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Clinical Paper

Computed Tomography Scanning for Sternal Wound Infections: A Systematic Review

Manasi Mahesh Shirke[1*], Catherine Dominic[2*], Pradipta Debnath[3], Jesvin Sunny[4], Mawiyah Haq[5], Hamza Nawaz[2], Amer Harky[6,7,8]

Abstract

Background

Sternal wound infection (SWI) has always been a significant risk in patients who undergo sternotomies as part of their cardiac surgical procedures. Computed tomography (CT) imaging is often used to diagnose and assess sternal wound infections. Its purpose includes identifying and locating infection and any sternal dehiscence.

Methods

A systematic literature review across PubMed, Embase, and Ovid was performed according to PRISMA guidelines to identify relevant articles that discussed the utility of CT scanning for SWI, common features identified, patient outcomes and sensitivity/specificity (Figure 1).

Results

25 papers were included. 100% (n=25) of the papers were published in peer-reviewed journals. CT scans in SWIs can be seen as a beneficial aid in diagnosing as well as determining the components of infection. Commonalities were identified such as fluid collection in the mediastinum, free gas, pleural effusions, and sternal dehiscence which point towards the presence of sternal wound infection.

Conclusion

CT scanning is a novel and emerging methodology for imaging in SWI and post-sternotomy complications, hence increased research is required to expand the literature on this area as well as the creation of guidelines and cut-offs or signs for radiology professionals to identify and determine the extent of infection.

Introduction

Sternal wound infection (SWI) has always been a significant risk in patients who undergo sternotomies as part of their cardiac surgical procedures. SWIs are classified into superficial sternal wound infection (SSWI) and deep sternal wound infection (DSWI). SSWIs usually affect the skin, subcutaneous tissue, and pectoralis fascia and are often eradicated with intravenous antibiotics and proper wound care of the surgical site.[1]

For the purpose of this paper, the focus will be on DSWIs. DSWI, also known as mediastinitis, is a fatal complication of cardiac surgery since it is associated with a high morbidity and mortality rate.[2] The incidence of DSWIs ranges between 0.3% and 8%, and the mortality rate ranges from 19% to 29%.[3] Patients with DSWI deteriorate and die two times faster than those without mediastinitis. Risk factors associated with the development of DSWIs include obesity, diabetes, chronic obstructive pulmonary disease, tobacco use, osteoporosis, prolonged intensive care unit stays, redo sternotomy, and use of assist devices. After surgery, many surgical wound sites are infected with endogenous pathogens. DSWIs usually present with local or systemic signs of infection, such as chest pain and wound discharge. As a result of this, patients with DSWIs stay an average of 20 additional hospital days and have an increased financial impact in comparison to those patients with uncomplicated postoperative stays at the hospital.[2]

Computed tomography (CT) imaging is often used to diagnose and assess sternal wound infections. According to Hosokawa et al., the sensitivity and specificity for mediastinitis diagnosis were 100% and 92.3% respectively.[4] Its purpose includes identifying and locating infection and any sternal dehiscence. This along with other clinical signs like elevated leukocyte levels, C-reactive protein and temperature help clinicians decide on further treatment of the patient.[5] This study aims to delineate the use of CT scans as a

[1] School of Medicine, Queen's University Belfast, School of Medicine, Belfast, UK

[2] Barts and the London School of Medicine, QMUL

[3] School of Medicine, University of Nottingham, Nottingham, UK

[4] Department of Medicine, University of Central Lancashire, Preston, UK

[5] Faculty of Medicine, St. George's University of London, London, UK

[6] Department of Cardiothoracic Surgery, Liverpool Heart and Chest, Liverpool, UK

[7] Department of Integrative Biology, Faculty of Life Science, University of Liverpool, Liverpool, UK

[8] Liverpool Centre for Cardiovascular Science, University of Liverpool and Liverpool Heart and Chest Hospital, Liverpool, UK

*Authors contributed equally

Corresponding author: Amer Harky MRCS, MSc
Department of Cardiothoracic Surgery,
Liverpool Heart and Chest Hospital, Liverpool, UK
Email: aaharky@gmail.com

clinical assessment tool for sternal wound infections.

