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RESEARCH ARTICLE

CARDIAC COMPUTED TOMOGRAPHY (CT) FOR ACUTE CHEST PAIN: SYSTEMATIC REVIEW

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Abstract

Background: Coronary CT angiography (CCTA), a non-invasive approach for detecting anatomic atherosclerotic disease, is a potential diagnostic tool for patients with chest discomfort.CCTA has several benefits over other modalities (such as physiologic testing), including better accuracy in diagnosing obstructive coronary artery disease, identification of high-risk disease, and detection of subclinical atherosclerosis.

Objective: When opposed to stress testing, coronary CT angiography (CCTA) offers several advantages, including improved accuracy in detecting obstructive coronary disease. The study's goal was to conduct a systematic review and meta-analysis comparing CCTA to other standard-of-care (SOC) techniques in the assessment of patients suffering from acute chest discomfort.

Methods: Authors began with recognizing the important examination proof that spots light on the significance of cardiac computed tomography for acute chest pain among patients presenting to the emergency department. We led electronic writing look in the accompanying data sets: Ovid Medline (2010 to present), Ovid Medline Daily Update, Ovid Medline in process and other non-filed references, Ovid Embase (2010 to present), The Cochrane Library (latest issue) and Web of Science. Just examinations in English language will be incorporated. The precise selection was acted in close collaboration with a clinical examination curator.

Results: Ten studies with a total of 6285 patients were included in the study.The trials employed diverse definitions and methods for SOC, but they all used physiologic testing. There were no significant differences between the groups in terms of all-cause mortality (RR 0.48, 95 percent CI 0.17 to 1.36, p=0.17), MI (RR 0.82, 95 percent CI

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0.49 to 1.39, p=0.47), or MACE (RR 0.98, 95 percent CI 0.67 to 1.43, p=0.92). However, the CCTA arm had substantially higher incidence of ICA (RR 1.32, 95 percent CI 1.07 to 1.63, p=0.01) and revascularization (RR 1.77, 95 percent CI 1.35 to 2.31, p0.0001).
Conclusion: CCTA is related with similar significant adverse cardiac events as other SOC methods, but greater rates of revascularization in individuals with acute chest pain.

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Introduction:-

Chest discomfort is the second most common reason for emergency department visits in the United States, accounting for around 8 million visits each year and costing the country more than $100 billion in medical expenses[1]. Acute chest discomfort can be caused by a range of illnesses, including esophageal and skeletal system problems, as well as more serious conditions such as acute coronary syndrome (ACS) leading to myocardial infarction (MI), acute aortic syndrome (AAS), or pulmonary embolism (PE). As a result, early and precise identification or exclusion of many later disorders is critical[2].Acute coronary syndrome and acute cardiovascular disorders such as aortic dissection or pulmonary embolism are among the primary causes of chest discomfort, and they are associated with significant morbidity and death. When a clinical suspicion of PE or AAS exists, computed tomography (CT) is the modality of choice. In the occurrence of ACS, initial symptoms, cardiac enzymes, and electrocardiograms (ECG) may be ambiguous, prompting further inquiry and testing, such as coronary CT angiography. The use of coronary CT angiography to rule out ACS in people at low to intermediate risk who present with acute chest pain is well established[3].Hoffmann et al. discovered that employing early coronary CT angiography as part of a triage evaluation method improved clinical decision making in the ED, resulting in shorter hospital stays and more direct discharges[4]. Litt et al. demonstrated that a coronary CT angiography-based strategy for low- to intermediate-risk patients with suspected ACS resulted in safe and early discharge from the emergency room[5].

If ACS, PE, or ASS are suspected, the three CT exams can be combined into a single CT scan, which is commonly referred to as a chest pain CT scan[6]. Depending on the clinical suspicion, a chest pain CT with coronary arteries (to rule out ACS, PE, and AAS; rule out ACS and PE; rule out ACS and AAS) or a chest pain CT without coronary arteries (to rule out PE and AAS) may be performed[7].

