%) and neck 14 (6.4%), and chest 36 (16.5%) and 32 abdominal injuries (14.7%). When comparing the injuries that were discovered by the CT scan at admission, the most common injury site were the head 72 (33%), chest 60 (27.5%), abdomen and pelvis 51 (23.4%), lower extremity 36 (16.5%), neck 22 (10.1%) and upper extremity 12 (5.5%).

Figure 1 shows that the CT exam revealed more than 50% additional injuries in the: Head, neck, Chest, and abdomen and pelvis when compared to physical exam alone ($p<0.01$). However in the extremity injuries there was no additional effect of the CT exam compared to physical exam.

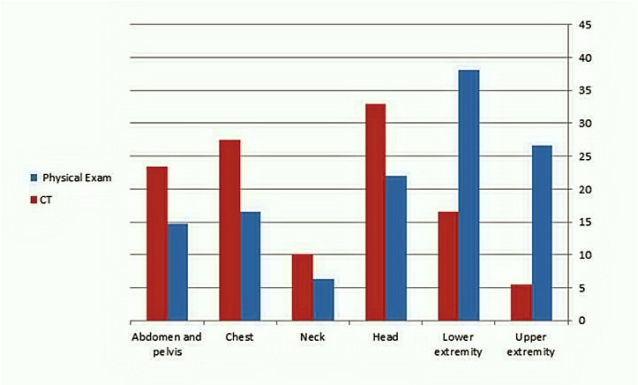

Figure 1 Percentage of injured body system as revealed by physical exam and CT exam.

Figure 2 shows CT exam performance (sensitivity and specificity) compared to physical exam as a goal standard in different body area injuries:

Head injuries: Those who were found to have positive PE for any head injury (from lesions to open fracture), 28 (58.3%) also had findings in head T, which translated to 58.3% sensitivity and 83.4% specificity.

Chest injuries: Those who were found to have positive PE for any chest injury, 24 (63.2%) also had findings in head CT, which translated to 63.2% sensitivity and 87.2% specificity.

Abdominal injuries: Those who were found to have positive PE for any abdominal injury, 12 (52.2%) also had findings in head CT, which translated to 52.2% sensitivity and 87.6% specificity.

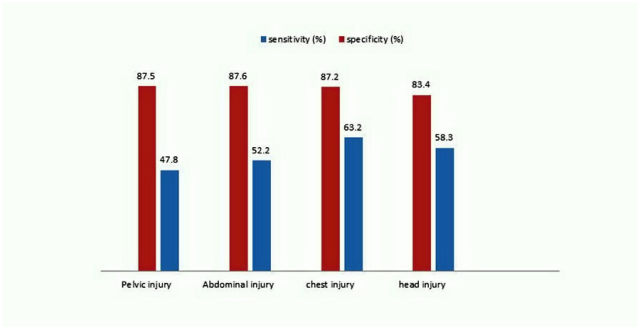

Figure 2 CT exam performance (sensitivity and specificity) compared to physical exam as a goal standard in different body area injuries.

Pelvic injuries: Those who were found to have positive PE for any chest injury, 11 (47.8%) also had findings in head CT, which translated to 47.8% sensitivity and 86.5% specificity.

CT and GCS

When comparing the head CT with regard to their corresponding GCS in admission, it appears that only those who had positive brain finding per CT were having statistically significant lower GCS than those who didn't (14.2 for those without brain finding *vs.* 9.5 points with brain findings, $p<0.05$). When comparing those who have had TBCT, there were 38 patients with positive findings per CT scan (either brain lesion, eye lesions or skull lesions), with an average GCS score of 11.78, compared to 32 patients without any CT finding, with an average GCS of 14.84 ($p<0.05$).

The role of CT

We tried to compare those who did *vs.* those who didn't have CT scan regarding- GCS, emergent surgery, age, sex, location of injury, visible injury etc.

88 of 220 patients didn't have any CT scan upon admission, out of which, 28 (31.8%) didn't have any injury per PE. 29 (33%) have had orthopedic injuries and were later treated surgically (81%). The rest were either non-trauma patients (23 patients); arrived deceased (5 patients) or transferred to other tertiary centers for further treatments (3 patients).

