Effectiveness of Low Dose Over Standard dose CT for Detection of Urolithiasis: A Systematic Review

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Abstract

Computed Tomography (CT) of the Kidneys, ureter, bladder is prime investigation to study the pathologies of the Genitourinary system. Despite the advantages of CT, radiation exposure poses major risk. The objective of the review is to investigate the effectiveness of Low dose dose CT over standard dose CT for detection of Urolithiasis. The literature search was performed on PubMed, Scopus, CINHAL, Cochrane Library and Web of Science databases for original research articles published between 2000 and 2020. Research Articles that included the efficacy of low dose CT over standard dose CT in identification of Urinary stones were included. Total 4558 studies were detected from the literature search. After thorough screening 12 articles were included in the review. The Sensitivity of Low dose CT KUB was 80 to 99% and the Specificity ranged from 88 to 100%, the diagnostic accuracy of Low dose CT was 96.1%. From our study we conclude that Low dose CT KUB was effective in maintain the diagnostic confidence with optimal image quality and reduced radiation dose.

Keywords: *Low dose, CT KUB, Urolithiasis, Radiation dose*

Introduction

Urolithiasis is widely known problem across the globe. The incidence and prevalence rates of kidney stones may be affected by genetic, nutritional and environmental factors. The incidence of urolithiasis is 1 in 1,000 per year. The non-enhanced CT KUB was used for identifying urolithiasis in patients with acute flank pain and hematuria[1-3]. The radiation dose and risk associated with CT KUB is a major concern. Due to repeated CT KUB scans for assessment of urolithiasis has caused raise in radiation received by the patients. The National Dose Reference Level for CT KUB in UK for assessing urolithiasis is 6.44 mSv[4-5]. With respect to this issues of high radiation dose, low dose protocols for CT KUB has been used in recent years to reduce the radiation dose by maintaining optimum image quality[6-7]. The objective of the review is to investigate the effectiveness of Low dose CT over standard dose CT for identification of Urinary stones.

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Design and Literature search strategy:

The systematic review was done according to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA).

The literature search was performed on PubMed, Scopus, CINHAL, Cochrane Library and Web of Science databases for published original articles between 2000 and 2020. The keywords that were used in the literature search was: 'Urolithiasis', 'Renal Colic' 'CT KUB', Low dose CT'. Study retrieval methods from various data base are shown in Table 1.

Table 1: Showing methods of study retrieval from database

Database	Year	No. of studies	Total Number
PubMed	2000–2020	935	4558
Scopus Direct	2000–2020	1100	
CINHAL	2000–2020	856	
Cochrane Library	2000–2020	664	
Web of Science	2000–2020	1003	

Inclusion criteria:

Original articles that were published in language English between 2000 and 2020

Studies reported CT KUB comparing low dose with standard dose were included

Exclusion criteria:

Articles with case studies, case reports, posters and narrative literature reviews were excluded as they did not fulfill the criteria.

Data extraction and analysis

Two independent reviewers extracted data individually from each article and any differences were solved following consensus between them.

Quality Assessment

The quality of articles was evaluated by two independent reviewers using QUADAS-2 assessment tool. Results were reported according to STARD guideline[8]

Results

A total of 4558 articles were detected by extensive literature search. 400 duplicates were excluded. 4136 studies were excluded after evaluation of article title and abstract content. Further 10 studies were excluded after examining the full text. Finally, twelve studies were included [Fig. 1].

