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ASSESSMENT OF FACTORS AFFECTING FLOW OF CONTRAST DURING CHEST CT SCAN

[1]Mohit Kumar Pandey, [2]Shashi Kumar Shetty

[1]Assistant Professor, [2]Assistant Professor

[1]Medical Imaging Technology (Dept of Radiology, Goa Medical College), [2]Medical Imaging Technology (Dept of Radiology, Nitte Deemed to be University, K S Hegde Medical Academy)

Abstract

Due to the advance development in the CT software, angiography based on the conventional catheter techniques has been replaced by the CT angiography. In order to study the contrast based CT examination, large proportion of intravenous iodinated contrast agent were required to enhance the region of interest. The enhancement of contrast in CT examination is affected by three main factors such as patient, contrast media and scanning techniques factors. The factors which are related to the patient affecting the contrast enhancement are age, sex, height, weight and cardiac output. Aim of our study is to evaluate the factors affecting on the intravenous contrast flow during chest studies. In conclusion, outstanding vascular enhancement can routinely be obtained for CT scan of the chest. The relationship between injection rate, injection duration and required vascular enhancement as shown in our study will remain an important consideration as technology improvements in CT scanning.

INTRODUCTION

Since the introduction of computer tomography (CT) in 1974, there has been a remarkable revolution in the medical treatment of patient. The clinical use of CT has had a broad positive impact on patient management. This improvement in diagnosis and management has occurred in all medical subspecialties, including neurological, cardio-pulmonary, gastro-intestinal, genitourinary and neuromuscular medicine. Introduction of Multi Detector Computed Tomography (MDCT), an advanced CT scanner result in a drastic improved in the spatial and temporal resolution of CT image. Due to the advance development in the CT software, angiography based on the conventional catheter techniques has been replaced by the CT angiography. In order to study the contrast based CT examination, large proportion of intravenous iodinated contrast agent were required to enhance the region of interest. The enhancement of contrast in CT examination is affected by three main factors such as patient, contrast media and scanning techniques factors. The factors which are related to the patient affecting the contrast enhancement are age, sex, height, weight and cardiac output[1]. Many studies in the literature had reported that body weight of patients who are undergoing the CT examination play an important role in the vascular enhancement of a contrast[2-6]. This is due to the patient with large body weight have more blood volumes than small patient, which result in the more dilution of contrast media in large patient as compared to the small patient The other factors such as contrast media and scanning techniques play an important role in determining the CT protocol for the contrast study[7-9]. In present CT scanner, most of the standard protocol for contrast study available in the CT examination are based on studies in western literature. In Indian scenario no study has been performed to see the effect of patient factors such as age, sex, height, weight and cardiac output on the intravenous contrast kinetics. With this study we propose to study the influence of these factors individually and collectively in the

Indian scenario. This can help in designing better protocols taking into consideration the variation of the above mentioned factors in each individual patient in Indian scenario.

AIM

- To evaluate the factors affecting on the intravenous contrast flow during chest studies

OBJECTIVES

- To determine mean average time for the contrast to reach at the level of carina during chest study.
- To differentiate contrast flow in various age groups.
- To evaluate gender related variations in contrast flow.

MATERIALS AND METHODS

The data was collected in Department of Radio- Diagnosis and Imaging, Justices K S Hegde Medical hospital, Mangalore, using GE Bright Speed Select Elite 16 slice MDCT. The consecutive research populations who were referred for the contrast CT scan of thorax were prospectively enrolled in the study. The ethical clearance for the study was approved by The Institutional Ethical Committee of K S Hegde Medical Academy. The informed consent from the research population who are undergone the CT thorax examination was obtained. The patient aged above 18 years are considered for the study and the patient with hypersensitivity and severe renal impairment are excelled. In our study we had divided the research sample into 2 groups on basis of gender and 2 groups on basis of age (18-49) and (50-70).

STUDY PROCEDURE

The CT scan of thorax was performed on 69 research population using GE Bright Speed Select Elite 16 slice MDCT using standard bolus tracking protocol Bolus tracking was performed by taking axial sections at 6th thoracic-7th thoracic spine using 120 kV. The intravenous contrast medium (ultravist) injection was giving to all research population. The contrast was delivered at a Rate of 3 ml/s. The Arterial phase acquisition with a bolus-tracking device is initialized when enhancement in the aorta exceeded 50 HU.

