

# Evaluating the Use of Computed Tomography for Orthopedic Trauma Patients in the Emergency Department

## Acil Ortopedik Travma Hastalarında Bilgisayarlı Tomografi Kullanımının Değerlendirilmesi

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### SUMMARY

#### Objectives

The purpose of this study is to evaluate the necessity of computed tomography (CT) scans requested to examine the spine, extremity, or pelvis of orthopedic trauma patients in the emergency department.

#### Methods

We retrospectively screened the medical records of all patients who had a CT scan during their emergency department (ED) evaluation. All data were classified as either child (aged 0-14 years) or adult (aged >14 years).

#### Results

Of the 32,685 patients examined in the child and adult emergency trauma unit over one year, 1,664 were recommended for an extremity, pelvis, or spine CT (7.02%). The mean age of the patients was 38.6 years (range 2-94 years). Of these patients, 145 of the computed tomography scans (CTs) (80.1%) in the child group and 1,108 CTs (74.7%) in adult group were negative.

#### Conclusions

The unnecessary use of CT in the emergency department to examine orthopedic trauma patients has drawn attention. Considering the risk of radiation to the patient, it is necessary to develop protocols to determine which emergency department patients should undergo computed tomography.

**Key words:** Computed tomography; emergency room; radiation; trauma.

### ÖZET

#### Amaç

Bu çalışmanın amacı acil ortopedik travma hastalarında omurga, pelvis ve ekstremitenin değerlendirilmesi için istenilen bilgisayarlı tomografinin (BT) gerekliliğini değerlendirmektir.

#### Gereç ve Yöntem

Geriye dönük olarak acil servisimizde değerlendirme esnasında BT çekilen hastaların tıbbi kayıtları tarandı. Bütün veriler çocuk (0-14) ve erişkin yaş grubu (>14) olarak gruplandı.

#### Bulgular

Çocuk ve erişkin acil travma bölümünde bir yılda muayene olan 32.685 hastadan 1.664 tanesinden ekstremita, pelvis veya vertebra BT (%7.02) istenmiştir. Hastaların yaş ortalaması 38.6 (2-94) idi. Bütün hastalar içinden çocuklarda çekilen BT'lerin 145'i (%80.1) ve erişkinlerin 1.108'i (%74.7) negatif olarak bulundu.

#### Sonuç

Acil serviste ortopedik travma hastalarının değerlendirmesinde gereksiz BT kullanımı dikkat çekmektedir. Radyasyon riski de göz önüne alındığında hangi hastaya tomografi çekileceği hususu ile ilgili protokollerin geliştirilmesinin gerekli olduğu düşünülmektedir.

**Anahtar sözcükler:** Bilgisayarlı tomografi; acil servis; radyasyon; travma.

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## Introduction

While computed tomography (CT) in addition to direct radiography is of great importance for the diagnosis and treatment of certain orthopedic patients in the emergency room, it is regarded as unnecessary for others.<sup>[1-3]</sup> The recent advancements in the quality of CT imaging and the ability to obtain CT sections at different planes have resulted in orthopedists demanding CT more often.<sup>[4,5]</sup> For example, a CT scan is a very useful imaging method in the evaluation of the posterior wall in acetabular fractures, the posterior elements, the loss of alignment and intra-canal fragments in spinal fractures, joint surfaces in intra-articular fractures, and especially the multi-planar epiphysiolysis in children.<sup>[5-7]</sup>

The initial diagnosis, classification, and planning the treatment of spinal fractures in the Emergency Room (ER) is important.<sup>[8]</sup> Although pelvic fractures constitute only 3 % of all fractures, they are destructive traumas requiring careful attention in the ER. Since the mortality rate is high in pelvic traumas, their treatment and diagnosis should be aggressive.<sup>[9]</sup> For intra-articular fractures and infant fractures, the accurate diagnosis of the fracture is very important in order to accurately plan the treatment.<sup>[7]</sup>

Though direct radiography can be used as an initial imaging method, CT is often used, especially in certain complicated locations. Now, CT is a reliable and safe method that can be used to examine spine traumas.<sup>[9]</sup> Yet, CT must be considered as a method to be used in addition to direct radiography. CT is indicated in instances especially when direct radiography is insufficient and findings are doubtful. In addition, even if there were no abnormal findings found with direct radiography, the presence of neurological deficiency, head trauma, persistent serious pain, and suspicion for serious injury indicate the need for CT.<sup>[1,6,10]</sup> Another benefit of CT is its capability to properly image the craniocervical, cervicothoracic, and posterior pelvic ring, which cannot be imaged via direct radiography.<sup>[9,10]</sup>

The purpose of this study is to evaluate the necessity of CT scans requested for spine, extremity and pelvis examinations of emergency orthopedic trauma patients, and to determine the rates of positive and negative examinations.