A triple-rule-out (TRO) CT method simultaneously assesses the coronary arteries (for stenosis), the thoracic aorta (for dissection), and the pulmonary arteries (for embolus), While the technique is comprehensive, a fourth diagnosis, nonischemic cardiomyopathy, a cardiac condition, has been neglected. Magnetic resonance imaging has been the best and only imaging test for nonischemic cardiomyopathy (MRI). Acute chest discomfort can occur in persons suffering from myocarditis and a variety of other nonischemic cardiomyopathies (e.g., hypertrophic cardiomyopathy, takotsubo cardiomyopathy, or tachyarrhythmias). Cardiac troponin levels measured in the emergency department are highly selective for any cardiac injury that results in cell membrane disintegration[8].

It is difficult to distinguish coronary artery disease (immediate referral to the cardiac catheterization laboratory) from myocardial illness (e.g., myocarditis). Current recommendations propose utilizing coronary CT to assess obstructive coronary disease in the acute environment, while cardiac MRI has been reserved for myocardial disease[9].

Let's take a look at prior attempts to evaluate myocardial damage using cardiac CT. More than 10 years ago, Drs. Albert Lardo and Joo Lima, together with collaborators at Johns Hopkins, developed and validated late contrast enhancement (LCE) CT in animal models. The concept is similar to late gadolinium enhancement MRI in that both gadolinium-based and iodinated contrast agents are found outside of the cell and are known as extracellular contrast agents. During a myocardial infarction, cell membranes are disturbed.This allows gadolinium-based (or iodinated) contrast material to reach a much larger region of the myocardium, enhancing aberrant cardiac tissue. We refer to this as "late" gadolinium augmentation since MRI imaging is performed 10-15 minutes after injection. After a 10-15-minute wait, gadolinium might wash out of the normal myocardium and diffuse into the damaged myocardial. Lardo et al. revealed in their study that late enhancement using cardiac CT with iodinated contrast material is

equivalent to late enhancement using cardiac MRI with gadolinium-based contrast material in the setting of myocardial infarction[10].
Even when using MRI to identify gadolinium effects, a standard TI-weighted sequence results in poor visualization of enlarged myocardium unless additional technique is introduced to the MRI pulse sequence. To cancel out the signal from normal heart tissue, an inversion recovery pulse is added to the signal. When the inversion pulse is administered, the enhanced, wounded myocardium appears at least ten times brighter than the normal myocardium. Acute myocardial infarctions are visible areas of high signal intensity on MRI, visible not only to referring physicians and trainees, but also to competent cardiothoracic imagers. The difficulty with CT was that until recently, there were no technologies such as inversion recovery pulse sequences available[11].

The main disadvantage of CT over MRI is its lower soft-tissue contrast-to-noise ratio (think of the appearance of the brain at MRI compared with that at CT). Lando et al. solved the problem of poor contrast-to-noise ratio in the original animal validation studies by using three methods: (a) massive amounts of iodinated contrast material (equivalent to more than 300 ml in humans), (b) imaging relatively quickly (5 minutes after iodine injection), and (c) high doses of radiation[10].

Methods:-

Review Question

This review seeks to evaluate and point out significance of cardiac computed tomography for acute chest pain among patients presenting to the emergency department. The specific review questions to be addressed are:
(1) What is the importance of cardiac CT for patients presenting with chest pain to the emergency department?
(2) What is the clinical diagnostic value of cardiac CT for patients with chest pain at the emergency department?

Searches

We began with recognizing the important examination proof that spots light on the cardiac computed tomography for acute chest pain among patients presenting to the emergency department. We led electronic writing look in the accompanying data sets: Ovid Medline (2010 to present), Ovid Medline Daily Update, Ovid Medline in process and other non-filed references, Ovid Embase (2010 to present), The Cochrane Library (latest issue) and Web of Science. Just examinations in English language will be incorporated. The precise selection was acted in close collaboration with a clinical examination curator.

Also, the bibliographies of any qualified articles recognized was checked for extra references and reference look were done for all included references utilizing ISI Web of Knowledge.

