

Diagnostic value of abdominal follow-up sonography in polytrauma patients

A retrospective study

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Abstract

In many German trauma centres, it is routine to perform abdominal follow-up sonography (AFS) 6 h after admission for patients with multiple trauma, even if the clinical course is uneventful and multi-slice computed tomography (MSCT) reveals no abdominal pathology. However, this approach is not recommended in the German Guidelines for trauma, and recent studies have questioned the value of AFS to these patients. The present study aimed to evaluate the revised German Guidelines for trauma with respect to the omission of AFS.

We included patients with multiple injuries with no clinical signs of abdominal trauma and with normal abdominal MSCT. We collected clinical data of 370 consecutive patients who underwent AFS (Group A) and another 370 consecutive patients who did not undergo AFS (Group B).

No abdominal injury was missed by the omission of AFS, and thus, no patient suffered from its omission or benefitted from the use of AFS. In our study population, the negative predictive value of normal MSCT results combined with no clinical signs of abdominal trauma was 100% (95% confidence interval: 99.5%–100.0%).

This single-centre study conducted in a large German trauma centre demonstrates AFS to have no utility in the diagnosis of abdominal injury. Moreover, omission of AFS for conscious patients without clinical signs of abdominal trauma and with negative abdominal MSCT does not appear to have negative consequences in terms of missed abdominal injury.

Therefore, AFS can be safely omitted in the majority of cases of polytrauma, which simplifies the imaging workup tremendously.

Abbreviations: AFS = abdominal follow-up sonography, FF = free fluid, GCS = Glasgow Coma Scale, GTR = German Trauma Register, ICU = intensive care unit, ISS = injury severity score, MSCT = multi-slice computed tomography, RIS = radiological information system, SOP = standard operating procedures.

Keywords: polytrauma, multiple trauma, ultrasound, FAST, follow-up examination, whole-body computed tomography

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1. Introduction

In Germany, there is an ongoing debate regarding the utility of abdominal follow-up sonography (AFS) in cases of acute polytrauma. The procedure is typically performed 6 h after admission as part of the routine imaging workup, even in major Level 1 Trauma Centres. It is generally performed after the initial focused assessment with sonography for trauma (FAST) scan and the subsequent multi-slice computed tomography (MSCT) scan. Interestingly, this approach is still common, even though the current German S3 Guidelines for the treatment of polytrauma do not demand AFS if MSCT is performed upon admission.^[1] The recommendation to omit AFS was made in 2011, when the previous guidelines were updated.^[2,3]

The present study aimed to evaluate the revised guidelines with respect to the omission of AFS based on a retrospective review of patient data from our institution by a head-to-head comparison of diagnostic strategies which was available due to revision of the Institutional Standard Operating Procedures (SOPs) in accordance with the German S3 guidelines in 2014. According to these guidelines, AFS was omitted for patients with multiple trauma who showed no clinical signs of abdominal trauma and normal results of abdominal MSCT. To the best of our knowledge, this is the first study to compare these two imaging protocols in a single-centre study.

2. Methods

2.1. Study design

This retrospective, single-centre, historically controlled study compared two cohorts. For Group A, we recruited all consecutive patients admitted to our Level 1 Trauma Centre at the University Hospital Cologne, Germany as polytrauma according to the preclinical assessment but with no clinical signs of abdominal trauma between February 2012 and September 2014. All patients underwent complete imaging workup, including initial FAST in the trauma room, and subsequent MSCT and AFS.

For Group B, we recruited all consecutive cases that were preclinically classified as polytrauma, which were admitted to our centre with no clinical signs of abdominal trauma between September 2014 and August 2015. Other than the omission of AFS implemented in 2014, the treatment protocol was the same as for Group A.

This study was approved by the institutional review board of the medical faculty of the University Hospital Cologne, which waived the requirement for written informed consent because of the retrospective, observational nature of the study.

2.2. Diagnostic imaging

Initial FAST examination was performed by an experienced senior resident or fellow. One of the institutional sonography devices was used (LOGIQ P5, P6 or S7, GE Healthcare, Waukesha, Washington) with a 3.5-MHz convex probe. Longitudinal views of the right and left upper quadrants, transverse and longitudinal views of the suprapubic region and transverse views of the subxiphoid region were recorded. If hemato- or pneumothorax were suspected, additional right and left longitudinal thoracic views may have been performed.