RESULT

Table1: Mean ± SD of Age is (53.26 ± 11.252), AET is (16.42 ± 4.117)

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	69	21	78	53.26	11.252
AET (50 HU) in sec	69	8	31	16.42	4.117

Table 2: The Correlation of Age with AET shows weak positive correlation (ref Figure 3) among the all patient (n = 69 and p = 0.451) with r equal to 0.092 (Table 2).

		AGE	AET (50 HU) in sec
AGE	Pearson Correlation	1	.092
	Sig. (2-tailed)		.451
	N	69	69
AET (50 HU) in sec	Pearson Correlation	.092	1
	Sig. (2-tailed)	.451	
	N	69	69

Table 3: In order to evaluate the gender related variations in contrast kinetics, Independent t-test was considered. From our study shows that there is a signification different between the male and female research population with the P value = 0.030. The mean AET for the male (n = 65) is slightly higher (17.37 ±4.290) as compare to the mean AET for female (n=59) research population (15.26 ±3.633) with the Std. Error Mean of 0.696 for male and 0.652 for female. The mean difference between the male and female in arterial enhancement time was 2.110.

		SEX	N	Mean	Std. Deviation	Std. Error Mean	
AET (50 HU) in sec		Male	38	17.37	4.290	.696	
		Female	31	15.26	3.633	.652	
		Levene's Test for Equality of Variances	t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
AET (50 HU) in sec	Equal variances assumed	.081	.777	2.175	67	.033	2.110
	Equal variances not assumed			2.212	66.891	.030	2.110

DISCUSSION

In our study we made six age groups with interval of 10 years. Showed there is a no significant differences in AET among the group at the p>0.5 level of the six groups (F (5,119) =0.411, p=0.84. Age is likely related to a delayed contrast enhancement because cardiac output is reduced with age[10]. Some studies reported a mild positive correlation between age and delayed contrast material arrival[11], whereas other earlier studies showed little correlation between the two[12]. A study[13] reported that contrast enhancement tended to be stronger in elderly patients (>60 years old) than younger patients for a given iodine load and suggested that iodine dose and injection rate could be reduced in elderly patients by 10% to achieve the same degree of enhancement. It appears reasonable to expect that the resting cardiac output may decrease with age, because the basal metabolism decreases with age. There have been no large-scale studies to evaluate the effects of patient age on contrast enhancement[12].

In our study showed gender related variations in AET are likely slightly difference seen in mean between men and women (men=38, women=31). Men having higher AET time compared to women. Mean AET in men was 17.37 seconds and in women its 15.26 seconds. There are numerous miscellaneous patient-related factors or sources of biologic variations that may affect contrast enhancement. The effects of these factors are largely unknown with little published clinical data. Some of the effects may be inferred from the available physiologic data and contrast material pharmacokinetics. The magnitude and timing of contrast enhancement are likely slightly different between men and women, in part because of their difference in blood volume. Blood volumes in female patients are less than (by 5%– 10% for an average-sized adult) those in male patients for a given weight and height[14]. This difference may explain the clinical observation of higher contrast enhancement in female patients than male patients with the administration of a fixed iodine load per body weight[15]. Decreased blood volume in female patients for a given cardiac output should affect the timing of contrast enhancement; contrast material bolus arrives slightly earlier in female patients than male patients[16]. Some earlier studies reported no significant difference between sex in contrast enhancement timing [17].

The most important patient-related factor affecting the timing of contrast enhancement is cardiac output and cardiovascular circulation[18]. In the presence study out of 124 patients having only 29 patients ejection fraction data. All 29 patients data will be within normal range. So, we didn't find any variation in AET. Same way comparison of pulse rate with total number of patients, there was weak correlation in the study. But recent published article gives, time of contrast material bolus arrival and the time to peak enhancement in all organs are highly correlated with, and linearly proportional to, the reduction in cardiac output[19,20]. Slower clearance of contrast medium due to reduced cardiac output or circulation results in a higher, prolonged contrast enhancement profile. The most important patient-related factor affecting the magnitude of vascular and parenchymal contrast enhancement is body weight[21]. Numerous studies have been conducted to investigate the effect of body weight on contrast enhancement[22]. Because large patients have larger blood volumes than small patients, contrast medium administered into the blood compartment dilutes more in a large patient than in a small patient. The result is a reduced iodine concentration in the blood and lower contrast enhancement.