We considered “published” articles to be compositions that showed up in peer-reviewed journals. Articles present in grey literature were excluded from our review.

Types of studies to be included

We included articles covering how to coordinate different review plans in orderly review cardiac computed tomography for acute chest pain among patients presenting to the emergency department. We did exclude articles only depicting case reports only.

We concentrated on cardiac computed tomography for acute chest pain among patients presenting to the emergency department. We included articles depicting sample sizes and articles that planned to sum up their outcomes to the populace which test was drawn from. Case series and case reports were excluded from our search. Studies from all area all over the world were incorporated with focus around studies from Kingdom of Saudi Arabia

Participants

The systematic review included examinations with tests of population >18 years who had a chest pain presentation to the emergency department.

Searching key words

For every data set, looking through was led by utilizing a mix of the accompanying keywords: (Chest pain OR coronary computed tomography OR coronary computed tomography angiography OR coronary artery disease OR acute coronary syndrome OR myocardial infarction OR myocardial perfusion imaging OR stress imaging OR Kingdom of Saudi Arabia OR systematic review).

We included examinations enrolling members in everyone as well as clinical settings. Studies were incorporated assuming they revealed significance of cardiac computed tomography for acute chest pain among patients presenting to the emergency department. No comparator or control test size is required in the review to be incorporated.

Studies selection process
All list items were brought into an EndNote record. Two analysts evaluated titles and abstracts for their likely pertinence.

One reviewer freely screened titles and abstracts from the search and any articles that report significance of cardiac computed tomography for acute chest pain among patients presenting to the emergency department. We gained the full text of articles that possibly meet the eligibility criteria.

There was no geographical limit on the included studies. Just published articles in the English language will be incorporated.

Outcomes
Primary outcome
To perform a systemic review comparing cardiac CT with other standard of care approaches in evaluation of patients with acute chest pain.

Secondary outcome
None.

Information extraction, (choice and coding)
Information was extracted from the included articles utilizing an electronic information extraction structure on Microsoft Access programming. Two reviewers freely extracted information, utilizing a standard information extraction structure which was created by the survey creators with the end goal of the review. The extraction structure incorporated the accompanying data:

1- Publication subtleties: title, authors, journal name and year and city, of distribution, country in which the review was led, sort of distribution, and wellspring of financing.
2- Study subtleties: concentrate on plan (cross-sectional, cohort, case-control), settings (clinical or population based), concentrate on transience (planned or review), patients' enlistment techniques (successive or non-continuous), the geographical area, year of information assortment and reaction rate, qualification (consideration and avoidance rules), name of appraisal tool(s), approval of evaluation tool(s).
3- Study members' subtleties: number of people reviewed/examined, population qualities including mean age (SD), and gender distribution, relationship status, demographic data.

Data management
A descriptive statistics is employed and relevant data are extracted from eligible studies and presented in tables. We then presented a narrative synthesis of the summary of the signs, symptoms, complications and management of foreign body ingestion among pediatric population.

Results:-

The computerized and manual searches yielded a total of 648 studies. Ten randomized clinical trials were included in the analysis (figure 1). The research were published between 2010 and 2021. The studies were carried out on patients who were seen in an acute care setting, such as an emergency department or an inpatient ward. At the outset, the mean age varied from 50 to 60 years, and the proportion of female patients ranged from 42% to 63%. In addition to generally established exclusion criteria (pregnancy, renal insufficiency, allergy to iodine contrast, and inability to get informed permission), studies needed a non-ischemic ECG and/or negative cardiac biomarkers.

Patients with established coronary artery disease were excluded from eight investigations.Only two studies accepted patients with established coronary artery disease, however one of them excluded individuals who had already undergone CABG operation. Only three trials included participants based on the Thrombolysis in Myocardial Infarction (TIMI) score. The TIMI risk ratings in the trial populations were low. As a result, these trials focused on low-risk and low-to-intermediate risk individuals who were predicted to have a low probability of adverse cardiac events.