The MSCT examination included unenhanced imaging of the head and contrast-enhanced examination of the thorax, abdomen, pelvis, and the entire spine. Two scanning protocols were used; from February 2012 until May 2015, unenhanced scans of the head and cervical spine were obtained followed by portal-venous contrast-enhanced scans of the thorax and abdomen (delay: 49s after attenuation in the descending thoracic aorta reached a predefined threshold of 120 Hounsfield units). From May 2015, unenhanced head scans were obtained, and portal-venous phase scans were recorded from the skull base to the pelvis after injection of contrast agent. If cervical-artery injury was possible, the cervical spine was examined by phase-contrast angiography. All examinations were obtained with a 256-row MSCT scanner (iCT, Philips Healthcare, Arnhem, Netherlands).

In Group A, AFS was performed about 6h after the initial patient check using one of the institutional sonography devices. The same standard projections were obtained as for FAST.

Scan images were reviewed using Agfa HealthCare PACS Software (IMPAX EE, Agfa HealthCare, Bonn, Germany). Radiological reports and the time between MSCT and AFS were extracted from the radiological information system (ORBIS RIS Agfa HealthCare, Bonn, Germany). We recorded and analysed all non-abdominal injuries identified by MSCT. Where AFS revealed free fluid (FF) or organ lesion, the initial MSCT results were re-analysed by an experienced radiologist (with 6 years of training). Thus, we assessed whether the findings of AFS could have been detected through the use of MSCT alone.

2.3. Clinical data

Clinical data was retrieved from the hospital information system (ORBIS, Agfa HealthCare, Bonn, Germany). To evaluate the severity of trauma, the trauma mechanism, type of injury, time of hospitalisation, number of deaths, and Glasgow Coma Scale (GCS) score were noted. In addition, the Injury Severity Score (ISS) was determined in a sample of 50 patients per group. The clinical course was extracted from the Emergency Departments and Intensive Care Units (ICU) records and from discharge reports. We recorded the development of abdominal symptoms and requirement for surgery or further MSCT scan during admission. In the case of death, we evaluated whether missed abdominal injury could have been the cause.

2.4. Statistical analysis

The sample size gives a precision of $\pm 5\%$, according to the half-width of the 95% confidence interval.^[4] Statistical analyses were descriptive only. Continuous variables are presented as mean (range) and categorical variables as count (percentage). Calculations were performed using Microsoft Excel (Microsoft Corp., Redmond, WA) and Stata (StataCorp LP, College Station, TX).

3. Results

A total of 370 consecutive patients were recruited for each group. The characteristics of all patients are presented in Table 1. The mean GCS was slightly lower in Group B but higher in both groups compared with the German Trauma Register (GTR). The number of patients with GCS < 8 was higher in Group B than in Group A (60 vs 44). The ISS values were correspondingly reversed. In Group B the mean ISS was slightly higher (6.3 in Group A vs 8.2 in Group B), in both groups it was lower than in the GTR. The number of patients with an ISS ≥ 16 was also higher in Group B and lower in both groups than in the GTR (Group A: 6%, Group B: 22%, GTR: 46%).

In both groups, head and thorax injuries were most common, although there were fewer head injuries in Group A (41.2%) than in Group B (61.7%; GTR=48%). About 45.1% of all injuries in Group A were thoracic injuries, which was similar in Group B (45.2%) (GTR=44.7%). From most to least frequent, other recorded injuries were to the spine, upper extremities, pelvis and lower extremities (Table 2).

In Group A, AFS detected tiny amounts of FF in nine patients: three women, four men, and two children. Organ lesions or clinical deterioration were not observed in any patients, and none of the findings led to therapeutic consequences. In Group B, no FF was detected in computed tomography and no patients died of missed intra-abdominal bleeding or organ lesion.

Overall, 29 patients died (22 in Group B, 7 in Group A; causes of death are detailed in Table 3).

4. Discussion

This study compared two different imaging protocols for the assessment of polytrauma: specifically, inclusion of AFS as is widely practised in Germany and omission of AFS as suggested in recent studies and guidelines. Analysis of 740 patients admitted with polytrauma revealed AFS to have no diagnostic benefit for patients who are conscious, do not have abdominal symptoms and have normal MSCT results.