107 patients (48.6%) did not have any operation, while 113 patients (51.4%) had at least one surgery after or during their admission. 87 (77%) had 1 operation only, 16 (14.2%) had 2, 7 (6.2%) had 3, 2 (1.8%) had 4, and 1 patient (0.8%) had 5 operations.

16.5% had to be transported to another hospital (mostly into the nearest neurosurgical ward), whilst 2.3% dyed or arrived dead to the ER.

119 patients had axial assessment, most of which had total body CT scan (60%). There were 13 patients with appendicular CT, 12 of which had orthopedic injuries and 1 had a non-traumatic abdominal aorta occlusion. They were all assessed by intravenous contrast material injection CT angiography scan.

CT scan and surgery

Figure 3 shows that 113 (51.4%) patients have had at least one surgery during their staying. 76 (67%) patients had a CT scan before having the operation done. Most of the patients 34 (91.8%) who did not have a pre-operative CT scan had an orthopedic procedure, and only 4 (11.8%) of them needed to have a post-op CT scan, with an average time of 9 days (range 2-28 days).

The average waiting time, for those who had a CT scan at the ER, measured from entrance to the hospital to the CT exam itself was 0.45 hours (27 minutes) (range 0.1-6 hours=6 minutes–6 hours).

The most common surgery was orthopedic 75 (34.4%) followed by 27 laparotomies (12.4%).

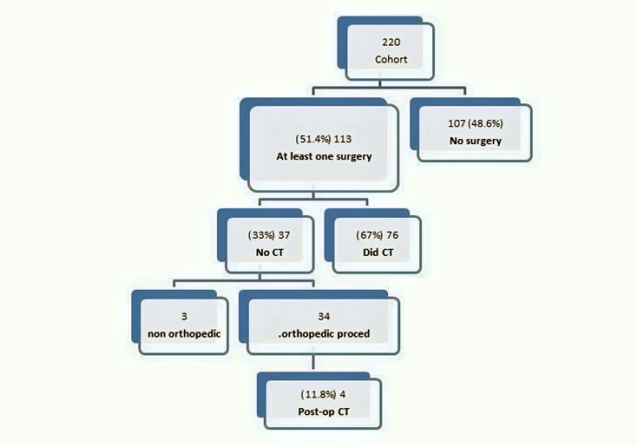

Figure 3 CT scan within patients who underwent surgery.

The strongest positive correlations in the group of patients who have had surgery and also had a CT scan before it, were to be found between those who had laparotomy and have had positive pelvic CT findings ($r=0.90$), followed by ENT surgeries conjoined with positive neck findings in the scan ($r=0.62$). The strongest negative correlations were to be found in patients who had laparotomy and a head CT ($r=-0.86$).

CT scan and time to surgery

Regarding the surgery time, the average waiting time from admission to operation was 9.2 hours when CT was preformed, and 16.2 when CT was not preformed (**Figure 4**) ($p<0.05$) no matter what type of surgery it is; Orthopedics: The average waiting time for the 74 patients who have had the surgery was 11.6. Laparotomy: Average waiting time for the 23 patients who have had the surgery was 9.0 (not statistically different).

The mean waiting time for surgery when CT was performed was 9.2 hours. Most patients waited around 4 hours (40.8%). Whereas, the average waiting time from admission to operation, when no CT scan was done was 16.21 hours.

Most patients (56.8%) who did have surgery without a CT scan before it performed it after 25 hours from admission.