There were ten clinical studies with a total of 6285 subjects. There were no significant differences between the groups in all-cause mortality (RR 0.48, 95 percent CI 0.17 to 1.36, p=0.17), MI (RR 0.82, 95 percent CI 0.49 to 1.39, p=0.47), or MACE (RR 0.98, 95 percent CI 0.67 to 1.43, p=0.92). However, the CCTA group had substantially higher rates of ICA (RR 1.32, 95 percent CI 1.07 to 1.63, p=0.01) and revascularization (RR 1.77, 95 percent CI 1.35 to 2.31, p0.0001). Because the number of fatalities was so low, the mortality comparison should be evaluated with care. Heterogeneity in all-cause mortality, MI, and revascularization was low, but it was considerable in major adverse cardiac event (MACE) and ICA. The funnel plots used to evaluate publication bias were generally symmetric. Meta-regression analysis revealed no significant connection between mean age and MACE (p=0.18) or revascularization (p=0.696) outcome metrics when comparing CCTA and SOC methods. Similarly, no significant relationship was seen between diabetes rates in the trials and MACE (p=0.437) or revascularization (p=0.624) outcome measures.

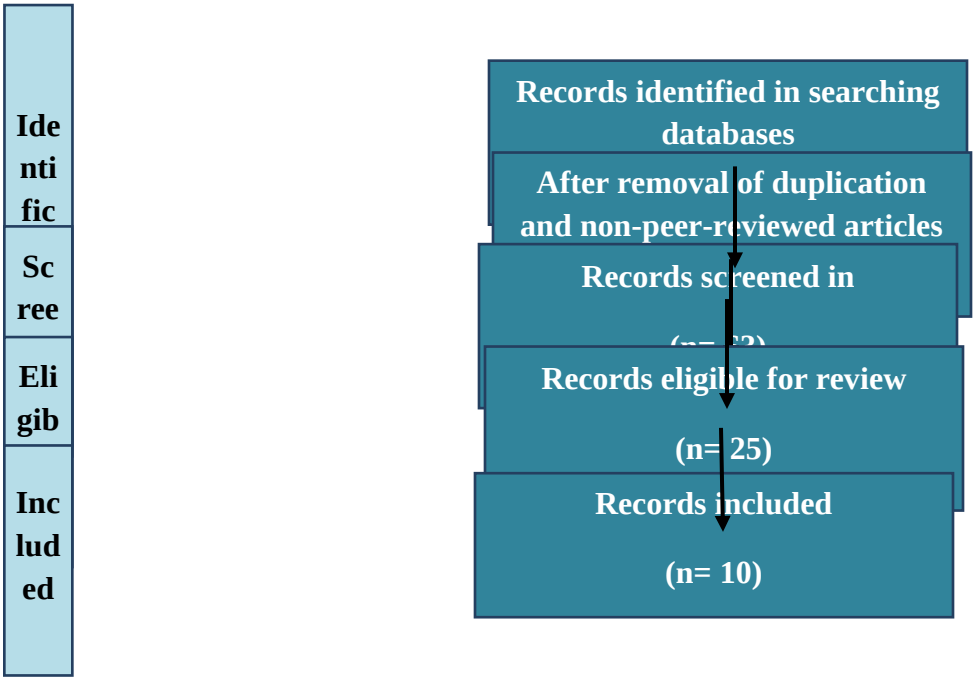

Figure 1:- Flow chart of selection process.

Table 1:- Baseline characteristics of studies involved in this systematic review.

Study	Age Years, Mean	Female (%)	HTN (%)	T2DM (%)	Hyperlipidemia (%)	Smoking (%)
Gray, 2021[12]	50	54	51	14	27	33
Hoffmann, 2012[4]	54	47	27	13	24	34
Puchner, 2014[13]	56	43	42	11	38	64
Truong, 2016[14]	52	42	31	7	25	23
Bittner, 2017[15]	50	54	37	7	34	22
Goldstein, 2011[16]	50	50	39	10	36	18
Pursnani, 2015[17]	53	56	50	15	38	27
Truong, 2013[18]	60	54	69	29	48	46
Ferencik, 2015[19]	57	63	72	32	52	15
Hoffmann, 2012[20]	54	47	54	17	46	50
HTN: Hypertension; T2DM: Type 2 Diabetes Mellitus						

Table 2:- Standardized risk assessment based on Thrombolysis in Myocardial Infarction risk score.