Table 1**Background data and clinical parameters of the study population.**

Characteristic		Group A (n=370)	Group B (n=370)	German Trauma Registry DGU: 10 years (n=180,870)
Sex	Male	258 (69.7%)	257 (69.4%)	128,417 (71%)
	Female	112 (30.3%)	113 (30.6%)	52,453 (29%)
Age (years)	Mean	42.50 ± 21.4	46.23 ± 22.5	49.2
	Min.	1.6	0.8	–
	Max.	92.8	101.8	–
	Mean	12.9	12.2	10.9
GCS	Min.	3	3	–
	Max.	15	15	–
	<8	39 (10.5%)	57 (15.4%)	29,805 (19.7%)
	Mean	6.3	8.2	18.1
ISS	Min.	1	1	–
	Max.	27	26	–
	≥16	3/50 (6%)	11/50 (22%)	17630 (45%)
	Mean	9.14 (n=322)	9.1 (n=325)	17.3
Time of hospitalisation (days)	Min.	0	0	–
	Max.	305	307	–
	–	7 (1.9%)	22 (5.9%)	20,123 (11.8%)

Continuous data are presented as mean ± standard deviation; categorical data are presented as number (%).
GCS = Glasgow Coma Scale, ISS = injury severity score.

The motivation for this study was the discrepancy between common clinical practice and results of recent studies in terms of the benefits of AFS for patients with multiple injuries.^[5–7] Despite the results of studies and recommendations of the guidelines, AFS is still common practice in German trauma centres despite the time, cost, and risk of false-negative results that are involved and the potential delay to treatment decisions. In this context, Geyer et al. evaluated the benefit of AFS in patients with multiple

injuries, including abdominal injuries, and reported that AFS does not provide additional information regarding abdominal trauma. Moreover, they concluded that “MSCT should be considered if indicated by abnormal clinical and/or laboratory findings” because of the risk of false-negative AFS results.^[6] Additionally, Maurer et al. reported AFS to be too time consuming and expensive and stated that the technique “yields only a low overall diagnostic gain in polytraumatised patients in

Table 2**Details of non-abdominal injuries among the study population.**

Region of injury	Type of injury	Group A (n=254)	Group B (n=230)	GTR 2013–2015 (n=92,894)
Thorax	–	115 (45.3%)	104 (45.2%)	44.7%
	Fracture	87	67	–
	Pulmonary contusion	37	38	–
	Pneumothorax	23	31	–
	Pleural effusion	7	8	–
	Haemorrhage	4	3	–
	Pulmonary laceration	1	1	–
Head	Skull fracture	104 (40.9%)	142 (61.7%)	48%
	Intracranial haemorrhage	98	105	–
Spine	Fracture	44	81	–
	Hematoma	84 (33.1%)	63 (27.4%)	28.2%
Upper limb	Fracture	83	62	–
	Other	6	2	–
Lower limb	Fracture	33 (13.0%)	27 (11.7%)	28.2%
	Other	30	25	–
Pelvis	Fracture	3	2	–
	Other	22 (8.7%)	20 (8.7%)	27%
Total	Fracture	21	20	–
	Hematoma	3	0	–
Pelvis	Fracture	24 (9.4%)	15 (4.1%)	13.3%
	Hematoma	23	15	–
Total	Fracture	1	0	–
	Hematoma	383	370	–

Data are presented as number (%).
GTR = German Trauma Register.

Table 3
Causes of death.