While numerous studies have been conducted on the effect of body weight on contrast enhancement, the effect of the patient's height on contrast enhancement has been rarely studied. One recent study [(22)] showed a moderately strong inverse correlation between aortic attenuation and height (i-e, a lower aortic attenuation in a taller patient when all other variables remained fixed). Another study showing, as with body weight, the time to peak enhancement is affected little by height [23] because both blood volume and cardiac output increase proportionally with height. In our study there was weak positive correlation result came in the calculation. So, for a given administration of contrast medium dose, the magnitude of contrast enhancement decreases proportionally with an increase in patient weight and height. But we have given average constant contrast volume of 80ml to all the patients to achieve desirable AET in given fixed amount of contrast.

Reducing the injection of contrast material may degrade the diagnostic capabilities of abdominal CT by lowering the contrast resolution. On the other hand, an increase in the injection of contrast material is associated with higher cost and a greater risk of complications such as renal dysfunction and extravasation[24,25]. Hence in the present study we kept all affecting contrast factors constant. Usually in our department we give 80ml contrast to all patients, regardless of patient weight. In our study one of the main object to find the mean time of AET with constant contrast factors and patient factors.

RECOMMENDATION

The peak AET during the scan occurred 16±3.93 seconds after triggering when a 128 detector CT was used and the trigger threshold level was set at an increase of 50 HU over the aortic baseline CT number with flow rate of 4ml/second with 80 ml contrast for all 69 research population. Hence in the future, it is of significances to clarify how much time elapses between attainment of the trigger threshold for bolus tracking and aortic peak enhancement with various patient protocols. It helps set the time protocol were bolus tracking not available in the scanning centers to achieve a desirable organ specific contrast enhancement. Study also helps to optimize the injection protocol or parameters and achieve a desirable organ specific contrast enhancement for the older patient application.

CONCLUSION

In conclusion, excellent vascular enhancement can routinely be obtained for CT scan of the chest. The relationship between injection duration, injection rate, and optimal vascular enhancement as shown in our study will remain an important consideration as technology improvements in CT scanning continue and new clinical applications emerge.

REFERENCES:

1. Bae, K.T. 2010. Intravenous Contrast Medium Administration and Scan Timing at CT: Considerations and Approaches. 256 (1).
2. Han, J.K, Choi, B.I, Kim, A.Y, Kim, S.J. 2014. Contrast media in abdominal computed tomography: optimization of delivery methods. *Korean J Radiol* (Internet). (cited Apr 21);2(1):28–36. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2718092&tool=pmcentrez&rendertype=abstract
3. Platt, J.F, Reige, K.A, Ellis, J.H. 1999. Aortic enhancement during abdominal CT angiography: correlation with test injections, flow rates, and patient demographics. AJR Am J Roentgenol (Internet). Jan (cited 2014 Apr 22); 172(1):53–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/ 9888738
4. Awai, K, Hori, S. 2003. Effect of contrast injection protocol with dose tailored to patient weight and fixed injection duration on aortic and hepatic enhancement at multidetector-row helical CT. Eur Radiol (Internet). 2003 Sep (cited 2014 Mar 19); 13(9):2155–60. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12736754
5. Schoellnast, H, Deutschmann, HA, Berghold, A, Fritz, G.A, Schaffler, GJ, Tillich, M. 2014. MDCT angiography of the pulmonary arteries: influence of body weight, body mass index, and scan length on arterial enhancement at different iodine flow rates. *AJR Am J Roentgenol* (Internet). 2006 Oct (cited 2014 Apr 22); 187(4):1074–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16985159
6. Ho, L.M, Nelson, R.C, Delong, D.M. 2014. Determining contrast medium dose and rate on basis of lean body weight: does this strategy improve patient-to-patient uniformity of hepatic enhancement during multi-detector row CT? Radiology (Internet). 2007 May (cited 2014 Apr 23); 243(2): 431–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17456869
7. Kondo, H., Kanematsu, M., Goshima, S., Tomita, Y., Miyoshi, T., Hatcho, A., et al. 2014. Abdominal multidetector CT in patients with varying body fat percentages: estimation of optimal contrast material dose. Radiology (Internet). 2008 Dec (cited 2014 Apr 23); 249 (3):872–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18941161
8. Bae, K.T., Seeck, B.A., Hildebolt, C.F., Tao, C., Zhu, F., Kanematsu, M., et al. 2014. Contrast enhancement in cardiovascular MDCT: effect of body weight, height, body surface area, body mass index, and obesity. AJR Am J Roentgenol (Internet). 2008 Mar (cited 2014 Apr 23);190 (3):777–84. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18287452
9. Yanaga, Y, Awai, K, Nakaura, T, Oda, S, Funama, Y, Bae, KT, et al. 2014. Effect of contrast injection protocols with dose adjusted to the estimated lean patient body weight on aortic enhancement at CT angiography. AJR Am