Methods

3.1. Search strategy

A comprehensive literature search was performed on PubMed, Embase, and Ovid, identifying articles that discussed the role of computed tomography scans in sternal wound infections following surgery in accordance with Preferred Reporting items for Systematic Reviews and Meta-analysis (PRISMA) guidelines.

Search items used included "computed tomography", "mediastinitis", and "sternal wound infection". A staged literature search was performed, and relevant articles were cited and referenced. All identified articles' reference lists were analysed for additional studies. All relevant articles were screened; the results are summarized in a narrative manner within the text of this review, with a summary table provided (Table 2).

3.2. Inclusion and exclusion criteria

All studies discussing the role of CT imaging in sternal wound infection were included. Studies discussing both superficial and deep sternal wound infections were included. Editorials, consensus documents, commentaries, case series of less than three patients, literature reviews, and studies not in English were excluded

3.3. Data extraction

All articles were screened by at least two authors at each stage and any disagreement was reach by consensus or involvement of a third author (CD, MMS). Data was extracted by four authors and validated by two authors.

3.4. Quality assessment

The quality of each publication was evaluated using the Newcastle-Ottawa scale (Table 1). Thisreview addressed key domains depending on the representation of patients with SWI, the role of CT scan, and follow-up assessments.

3.5. Statistical analysis

It was not possible to conduct an appropriate meta-analysis due to limited research data among the studies on this subject.

Results

25 papers were included. 100% (n=25) of the papers were published in peer-reviewed journals. The range of years published was 1996-2020. All articles were original research papers, with one being a conference abstract. 20% (n=5) papers were based on work conducted in Japan, 32% (n=8) from the USA, 12% (n=3) from Germany, 8% (n=2) from Israel, and 1 paper each from Canada, the UK, France, Iran, Sweden, Greece, and Spain. No population databases were analysed in any of the included studies. The majority of studies were conducted on records of surgical in-patients who had undergone a sternotomy and then developed an SWI, though a few (n=2) were based on data from emergency departments/ICU.

For the purpose of this systematic review, 25 papers were reviewed and chosen to identify the role of CT scans in detecting sternal wound infections after cardiac surgery. The extraction process looked at whether or not the papers were chosen provided details regarding the following domains – the total number of patients included; patients with sternal wound infection included; the number of patients with sternal wound infection undergoing CT scanning; context/ role of CT scan use; Population studied: age (mean & range) and gender (%M); diff. between CT scanner and other pts. (& p-value); Presentation(s) of sternal wound infection as reported by paper: symptoms, signs, investigation results.

The role of CT scan imaging was utilised to further evaluate for the presence of either pulmonary or pericardial fluid collections, copious collection of infection under the surgical site, sternal instability, and wound dehiscence both preoperatively and postoperatively. According to Francel and Kouchoukos[6], a CT scan is indicated only if the sternum is stable. However, the majority of the papers used CT scan imaging to identify infections and wound dehiscence as mentioned above. According to Spiess[7], the authors suggest thoracic CT scan scanning as a non-invasive means of clinically demonstrating osteomyelitis of the sternum. The age range of the patient population included across 20 papers was patients above the age of 60 years. The remaining 5 papers focused on patients below the age of 50 years and 2 papers out of the 5 focused on the paediatric population (Takahiro Hosokawa; Joseph Philip). The patients mentioned across the 25 papers presented with a variety of signs and symptoms of SWIs like having a discharging sinus, superficial erythematous wound infections, respiratory distress, fever, chills, leucocytosis, and sternal pain.

Depending on the severity of infection, patients either required admission or managed as an outpatient. In the prospective study of 350 patients by Francel., patients with a stable sternum (either deep or superficial) were treated in the outpatient department. This was done via local therapy using Vacuum Assisted Closure (VAC). Rewiring and/or reconstruction of the sternum was done for patients with an unstable sternum and a deep wound. Chronic sternal wound infection patients reported by Read et al all needed to be readmitted to the hospital for reconstructive surgery (8). Similarly, all of the patients included in the study by Gur et al have required admission for reconstructive procedures.[9]

Very few (n=2) papers mention any long-term complications for sternal wound infections. Read et al reported clinical resolution of all the patients reported with no long-term complications (8). Just like any surgical procedure involving significant dissection under the skin, Francel reported that a large proportion of patients complained of a numb chest