## Materials and Methods

The records for the application of CT on children (aged 0-14 years) and adults (aged >14 years) visiting the emergency trauma section of the hospital over one year (1 January 2010-1 January 2011) were analyzed. During this analysis, we used emergency examination cards, the computer-based hospital registration system, and pre-CT direct radiographies and CT images taken from the computer archive (PACS). The analy-

ses were performed by one orthopedist and one radiologist. Patients that did not have direct radiographic images, a trauma history, or recorded examination findings were not included in the study. All patients who had CT scans due to their trauma history and their related direct radiographies were included in the study. The reasons for demanding a CT and the findings of the physical examination were recorded. The analyses that yielded no relevant findings from CT, those that contained irrelevant findings, and those analyses that did not yield more information than that obtained from the direct radiography of the relevant region and did not affect the method of treatment were considered negative CT. Those analyses which yielded findings consistent with the request, more information than that given by the direct radiography and therefore changed the method of treatment, and CTs that were requested to plan the surgical treatment were considered positive CT. Those fractures seen as normal in direct radiography but evaluated as occult fractures with CT were considered necessary CT. The CTs were grouped as either extremity, pelvic, cervical, thoracic or lumbar spine. Iliac bone, sacrum, acetabulum and hip joint CTs were classified as pelvis CT. All data were also classified as either child (aged 0-14 years) or adult (aged >14 years).

The data were analyzed with the SPSS version 15.00 pack software program. Chi square and two sided analyses were used where appropriate, and the alpha value was accepted as 0.05.

## Results

The numbers of patients examined in the adult and child ERs of our hospital in 2010 were 183, 552 and 171, 450, respectively. Of the 32, 685 patients examined in the child and adult emergency trauma unit over one year, 1, 943 underwent an extremity, pelvis, or spine CT (5.9%). Both CT and plain radiographic imaging methods were used in 1, 664 patients. A total of 279 patients (14.3%), including those who had a CT scan but not a plain radiographic scan, and those whose examination findings were not recorded or no trauma history could be found were excluded from the study. The mean age of the adult patients was 42.06 years (15-94 years) and the mean age of the child patients was 10.2 years (2-14). Table 1 shows the distribution of the CTs according to anatomic locations. The number of occult fractures determined with CT scanning for adults and children, whose plain radiographic images were negative, were 102 and 12, respectively.

Out of the 493 extremity CTs requested for adults, a total of 176 (35.6%) were positive CT, with 37 detected to be occult. Out of the 56 extremity CTs requested for children, a total of 18 (32.1%) were positive, with 2 detected to be occult. Out of the 169 pelvis CTs requested for adults, a total of 63 (37.2%)

**Table 1.** The distribution of computerized tomography (CT) requests for emergency orthopedic trauma patients according to the anatomic locations

	Adults		Child		Total	
	n	%	n	%	n	%
Extremity CT	493	33.2	56	30.9	568	34.1
Pelvis CT	169	11.3	6	3.3	156	9.3
Cervical CT	504	34	107	59.1	611	36.8
Thoracic CT	44	2.9	4	2.2	48	2.9
Lumbar CT	273	18.5	8	4.4	281	16.9
Total CT	1.483	100	181	100	1.664	100

were positive CT, with 14 detected to be occult. Out of the 6 pelvis CTs requested for children, 5 (83.3%) were positive, with 2 being occult positive.