Study	CCTA			SOC			P value	Cut-off for inclusion
	0	1	>2	0	1	>2		
Gray, 2021[12]	51%	36%	13%	51%	36%	13%	NA	<2
Hoffmann, 2012[4]	30%	34%	36%	33%	37%	30%	0.31	No
Puchner, 2014[13]	49%	27%	24%	54%	24%	21%	0.21	No
Truong, 2016[14]	NA			NA			NA	<4
Bittner, 2017[15]	Mean 0.99 + 0.84			Mean 1.04 + 0.87			0.38	<4
Goldstein, 2011[16]	Mean 1.24 + 0.8			Mean 1.33 + 0.8			0.30	No
Pursnani, 2015[17]	50.4%	32.3%	17.4%	54.8%	29%	16.1%	0.67	No
Truong, 2013[18]	NA			NA			NA	No
Ferencik, 2015[19]	Mean 1.3			Mean 1.2			NA	No
Hoffmann, 2012[20]	NA			NA			NA	No
CCTA: Cardiac Computed Tomography Angiography; SOC: Standard of Care' NA: Not Available								

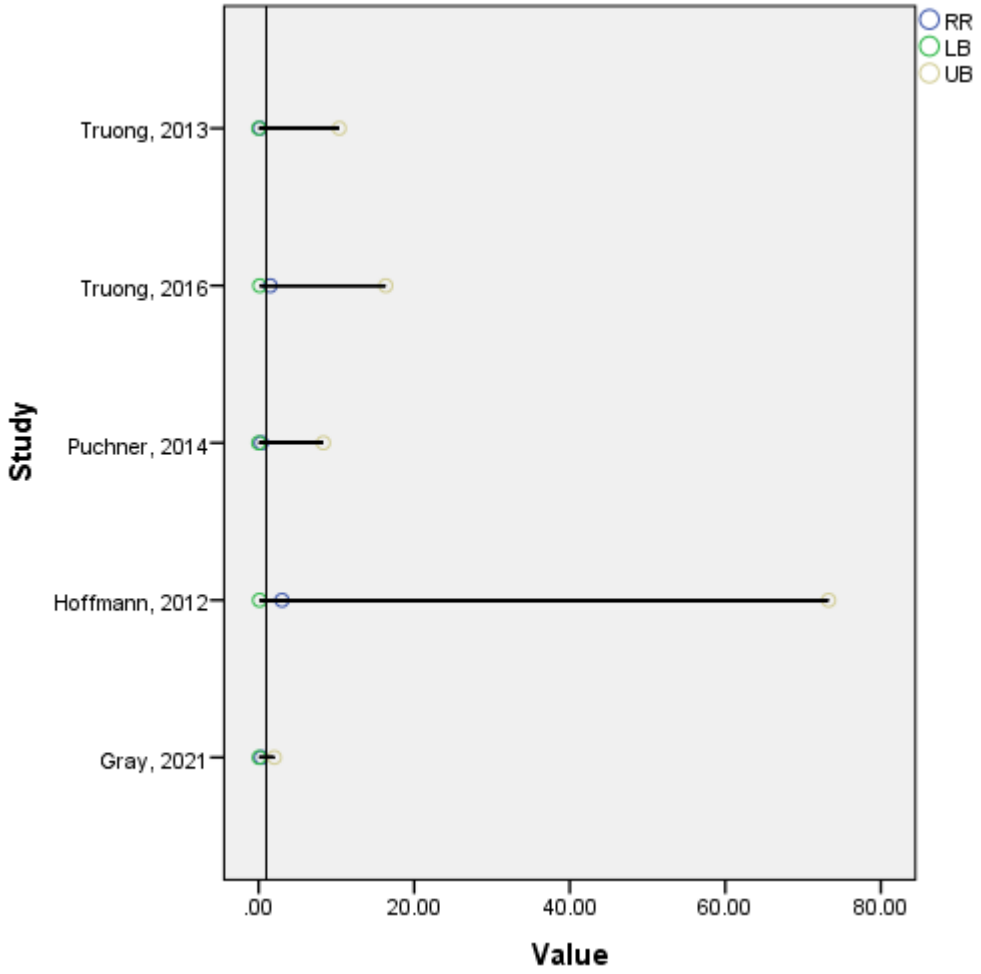

Figure 2:- Forest plot

HR: Relative Risk; LB: Lower Border of 95% Confidence Interval; UB; Upper Border of 95% Confidence Interval

Discussion:-

The comparative clinical effectiveness of cardiac testing has lately been the topic of several research, owing to both an increase in the number of cardiac imaging procedures and rising healthcare expenses. CCTA has been widely explored in both observational studies and clinical trials as one of the most promising modalities[19]. The National Institute of Health and Clinical Excellence (NICE) recently issued guidelines that recommend no routine non-

invasive testing in the initial assessment of acute cardiac chest pain with non-ischemic ECG and negative troponin but prioritize anatomic testing in patients with suspected myocardial ischemia, a recommendation that has sparked considerable debate. According to the findings of the current investigation, the CCTA-based method had no effect on mortality or MACE in patients with acute chest pain syndrome who require examination in the emergency room or admission for inpatient testing. While the CCTA-based technique may enhance efficiency metrics in acute care settings, it consistently results in increased rates of revascularization procedures in low-risk and low-to-intermediate risk patients[13, 17, 18].

CCTA has been demonstrated to have a high sensitivity for detecting obstructive coronary artery disease, which might be a benefit of a CCTA-based approach in patients with acute chest discomfort. A missed acute coronary syndrome has been linked to worse outcomes. Furthermore, CCTA has a better sensitivity in diagnosing high-risk coronary artery disease, although functional testing findings may not necessarily reflect the entire amount of the disease's anatomic severity[11]. However, the degree of anatomic atherosclerosis may not correspond with physiologic lesion