Table 1. Newcastle-Ottawa scale table

Author	Selection				Comparability	Outcomes		
	Representation of patients with SWI	Selection of patients with SWI based on CT scan	Ascertainment of exposure	Demonstration that outcome of interest was present at start of study	Reporting of SWI = * Reporting of SWI based on CT scan = *	Assessment of outcomes	Follow-up long enough for outcomes to occur	Adequacy reporting of outcomes
Yamashiro T et al.[13]	*	*	*	*	**	*	*	*
Jolles H et al.[19]	*	*	*	*	**	*	*	*
Hacibaramoglu M et al.[29]			*	*	*	*	*	*
Apter S et al.[27]			*		*	*	*	*
Gur E et al.[9]		*	*	*	*	*	*	*
Quirce R et al.[18]	*	*	*	*	*	*		*
Hosokawa T et al.[20]		*	*	*	*	*	*	*
Yamaguchi H et al.[12]		*	*	*	*	*		*
Abugameh A et al.[10]			*	*	**	*	*	*
Tamiya E et al.[23]			*	*	*	*	*	*
Francel TJ et al.[15]	*	*	*	*	**	*	*	*
Snyder C et al.[11]	*		*	*	*	*		
Spiess A et al.[7]	*		*	*	*	*	*	*
Cowan K et al.[14]	*	*	*	*	*	*	*	
Philip J et al.[30]	*		*	*	*	*		*
Read C et al.[8]	*	*	*	*	**	*	*	*
Stacy G et al.[28]	*	*	*	*	**	*	*	*
Jacobson J et al.[24]	*	*	*	*	**	*	*	*
Foldyna B et al.[17]	*	*	*	*	**	*	*	*
Hariri H et al.[22]	*	*	*	*	*	*	*	*
Banazadeh M et al.[16]	*	*	*	*	*	*	*	*
Bitkover C et al.[5]	*		*	*	**	*	*	*
Misawa Y et al.[21]	*	*	*	*	*	*	*	*
Exarhos D et al.[25]	*	*	*	*	*	*	*	*

Abbreviations: SWI: sternal wound infection; CT: computed tomography

Table 2: Summary of the literature analysed in this review

Study Title	Clinical Presentation of Patients	CT Imaging Findings	Hospital Stay	Mortality	Recurrence
Hosokawa T et al. (2020)[4]	N/A	CT findings of sternal destruction and capsular ring enhancement were seen in patients with mediastinitis	N/A	N/A	N/A
Bitkover C et al. (1999)[5]	N/A	Prospective group: clinically uneventful healing. Retrospective group: positive predictive value of CT for mediastinitis was 0.71. Of the 20 instances of mediastinitis, only five showed on CT, a sensitivity of only 0.25.	N/A	N/A	N/A
Francel T et al. (2004)[6]	SSWIs present 10-30 days post-op: local tenderness, erythema, fever, chills, lethargy, leucocytosis, ongoing chest pain, and general signs of sepsis.	CT scans show the expected signs of mediastinal collection with air fluid levels. In late presentation, CT scans in these patients are particularly helpful because they define involvement of the bone and soft tissue	11 days (7-15 days).	3.4% of reconstruction patients. 1-year mortality: 9%, (19 patients).	N/A
Read C et al. (2015)[8]	A: 4-6wks post-op; discharging sinus over the sternum. B: two draining sternal sinuses; one on the inferior end of her sternal scar and the other on the left inframammary fold approximately 5 cm from the midline. C: 6 months post-op;	A: Infected wound PET-CT showed a residual nidus of infection deep to the sternum and to the left second/third costal cartilages. PET-CT was essential in this case in locating the new focus of infection that was not clinically apparent. B: The area of residual infected musculoskeletal tissue was delineated using a PET-CT scan, and this demonstrated sternal infection, with right seventh costochondral cartilage involvement and a large seroma cavity on the left side. C: PET-CT allowed more comprehensive pre-operative planning before debriding the sternal wound.	N/A	29%	N/A
	after three debridements by the cardiothoracic team, patient referred to the plastics surgery team with wound dehiscence and multiple discharging sinuses				
Gur E et al. (1998)[9]	Infiltration of parasternal soft tissues.	CT scan was able to show different components of infection. Stage 1 infection shows infiltration of parasternal soft tissues; stage 2 shows bony debris, local soft tissue involvement, fluid air bubbles, fatty tissue infiltration; stage 3 shows sternum external plate bone resorption; stage 4 infection shows irregularity of both sternal plates with some infiltrate of retro-sternal fat, can also see signs of costochondral infection at this stage; and stage 5 shows oedematous and infiltrates under the sternum - deep infection.	N/A	N/A	N/A
Abugameh et al. (2013)[10]	N/A	N/A	Mean inpatient time was 7.0 +/- 4.2 days.	5.81%	N/A
Snyder C et al. (2009)[11]	N/A	CT of the chest confirmed sternal dehiscence in the setting of low-grade mediastinitis.	7 days – Sternal plates. 8 days – Sternal wires.	1: Sternal plates. 2: Sternal wires.	N/A
Yamaguchi H et al.	Purulent discharge was found from the mid-line wound in 4 patients	CT findings included mediastinal soft tissue mass with contrast enhancement containing fluid collection, bilateral pleural effusion, free gas appearance in 4, and sternal dehiscence or destruction in 2	N/A	4.878%	14.63 % (6 patients out of 41