J Roentgenol (Internet). 2009 Apr (cited 2014 Mar 19);192 (4):1071–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19304716

10. Murakami T, Kim T, Takamura M, et al. Hypervascular hepatocellular carcinoma: detection with double arterial phase multi-detector row helical CT. Radiology 2001;218:763–767.
11. Shamima Sultana, Kazuo Awai, Yoshiharu Nakayama, Takeshi Nakaura, Duo Liu, Masahiro Hatemura, Yoshinori Funama, Shoji Morishita, Yasuyuki Yamashita. Hypervascular Hepatocellular Carcinomas: Bolus Tracking with a 40-Detector CT Scanner to Time Arterial Phase Imaging. Radiology: 2007;243:1.
12. van Hoe L, Marchal G, Baert AL, Gryspeerdt S, Mertens L. Determination of scan delay time in spiral CT-angiography: utility of a test bolus injection. J Comput Assist Tomogr 1995;19(2):216-20.
13. Chang Hyun Lee, Jin Mo Goo, Hyun Ju Lee, KwangGi Kim, Jung-GiIm, Kyongtae T. Bae. Determination of Optimal Timing Window for Pulmonary Artery MDCT Angiography. AJR 2007; 188:313–317.
14. Kirchner J, Kickuth R, Laufer U, et al. Optimized enhancement in helical CT: experiences with a realtime bolus tracking system in 628 patients. ClinRadiol 2000; 55:368–373.
15. Dinkel HP, Fieger M, Knupffer J, Moll R, Schindler G. Optimizing liver contrast in helical liver CT: value of a real-time bolus-triggering technique. EurRadiol 1998; 8:1608–1612.
16. Haage P, Schmitz-Rode T, Hubner D, Piroth W, Gunther RW. Reduction of contrast material dose and artifacts by a saline flush using a double power injector in helical CT of the thorax. AJR 2000; 174:1049–1053.
17. Goshima S1, Kanematsu M, Kondo H, Yokoyama R, Miyoshi T, Kato H, Tsuge Y, Shiratori Y, Hoshi H, Onozuka M, Moriyama N, Bae KT. Pancreas: optimal scan delay for contrast-enhanced multi-detector row CT. Radiology. 2006;241(1):167-74.
18. Isao Yamaguchi, Hiroyuki Hayashi, Masayuki Suzuki, Katsuhiro Ichikawa, EijiKidoya, Hirohiko Kimura. Operation of bolus tracking system for prediction of aortic peak enhancement at multidetector row computed tomography: pharmacokinetic analysis and clinical study. Radiation Medicine 2008;26(5):278-286.
19. Shigeki Itoh, Mitsuru Ikeda, Hiroko Satake, Toyohiro Ota, Takeo Ishigaki. The Effect of Patient Age on Contrast Enhancement During CTof the Pancreatobiliary Region. AJR 2006; 187:505–510.
20. Birnbaum BA, Jacobs JE, Langlotz CP, Ramchandani P. Assessment of a bolustracking technique in helical renal CT to optimize nephrographic phase imaging. Radiology 1999; 211(1): 87 – 94.
21. Sandstede JJ, Tschammler A, Beer M, Vogelsang C, Wittenberg G, Hahn D. Optimization of automatic bolus tracking for timing of the arterial phase of helical liver CT. EurRadiol 2001; 11(8): 1396 – 1400.
22. Platt JF, Reige KA, Ellis JH. Aortic enhancement during abdominal CT angiography: correlation with test injections, flow rates, and patient demographics. AJR Am J Roentgenol 1999; 172(1): 53 – 56.
23. Itoh S, Ikeda M, Satake H, Ota T, Ishigaki T. The effect of patient age on contrast enhancement during CT of the pancreatobiliary region. AJR Am J Roentgenol 2006; 187(2): 505 – 510.
24. Graser A, Johnson TR, Chandarana H, Macari M. Dual energy CT: preliminary observations and potential clinical applications in the abdomen. EurRadiol 2009;19(1):13 – 23.
25. Kyongtae T. Bae, Intravenous Contrast Medium Administration and scan timing at CT: Consideration and approaches, Radiology 2010; 256: 32-61.