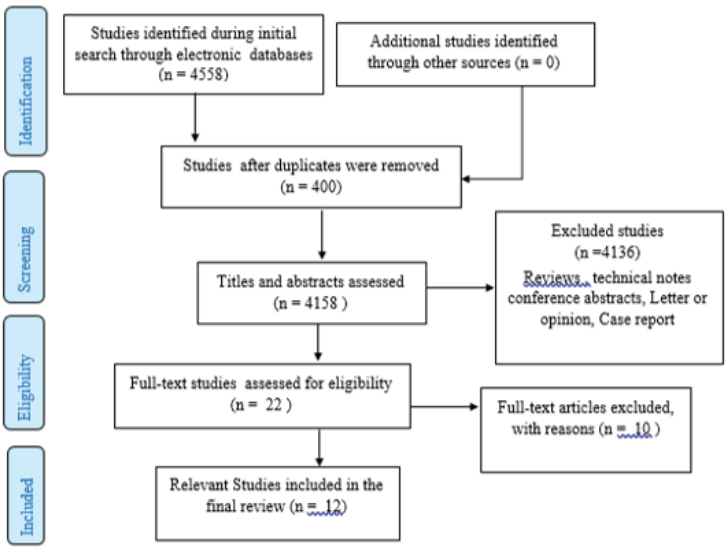

Fig. 1- Flow diagram of study selection process.

Characteristics of included studies:

After reviewing the inclusion and exclusion criteria, a total of 12 articles were included in the study. The study covers different regions of the world such as Germany, Belgium, South Korea, Switzerland, Belgium, America, France, UK, Kenya. A total of 1,439 sample size was included. All the included articles compared the low dose CT KUB with standard dose CT KUB. Table 2 shows the summary of sample characteristics of included articles.

Table 2: Shows the summary of characteristics of articles involved for the review

S.No.	Author (Year)	Country	Sample size	Dose (mSv)
1	Michael Hamm et al 9 (2002)	Germany	109 patients	1.1
2	DenisTack et al 10 (2003)	Belgium	106 patients	1.5
3	Bong Soo Kim et al 11 (2005)	South Korea	121 patients	1.7
4	Claudia Kluner et al 12 (2006)	Germany	142 patients	0.6
5	Pierre-Alexandre Poletti et al 13 (2007)	Switzerland	125 patients	1.7
6	Tom H Mulkens et al 14 (2007)	Belgium	300 patients	6
7	Mc Laughlin et al 15 (2014)	USA	33 patients	0.4
8	Mikael Fontarensky et al 16 (2015)	France	118 patients	1.4
9	T Meagher et al 17 (2001)	UK	69 patients	3.5
10	N Twahirwa et al 18 (2009)	Kenya	104 patients	-
11	John A Fracchia et al 19 (2012)	USA	101 patients	2.1
12	Christopher L Moore et al 20 (2015)	USA	201 patients	3.4

Discussion

Over the past years, there is enormous increase in use of CT KUB for diagnosis of urolithiasis. The CT KUB has been repeated as follow up for assessing the recurrent urolithiasis which lead to increase in radiation dose received. Urolithiasis often affect young patients who are relative risk of radiation induced carcinogenic effects. The sequential CT scans for evaluation of urolithiasis can result in carcinogenic effects, there subjects who are present in with recurrent urolthiasis [22,23,24].

Our review noticed the high sensitivity and sensitivity of low dose CT KUB. There was significant reduction in dose received by the patients with optimum diagnostic image quality. With the advent of automatic tube current and voltage modulation, iterative reconstruction techniques the dose levels in CT are almost equaling to that of X-ray [21].

Our review found the Sensitivity of Low dose CT KUB was 80 to 99% and the specificity ranged from 88 to 100%, the diagnostic accuracy of Low dose CT was 96.1%. The mean effective radiation dose of all the studies ranged from 0.48-3.5 mSv. All studies had reported higher sensitivity and specificity, one study reported very low sensitivity with reduced radiation dose[15].

Our study noted variation in dose reduction techniques used, methodology of determination of dose by using different conversion factors and also there is variation in classification of grouping based on BMI.

Recommendations

We recommend there is need for consensus on BMI based classifications, conversion factor which provides comfortable comparison of the studies and also recommend future studies to be based on advance noise reduction techniques such as iterative reconstruction techniques which provides optimum image quality at lower dose

Conclusion

Our review suggests that a low-dose CT protocol has highest sensitivity and specificity in identification of renal stones and could be used effectively for diagnosis of urolithiasis in renal colic patients. The low dose CT protocol would be really helpful in younger patients with recurrent urolithiasis as they are at the risk of effects of radiation dose.

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Conflicts of Interests: No potential conflicts of interest

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