(2001)[12]	and from the drainage tube in the retrosternal space in 2 patients.	patients. Soft tissue mass with contrast enhancement suggestive of abscess formation, bilateral pleural effusion, and free gas may indicate infectious mediastinitis. On the other hand, a CT which did not appear to be suggestive of mediastinitis showed only high-density fluid collection around the drainage tube in the retrosternal space and minimal free gas. CT was not indicative of sepsis and surgical re-exploration was required.			patients required redo sternotomy) .
Yamashiro T et al. (2008)[13]	N/A	CT findings in the early group included mediastinal fluid collection, free gas bubbles, lymphadenopathy, increased attenuation of mediastinal fat, pericardial effusion, pleural effusion and parasternal fluid collection, the late group had all the above CT findings as well as sternal destruction and sternal dehiscence.	N/A	N/A	N/A
Cowan et al. (2005)[14]	N/A	CT detected fluid collections in 73% of patients.	Preoperative stay days - 1.2 +/- 0.7	4%	N/A
Banazadeh M et al. (2011)[16]	Tonsillar abscess, neck effusion and respiratory distress.	CT scan was performed which showed fluid concentration in the medial mediastinum. CT scans showed air and fluid collections in medial and superior mediastinum up to the carina.	Mean hospital stay-24 days.	N/A	N/A
Foldyna B et al. (2019)[17]	N/A	Free gas and pleural effusions were nearly twice as common in patients with mediastinitis.	N/A	N/A	N/A
Quirce R et al. (2002)[18]	Fever, raised leukocyte count, sternal pain	SPECT showed well defined foci in patients with mediastinal abscess, with uptake if high intensity. Patients with retrosternal abscesses also had intense mediastinal foci that was picked up by SPECT.	N/A	N/A	N/A
Spiess AM et al. (2007)[7]	N/A	CT scan aids in the initial inspection prior to debriment. Intact, otherwise healthy appearing sternal bone at the time of initial debridement would warrant a thoracic CT interpretation of bone involvement for assistance with the diagnosis of sternal osteomyelitis.	N/A	N/A	N/A
Hariri H et al. (2019)[22]	N/A	72 were diagnosed with a SWI including mediastinitis, sternal osteomyelitis, costochondritis, and vascular graft infection.	N/A	N/A	N/A
Jolles H et al. (1996)[19]	Sternal instability, erythema, purulent discharge, clinical judgement alone	Primary mediastinitis CT findings showed mediastinal fluid collections and air collections. Secondary mediastinal CT findings included mediastinal edema, pericardial fluid, sternal abnormalities, high-attenuation streaks in the parasternal fat.	N/A	N/A	N/A
Misawa Y et al. (1998)[21]	11 patients with mediastinitis had high fever and leukocytosis associated with high levels of C-reactive protein. Supraventricular arrhythmia developed in 8 of them, and 8 patients experienced appetite loss.	Bilateral pleural effusion and mediastinal soft tissue swelling were seen. In the control group, no pleural effusion was recognized in 3 patients, unilateral pleural effusion in 6, and bilateral effusion in 1. An oval or round mass was seen in both groups. Sternal dehiscence, sternal erosion, and subcutaneous fluid accumulation were observed in the mediastinitis group alone.	2-3 weeks.	N/A	1.385%
Jacobson J et al. (2015)[24]	N/A	Patients with SWI have greater percentage of sternal asymmetry	N/A	N/A	N/A
Tamiya E et al. (2011)[23]	N/A	CT scans clearly visualize sternum cross-sections	1.5 months.	N/A	N/A
Exarhos D et al. (2004)[25]	N/A	Computed tomography has been regarded as the imaging modality of choice for the evaluation of suspected esophagopleural fistula because the site of communication between the two can often be seen	N/A	N/A	N/A