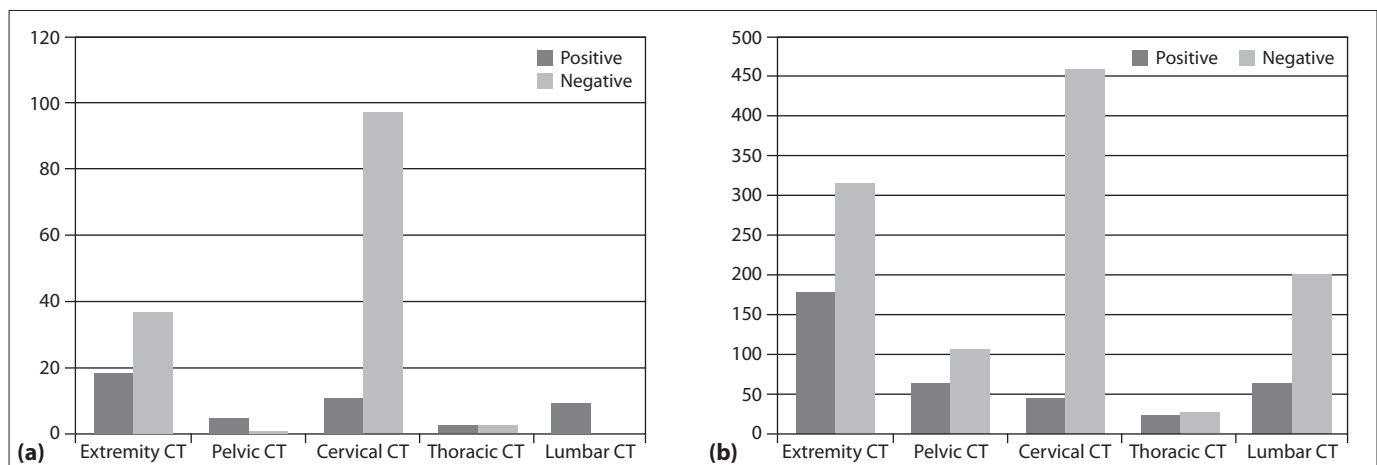
Out of the 504 cervical CTs requested for adults, a total of 45 (8.9%) were positive CT, with 16 detected to be occult. Out of the 107 cervical CTs requested for children, 11 (10.2%) were positive, with 7 being occult. Out of the 44 thoracic spine CTs requested for adults, a total of 21 (47.7%) were positive CT, with 3 detected to be occult. Out of the 4 thoracic vertebra CTs requested for children, 2 (50%) were positive, with 1 being occult. Out of the 273 lumbar spine CTs requested for adults, a total of 70 (25.6%) were positive CT, with 32 detected to be occult. All of the 8 lumbar spine CTs requested for children were negative (Figure 1). The negativity among adults seemed to increase at older ages, and it was seen that CTs were requested especially for compression spine fractures.

Of all patients, 145 of the CTs (80.1%) in the child group and 1, 108 CTs (74.7%) in the adult group were negative (Figure

1). The percentage of negative CTs in children was found to be significantly higher than that of adults ( $p < 0.001$ ). The percentage of negative CTs in spine locations in both the child and adult groups were significantly higher when compared to those of pelvic and extremity locations ( $p < 0.001$ ). The percentage of negative cervical CT in both the child and adult groups was significantly higher than that of thoracic and lumbar CTs ( $p < 0.001$ ). We also observed that there was a significant difference in favor of children in using CT to detect occult fractures ( $p < 0.004$ ).

## Discussion

The use of CT has increased rapidly since its introduction to clinical medicine in the 1970s. Over the last two decades, CT use has increased 20 times in the USA.<sup>[11]</sup> In these examinations, the number of child patients varies between 6-11%.<sup>[12]</sup> Because of the rapid increase in CT use, cancer risk may become a public health problem in the future. According to the statistics, 0.4% of all cancer cases in the USA between 1991



**Figure 1.** The distribution of the negative and positive CTs according to the anatomic locations in (a) children and (b) adults. CT: Computerized tomography.

**Table 2.** Mean effective dose for radiographies used in the radiological imaging of the extremity, pelvis and spine, and doses reported in the literature<sup>[19]</sup>

	Examination	Mean effective dose (mGy)	Doses reported in the literature (mGy)
Plain radiography	Cervical spine	0.2	0.07-0.3
	Thoracic spine	1.0	0.6-1.4
	Lumbar spine	1.5	0.5-1
	Pelvis	0.6	0.2-1.2
	Hip	0.7	0.18-2.71
	Other extremities	0.001	0.0002-0.1
CT	Spine CT	6	1.5-10
	Pelvic CT	6	3.3-10

CT: Computerized tomograph; mGy: Miligray.

and 1999 were caused by CT use.<sup>[13]</sup> This suggests that the benefits of a CT examination should be carefully considered before requesting one. However, CT examination should be used if it is medically necessary. Scans have to be carried out with the smallest dose required to obtain adequate information.<sup>[14]</sup> In our study, we retrospectively examined the 1,664 CTs requested by the child and adult emergency room trauma department during 2010. In our country, there have not been any extensive epidemiological studies about the risk of cancer associated with CT. We hope that our study can inspire more of these studies in the future.

In CT examinations, patients receive more radiation doses compared to those from conventional X-ray examinations (Table 2).<sup>[15]</sup> For instance, in a lung X-ray, the organ dose is about 0.01-0.15 mGy, while it is 10-20 mGy for a thorax CT and is 1.5-10 mGy for a pelvis or spine CT. This amount is about 5 mGy on average for the pediatric age group.<sup>[11,12,15-17]</sup> According to Berrington de Gonzalez et al., 29,000 cases of radiation-related cancer were seen in 2007 because of 72 million CT scans. It has been reported that 0.4% of the cancer cases diagnosed between 1991 and 1999 in the USA were caused by CT use.<sup>[13]</sup> Considering that 1,253 (75.3%) of the total 1,664 scans made within a year had negative results, it is possible to suggest that the use of CT increases cancer risk.