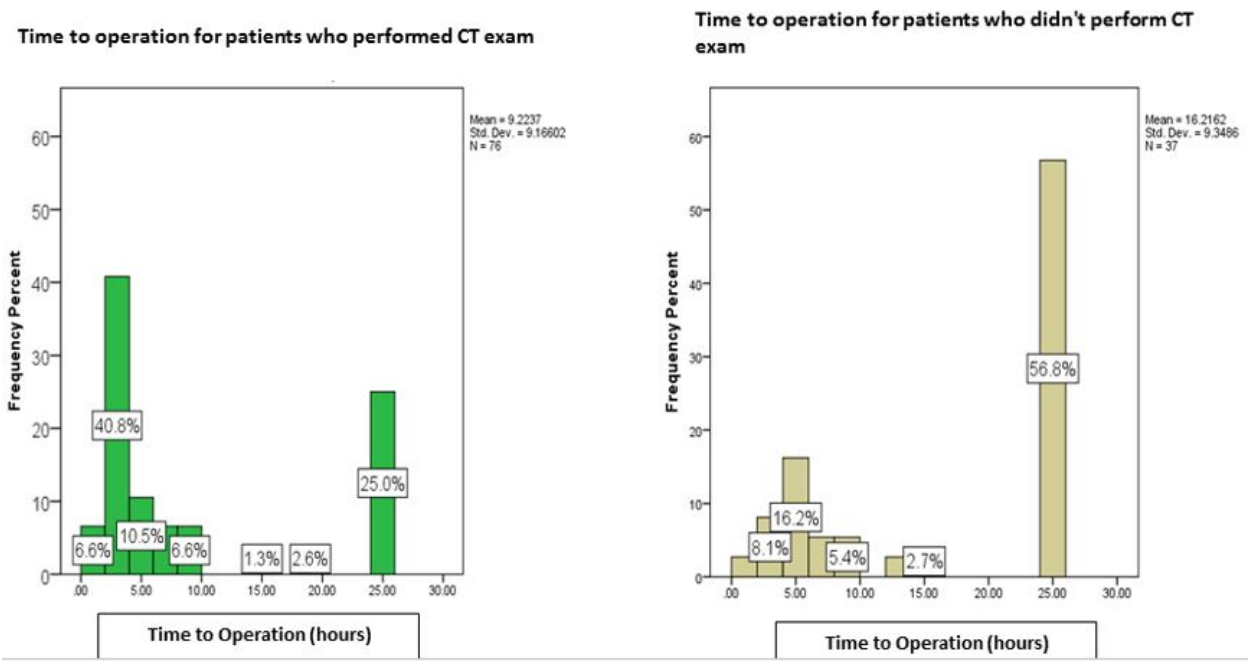

Figure 4 Time to survey in patients who performed and those who didn't perform CT scan.