Apter S et al. (2002)[27]	N/A	N/A	N/A	N/A	N/A
Francel T et al. (2001)[15]	Majority infections are superficial. Patients present with local tenderness, erythema, or drainage. Fever, chills, leukocytosis may suggest systemic involvement and deeper infection.	Preoperative evaluations included computed tomographic (CT) scans, testing for sternal stability, and the level of contamination. Intraoperative evaluations included bone, inflammatory tissues, Gram stain, and cultures.	N/A	25%	N/A
Stacy G et al. (2014)[28]	N/A	N/A	N/A	N/A	N/A
Hacibara moglu M et al. (2012)[29]	N/A	N/A	N/A	N/A	N/A
Philip J et al. (2018)[30]	N/A	1 patient in the 5-day group had a positive chest CT showing a sternal abscess and none in the 2-day group. There were no cases of mediastinitis in the entire cohort.	N/A	<1%	N/A

CT- computed tomography; SSWI- superficial sternal wound infections

following reconstructive surgery. There were also no reports of shoulder weakness following the procedure. Most rewire and reconstructive patients were able to do their previous hobbies. In addition, over two-thirds of them were able to return to the same profession before the surgery. Francel et al. reported that only a few patients found themselves disabled following sternal wound infection.[6]

Most of the included studies (n=20) have not reported any mortalities following sternal wound infection. Within the papers that reported deaths, most of them are due to unrelated reasons and not due to their wound infection.[1, 5, 5] Abugameh et al mention the death of one patient due to uncertain cardiac causes.[10] In addition, one of the six patients reported by Yamashiro et al died due to septic shock following mediastinitis.[13]

Most papers mention fluid collection in the mediastinum and free gas in the CT findings of mediastinitis patients.[12-20] Authors from Cowan et al have identified fluid collections in CT findings of 73% of deep sternal wound infection patients.[14] Banazadeh et al have reported air and fluid superior and medical mediastinum till the Carina.[16] CT findings of bilateral pleural effusion and free gas usually indicate infectious mediastinitis. Unfortunately, Yamaguchi et al.have identified a patient where the radiological findings were not pathological, but they were suffering from septic symptoms (following surgical exploration, a large amount of pus was found in the mediastinum).[12] Sternal dehiscence is another complication often confirmed by CT imaging.[6, 7, 11, 12] Misawa et al have identified dehiscence in only the infectious mediastinitis group and not the control group.[23] CT scans findings also show if the bone or soft tissue is involved, especially in a late presentation of sternal wound infection.[6] A thoracic CT scan of bone involvement may indicate a diagnosis of sternal osteomyelitis.[21] A PET-CT scan was used on patients presented by Read et al and allowed the determination of the extent of sternal osteomyelitis. Subsequent scans have helped highlight a newly infected portion in an area that was not affected.[8]

In terms of sensitivity and specificity of CT scans in relation to SWIs reported within the multiple papers reviewed, it was found that in the studies conducted by Spiess A, Istanbullu T, Brown P et al. and Hariri H, Tan S, Martineau P et al. CT scans had a sensitivity of 93% and specificity of 85-96% in identifying osteomyelitis of the external and/or internal sternal plate and a sensitivity of 91% and specificity of 97% when detecting SWIs, respectively.[17, 21] Similarly, another study has shown a sensitivity of 67% and specificity of 83% in terms of CT being able to diagnose mediastinitis after cardiac surgery.[6] In addition, a study done by Foldyna B, Mueller M, Etz C et al. showed specific sensitivities and specificities of CT scans picking up certain pathologies, for example, it was documented that CT scans ability to identify costochondral infection had a sensitivity of 87.6% and a specificity of 56.9%, in contrast to a sensitivity of 100% and specificity of 35.7% in detecting foreign bodies.[19] Interestingly one study done by Jolles H, Henry D, Roberson J, et al. found that CT had both sensitivity and specificity of 100% in detecting clinical mediastinitis after day 14 post-op in patients who had had a median sternotomy.[19] In contrast to this, a study done by Yamashiro T, Kamiya H, Murayama S et al. showed that after 21 days' post cardiovascular surgery with median sternotomy CT had a sensitivity of 100% and a specificity of 85% in detecting mediastinitis.[13]