In 1995, Ron reported that the age of exposure to ionizing radiation strongly affects the estimated risk for thyroid cancer, with those younger than 15 years having the strongest association. Children are more radiosensitive than adults, and the thyroid is considered one of the most radiosensitive organs in the body. With the increased use of CT for the evaluation of spinal trauma, it is important to determine the quantity of ionizing radiation that patients are being exposed to and

the risk of this radiation. The effects of radiation are not observed on the exposed individual, but rather on the further generations of that individual.<sup>[11,16,17]</sup> Therefore, it is essential to reduce the rates of preventable negative CT scans. In this study, we determined that the CT scans that gave negative results were mostly requested for old osteoporotic vertebra compression fractures, and for spine, hip and knee osteoarthritis patients.

A substantial amount of cervical spine injuries were detected in the cervical symptomatic cases following acute traumas (2-6%). It is possible to overlook some of the information in the radiological examination of the cervical region. The critical point is that there is often failure to take radiography with proper quality and the correct interpretation.<sup>[18,19]</sup> In 1995 Campbell et al. reported that 20% of thoracic and lumbar burst type fractures, including posterior column, were misdiagnosed as stable wedge type compression fractures, including only anterior column, with plain radiographs.<sup>[20]</sup> In our study, positive spine CT was determined in 149 patients (15.8%), and occult fractures were diagnosed in 59 of these patients, which led to a change in these patients' treatment strategies. In 52 patients, surgical treatment was performed as a result of the CT scans. Due to this reason, emergency service doctors should be skeptical and cautious concerning spine trauma patients.

Spinal traumas are less common in children than adults. Spinal injuries account for approximately 2-5% of all childhood traumas.<sup>[21,22]</sup> It has been often reported that CT use in pediatric patients offers only a small amount of improvement beyond plain radiography in the detection of fractures and wrong sequences despite the increase in the amount of radiation the patient is exposed to. Since there is usually a need for sedation during the CT examination of children,

the advantages the CT examination has for adults, such as short and effective use of time, do not apply.<sup>[17,23]</sup> In our study, 89.8% of patients who underwent CT for cervical trauma were evaluated normally. The percentage of negative CTs in children was found to be significantly higher than that of adults ( $p < 0.001$ ). Due to these differences between adult and pediatric patients, a trauma protocol should be designed specifically for pediatric patients.

In a research study involving radiologists and ER doctors in the USA, it was reported that the radiation dose caused by CT examinations was disregarded by 75% of both of these groups. Fifty three percent of radiologists, 91% of ER doctors, and 97% of patients questioned do not believe the fact that CT examinations increase cancer risk. In addition, 93% of 18 patients questioned said that the benefits and risks of CT were not explained to them before the procedure. Almost all patients stated they were not informed about the radiation dose. Despite the fact that the radiation dose of CT is much higher than that of other radiological methods, both doctors and patients disregard this fact.<sup>[24]</sup> Due to the high rates of negative findings from those undergoing CT that were obtained in our study, the attitudes of both doctors and patients concerning CT should be taken into consideration.

Other than one study regarding unnecessary CT use for the evaluation of the spine and pelvis in the ER, little research has been reported about unnecessary computerized tomography.<sup>[1,3]</sup> Daglar et al.<sup>[1]</sup> found examples of negative CT examinations (51.2%) in the evaluation of spine and pelvic regions in orthopedics clinics. Slovis et al.<sup>[3]</sup> found that one third of all CTs were unnecessary. Based on this information, they reported that about 20 million unnecessary CTs are requested in the USA each year. In the present study, negative CT was found in 80.2% of children and 74.8% of adults, which is remarkably higher than the results of the cited study.<sup>[1]</sup> Daglar et al. determined that the negativity in spine CT examinations is significantly higher than that for pelvic CT examinations, and a similar finding was also obtained in our study ( $p < 0.001$ ).

One limitation of our study is that it has a retrospective design. The second limitation is the fact that evaluations of the sensitivity and specificity of plain radiographs and CT examinations were not carried out. While extremity, pelvis, thoracic, and lumbar spine CT evaluations were carried out by an orthopedist, cervical vertebra evaluations were made by a radiologist. However, these experts cannot always perform the evaluations in the ER due to the high density of patients. A reason for the high negativity ratio in our study may be the high patient density of our hospital. This single center study exhibits the tendencies of our institution, and therefore, generalization of these to the entire universe may

not be accurate.

In conclusion, although CT has significant diagnostic medical benefits, it has a great risk of causing cancer due to exposure to radiation. Before using CT, a careful consideration should be made about its pros and cons. Also, other imaging methods should be considered.

As can be seen from our study, further retrospective and prospective studies should be done on the use of CT for trauma patients in order to establish guidelines of when to use CT and to prevent its superfluous utilization. Emergency service doctors should be adequately trained on CT and should consult the orthopedist first when needed.

### Conflict of Interest

The authors declare that there is no potential conflicts of interest.

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