Cause of death	Group A	Group B
Neurologic	3	14
Cardiovascular	2	2
Infection	1	4
Respiratory	1	1
Metabolic	0	1
Total	7	22

whom initial MSCT fails to detect any abdominal injuries”.^[7] Similarly, Schneck et al. could not find any additional benefits or impact on further treatment by including AFS in the tertiary survey in patients without abdominal findings from initial MSCT.^[5] In this context, the low diagnostic value of AFS can be explained by the high accuracy of MSCT, as suggested by the results of other studies.^[5,8,9]

Among Group A, all cases where FF was identified by AFS were isolated traces of FF without any causal organ lesions or clinical correlation. The significance of FF has been discussed widely in literature.^[10–12] In female patients of reproductive age, a small amount of isolated FF can usually be attributed to physiologic fluid, for example, due to ruptured follicles, retrograde menstruation, or increased ovarian permeability due to the influence of oestrogen.^[10] In addition, small amounts of FF are also considered physiologically normal in males and children. Yu et al. stated that “in male patients with blunt trauma, a small amount of isolated pelvic free fluid with attenuation equal to that of simple fluid and located in the deep region of the pelvis likely is not a sign of bowel and/or mesenteric injury”.^[11]

In each of the male and female patients for whom FF was identified by AFS, this finding was present on MSCT, identified by second-look review. Therefore, AFS did not reveal any new findings. In the three women and two children for whom FF was identified by AFS, no causal organ lesions were observed, and the findings were interpreted as physiological. In all four adult male patients, the findings remained unclear and were thus treated conservatively, as has been described in literature. For example, Brasel et al. concluded that patients with isolated trace amounts of FF can be safely observed and do not require exploratory laparotomy.^[12] Taken together with previous studies,^[5–7] our results indicate that AFS does not have any diagnostic or therapeutic consequences. Nevertheless, the benefits of tertiary patient survey (without AFS) in the case of FF at the initial examination are undisputed in order to rule out clinical deterioration.

Following the SOP update in our trauma centre in 2014, no negative consequences due to the omission of AFS were observed in any patients.

The average GCS in the GTR was lower than both the groups of the present study, which may be because very severely injured patients were excluded from this study as they were too unstable for MSCT. Furthermore, the higher GCS, as well as comparatively lower mean ISS values can certainly be explained by the fact that patients with abdominal injuries or free intra-abdominal fluid were excluded in this study. The comparable study by Schneck et al. found correspondingly lower ISS values (mean values in study were 10 compared to 17).^[5] The overall low ISS values in this study and those of Schneck et al. can be explained by the generous activation of the trauma team defined by the

German Polytrauma Guideline. Moreover, the accuracy of the preclinical assessment of trauma severity is known to be low.^[13,14] Thus, patient profiles can be considered to be comparable between the two groups of the present study and the GTR.^[15]

This study employed an intra-institutional approach, and so, it was important to preclude major differences between the two groups. We evaluated a number of preclinical and clinical parameters, and although no major differences were identified between the groups, the GCS score differed considerably. Also, the number of patients with an ISS ≥ 16 , the mortality rate and frequency of head injury (especially intracranial bleedings) were higher in Group B. These differences, along with the higher incidence of death due to neurologic causes in Group B, can be explained by selection bias in Group A which did not exist in Group B. For Group A, AFS assessment was routine for patients who met the inclusion criteria. Patients who were admitted primarily for head injuries would not have undergone AFS even before the SOP was changed. Therefore, these patients would have been excluded from this study.

This study has some limitations which should be acknowledged. Firstly, although the investigation consisted of an intra-institutional before-and-after comparison, the retrospective design remains a limitation. Secondly, as a single-centre study, the patients included may not be representative of all trauma patients and subgroups. However, our centre receives patients from urban and rural areas and is a major Level 1 Trauma Centre, so the significance of the bias is reduced. Furthermore, when we compared the analysed parameters of our institution with the GTR, no relevant differences were identified. Thirdly, unconscious patients were not excluded from this study despite the difficulties for examination. We did not identify any cases where unconscious patients either benefited from AFS or suffered from omission of this assessment. Nevertheless, because of the relatively small number of unconscious patients, the statistical power is comparatively low, and future studies involving larger cohorts are required.

5. Conclusion

This single-centre retrospective study demonstrates that patients with multiple traumas do not benefit from AFS, and omission does not have negative consequences. Our results confirm, with high statistical power, that AFS can safely be omitted in patients with multiple injuries, no clinical signs of abdominal trauma, and negative MSCT results, supporting the German S3 Guidelines. Trauma centres that have so far adhered to AFS should be encouraged by the results to change their diagnostic routine.

Moreover, our results suggest that AFS can be omitted for unconscious patients, again supporting the guidelines, but we suggest this to be investigated further in multi-centre studies involving larger patient cohorts.

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