Out of the 25 papers that were looked at some detailed the extent of infection, if present. A common recurring statement was that an unstable sternum usually indicates a deeper

infection, like mediastinitis.[6] Other studies mentioned seeing soft tissue masses in their patients, most probably abscesses as well as bilateral effusions, and free gas may also indicate infectious mediastinitis.[12] Interestingly, one study by Gur E et al. also categorized SWIs into categories. For example, stage 1 infections encompassed showing infiltration of presternal soft tissues.[9] In relation to the timeline of illness and outcome of patients within the 25 papers looked at it was found that some patients recovered and had subsequent follow up.[8] In contrast, a study done by Yamashiro T, Kamiya H, Murayama S, et al. found that one patient with mediastinitis died from septic shock.[13]

In regard to other treatment options looked at for patients within this review, it was found that antibiotics were a common occurrence within studies (6, 9, 13, 14, 20). Studies done by Francel T as well as Cowan Ket al. used vacuum-assisted closure (VAC) of SWIs as well as wound debridement.[6, 14] In contrast, studies done by Misawa Y,and Yamaguchi Het al. mentioned redo surgical intervention with other studies also mentioning using muscle flaps as the main mode of reconstruction.[12, 22] When analyzing post intervention morbidity or mortality one study conducted by Francel T. found that 3.4% of reconstruction patients who had SWIs died in the first 30 days after surgery due to other causes. In addition, all patients were healed at the 6-week follow-up, however, the one-year follow-up mortality was 9%.[6] Similarly, a study carried out by Yamashiro T, Kamiya H, Murayama S et al. showed that one patient with mediastinitis did die four days after having a CT scan, despite having a redo operation, due to septic shock.[13]

The use of multivariable analysis was also assessed within the 25 papers. P values were mentioned in a few studies for different variables. For example, a study by Tamiya E, Asakawa M, Shibamoto M et al. showed a p-value less than 0.01 for operative pain in patients with misalignment of the sternum, as compared to an aligned sternum, while other studies portrayed a p-value of 0.32 for positive infection seen on CT.[7] Interestingly, one study conducted by Jacobson J, Doscher M, Rahal W, et al. found that diabetes mellitus, as well as the degree of asymmetry, significantly increase the risk of sternal infections, with an odds ratio of 3.3 and 3.5 respectively. This corresponded to a p-value of 0.044 for diabetes and a p-value of 0.029 for the degree of asymmetry.[23] Only one study stated any confounders that were controlled for. Snyder C, Graham L, Byers R, et al. made sure to investigate temporal trends in length of stay to make sure changes in postoperative management overtime was not confounding with their results.[4] It was found that the length of stay was not confounded by time trends over the study period.[11]

By evaluating all 25 papers multiple benefits while using CT scan in relation to SWIs could be seen. One paper concluded that less invasive methods can be used to investigate osteomyelitis in sternal wounds. Instead of using a bone biopsy, a thoracic CT scan can be used to clinically demonstrate osteomyelitis in the sternum.[7] Other studies concluded that VAC is an appropriate adjunct to treat postoperative wound infections after a median sternotomy.[14] Contrastingly, two studies also showed that a CT scan was not a satisfactory way to diagnose mediastinitis, with one study focusing particularly on mediastinitis following cardiac surgery.[5, 12] Other studies focused on how flap reconstruction can have excellent outcomes in patients with mediastinal defects, due to a more correct diagnosis and knowledge of early healing.[15] Another study found correlations between asymmetric sternotomy and SWIs, hence prompting the recommendation of assessing sternal asymmetry in patients with SWIs, and if this is greater than 10% the surgeon should stabilize the sternum.[23] Moreover, two studies also concluded that CT was not useful in the early postoperative phase, but rather useful in the later phase, after 14 days and 21 days postoperatively, respectively.[13, 19]