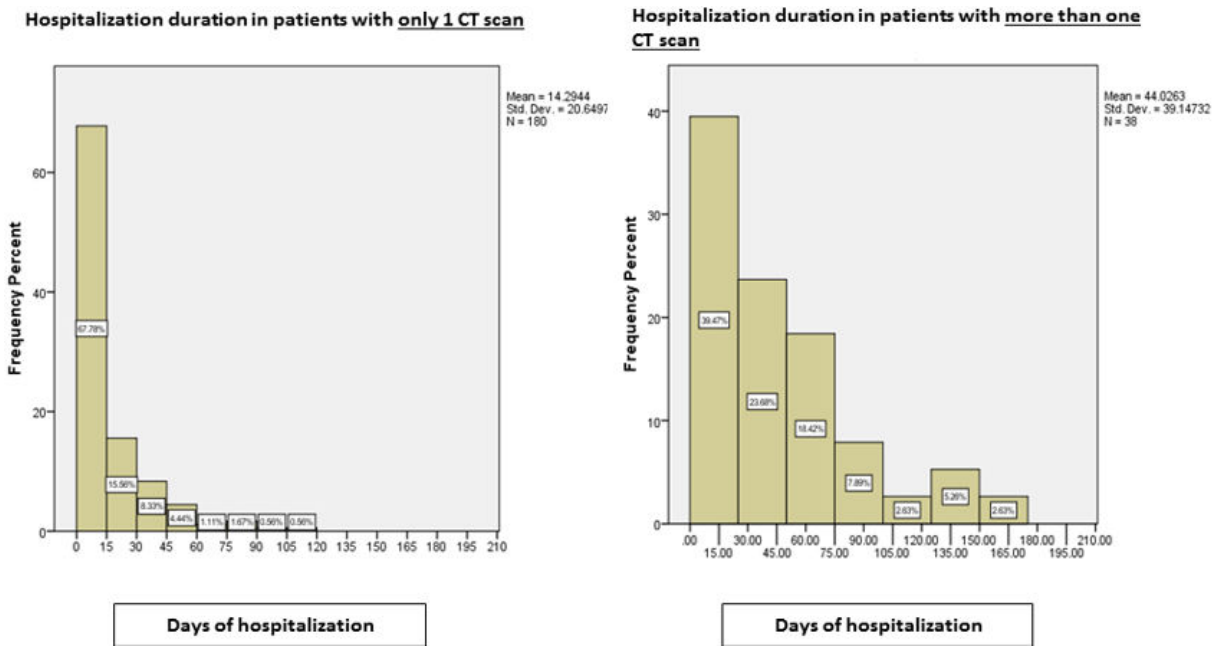

Figure 5 Hospitalization duration in patients who performed only in CT scan *vs.* patients who performed more than one CT scan during their stay.

CT scan and hospital stay

The mean hospitalization time in patients who performed only one CT scan was 14.29 days, ranging from 1-15 days.

On the other hand although most patients who performed more than one CT scan (39.47%) were staying up to 15 days, the mean duration of hospitalization duration in patients who performed more than one CT scan was 44 days, which is significantly longer duration than those who did only one CT scanning.

132 patients did a CT scan at admission. 34 of them, (25%) did another CT scan later on during their staying. The average length of hospitalization was 19.47 days.

When examining the relation between CT scan at admission, and length of hospitalization, no significant differentiation of mean (20.9 days for patient who performed CT scan, 17.1 for those who didn't perform CT). On the other hand, patients who had more than one CT scan spent significantly more days at hospitalization than those who did only one (14.2 days compared to 44.0 days respectively; $p<0.01$) (**Figure 5**). The average interval, for those who performed the second CT scan was 7.84 days.

CT scan and ISS score

When trying to find the relationship between CT scan and ISS score, we revealed many technical problems in determining the ISS score on admission. Many injuries were underestimated in their ISS score because of technical problems. Therefor we excluded this relationship from our scope.

Discussion

In this study, we examined the effect of the CT scan in unique war injury patient population, who had received their medical care at a different country.

The epidemiological data reveal a lower mean age as previously reported from our hospital [11], and by European countries [12], suggesting the fundamental impact of the civil war upon the young, who were not financially capable to flee to another continent.

When comparing the injury site distribution, the extremities are present in most of the patients, which can account to the fact, that in non-lethal injuries, the extremities are the most common to be affected, and in lethal injuries, the head is the most to be affected [10,13]. Those with head injuries were also the population with the highest mortality rate (4 deaths).

Physical examination in war injuries usually dictated by trauma protocols, such as the ATLS. In this report, every notion of other than normal clinical presentation was noted as a positive finding, since lack of proper patient history, language and emotional barriers left no room for risk taking. This may explain the relative low correlation between the physical examination findings and CT scan.

The CT scan revealed more than 50% additional injuries in the: Head, neck, Chest, and abdomen and pelvis when compared to physical exam alone ($p<0.01$). However in the extremity injuries there was no additional effect of the CT exam compared to physical exam. On the other hand, the false positive rate for each location is low (16.6% for head, 12.8% for chest, 12.3% for abdomen, 13.4% for pelvic)–suggesting that Total Body CT (TBCT) is recommended for war injury civilians.

In hemodynamically stable patients, the CT scan may determine the future to come in the general management strategy.

Although the TBCT exam itself may be time consuming, we have shown that performing the exam, may actually decrease time for operation, in other words- decrease the door-to-knife interval. Moreover, in this specific group of patients, who's funding from an outer source (and not by a medical insurance company, as commonly done in Israel) there is a great deal in estimating the hospital staying duration- which was also shown to be significantly longer in those who have had more than one CT scan. This finding does not imply that the CT scan has such major negative impact over the patient, that lead to his or hers longer staying, rather, and more likely, the severity of the injury, and complexity of treatment, required more than one scanning in order to reassure the clinicians about the patient's health status.

Conclusion

Our paper examines the role of the CT scan in Syrian civilian war injuries, who were treated in Israeli hospital during the year 2014. We have shown, that the scan itself may fasten or support the practitioner decision making with regard to any surgical intervention, may have prognostic properties, and may allow estimation of total duration of hospital staying.

In order to have a firmer understanding with regard to these issues, a prospective research is needed.

Acknowledgement

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