features. Anatomic diagnosis of 'incidental' coronary artery disease in the absence of physiologic confirmation may lead to revascularization. This study, like other meta-analyses and observational studies, found an increase in the utilization of ICA and revascularization with a CCTA-based method. Stress testing, particularly with exercise, offers the benefit of establishing the severity of the physiologic lesion as well as matching physiologic data with patient complaints[5, 8, 9].

Because the studies enrolled low-risk and low-to-intermediate risk individuals, the overall adverse cardiac event rates in the included trials were modest. Along with safety, numerous studies focused on efficiency, suggesting a possible advantage of a CCTA-based strategy in terms of duration of stay and acute care expenditures[6]. Because of the considerable range in SOC techniques and the fact that many low-risk patients may not require emergency department or inpatient non-invasive testing and can be safely released with outpatient follow-up, these measurements should be evaluated with care. 18 At the same time, our findings show no significant difference in all-cause mortality, MACE, or MI between the CCTA-based method and other SOC techniques.While the present analysis corroborated previous findings, it included a greater number of randomized trials, making the findings more solid[9, 15].

Our findings contradict previous findings that a CCTA-based approach may result in a considerable decrease in MI in individuals with stable chest pain. The use of stress electrocardiography as a comparison arm in certain outpatient studies may overstate the benefits of a CCTA-based method due to stress electrocardiography's somewhat lower performance in ischaemia detection compared to stress imaging. Alternatively, the discovery of anatomic coronary artery disease (independent of individual lesion severity) may motivate a change in medical regimen, such as intensive lipid-lowering medication and lifestyle changes, which reduce the long-term risk of acute coronary events. While there is a potentially significant advantage of anatomic imaging, additional confirmation of this idea in prospective studies is required[2, 3, 6, 12, 17].

Conclusion:-

In patients arriving to the emergency room or hospitalized for chest pain examination, anatomic imaging with CCTA is not related with a decrease in significant adverse cardiac events. The number of revascularization surgeries using a CCTA-based method is steadily increasing.

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