Discussion

This systematic review found a number of research papers discussing the emerging utility of CT scanning in potential sternal wound infection. CT scans in SWIs can be seen as a beneficial aid in diagnosing as well as determining the components of infection.[8, 9, 17, 18, 20, 21, 25] Thoracic CT scanning was seen to be an appropriate and noninvasive method of demonstrating osteomyelitis of the sternum or mediastinitis. Studies also reported multiple CT findings associated with SWIs including free gas, pleural effusions, capsular ring enhancement, mediastinal soft tissue swelling, and sternal erosion.[17, 20 ,22] One paper also detailed an evaluation and treatment pathway for sternal wound problems after sternotomy and possible treatment routes that could be taken.[15] The quality of each publication was evaluated using the Newcastle-Ottawa scale. Quality assessment of the published literature depended on the representation of patients with SWI, the role of CT scan, and follow-up assessments.

Some studies reported a high degree of sensitivity and specificity of CT scans for identifying SWIs. In contrast, two studies disagreed with using CT as a way to diagnose mediastinitis due to low sensitivity percentages as well as a high number of false positives in their study. [5, 12] Moreover, CT was found to be a beneficial tool when it comes to assessing postoperative SWIs.[13, 19] It was also acknowledged that even though PET-CT imaging has been reported in the past to be of benefit in managing presentations of infective musculoskeletal cases that undergo surgical debridement and reconstruction, the literature remains limited in this area.[8] Studies went on to conclude that CT was useful in diagnosing SWIs and of benefit in the recent surgery setting, as well as giving imaging scores based on patterns of FDG uptake which allows for a more accurate diagnosis to take place.[21]

Ultimately, CT scans have been shown to aid in the diagnosis of SWIs and improve patient outcomes in most

cases, however, they should be used in adjunct with surgery, appropriate antibiotics, and clinical guidance to ensure safe and effective resolution of SWIs. In current health care systems, CT and MRI have been deemed valuable in defining mediastinal abnormalities and finding the source of descending infections.[26] The literature has shown that interpretation based on patterns identified in imaging yields a high sensitivity without compromising the specificity, and this is independent of the timing between the operative procedure and imaging.[2, 21] Since clinical signs of sternal wound infection are typically non-specific, imaging has an important role, hence it is important for radiologists to be aware of the findings in SWI.

This systematic review was methodologically robust and used two reviewer screening at each stage to minimise the impact of human and other errors and increase reliability. It was, however, limited by the lack of existing literature in the area, with only 25 papers suitable for inclusion. Furthermore, in a number of cases, useful data such as the study design characteristics and demographics of patients were not reported. Since many of the studies were in a surgical setting it may have been biased toward patients with more severe SWI hence overestimating the utility of CT scanning. Out of the 25 papers that were reviewed it was evident that 13 papers had included a patient population of less than 100 people. The papers by Francel TJ, Apter S, and Eyal Gur et al. only included the patients that had sternal wound infections as that was the main focus of their papers.[6, 9, 27] In addition to this, only 14 papers out of the 25 had their entire patient population undergo CT scanning to diagnose SWI whereas in the remaining patient populations only a few patients and not all patients who had SWIs underwent CT scan imaging. On analysing these 25 papers further, it was evident that the majority of the patients included in the studies in these papers were males, leading to the question of inherent selection bias.

CT scanning is a novel and emerging methodology for imaging in SWI and post-sternotomy complications, hence increased research is required to expand the literature on this area as well as the creation of guidelines and cut-offs or signs for radiology professionals to identify and determine the extent of infection. CT scans can show different parts of the infection along with foreign bodies which are retained. Radiological classification (along with the location of the infection) allows for appropriate treatment and relevant reconstructive surgery. In the future multimodal imaging and the advent of three-dimensional ultrasound scanning for example may prove to be useful in this area.

Conclusion

CT scanning is a novel and emerging methodology for imaging in SWI and post-sternotomy complications, hence increased research is required to expand the literature on this area as well as the creation of guidelines and cut-offs or signs for radiology professionals to identify and determine the extent of infection. CT scans are able to show different parts of the infection along with foreign bodies which are retained. Radiological classification (along with the location of the infection) allows for appropriate treatment and relevant reconstructive surgery. In the future multimodal imaging and the advent of three-dimensional ultrasound scanning for example may prove to be useful in this particular area.

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