

Osteomyelitis of the pelvic bones in patients with spinal cord injury: Is magnetic resonance useful for preoperative diagnosis?

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Abstract

Aim of the study: We report a prospective, observational, single-centre study on adult patients with spinal cord injury (SCI) and pressure sores undergoing surgical debridement and reconstruction at Montecatone Rehabilitation Institute from July 2013 to January 2016. The aim is to assess usefulness of magnetic resonance (MR) in pre-operative diagnosis of osteomyelitis.

Materials and methods: All the patients underwent preoperative MRI each MRI was evaluated independently by two radiologists and the exam was considered positive for osteomyelitis only when the two radiologists agreed on the diagnosis. All the surgical procedures consisted of a wide debridement of soft and bony tissues and reconstruction: bone specimens were collected and sent for culture and histopathological evaluation. Results of MRI and histopathology were compared.

Results: 85 patients were included in the study. The two radiologists working independently agreed on the diagnosis of osteomyelitis in 96% of the cases. Pre-operative MRI was considered positive for osteomyelitis in 45 cases. According to histology, osteomyelitis was diagnosed in 40 patients. MRI findings and histology were concordant in 61% of cases; 19 false positive and 14 false negative cases were found. Sensitivity and specificity of MR in the diagnosis of osteomyelitis were 65% and 58% respectively, with a positive predictive value of 58% and a negative predictive value of 65%.

Conclusion: In our cohort sensitivity, specificity, positive predictive value and negative predictive value of MR for the diagnosis of osteomyelitis in patients with SCI and pressure ulcers are lower than previously described. Our findings suggest that MRI cannot be considered a reliable diagnostic technique for the diagnosis of osteomyelitis. We can conclude that MRI is not indispensable pre-operatively in SCI patients with pressure sores, and that all the patient should undergo a wide soft and bony tissues debridement as if they were all affected by osteomyelitis. Histological diagnosis is useful to decide the timing of antimicrobial therapy, that should be planned based on the results of the surgical specimen culture. Further studies are needed to investigate this topic.

Introduction

Patients with spinal cord injuries (SCI) are at a high risk of developing pressure sores due to decreased mobility and lack of sensation, with a reported prevalence between 23% and 33%, [1,2]. Lifetime risk is estimated between 25% and 85%,³ and an associated mortality between 7% and 8%. [1-3]

Montecatone Rehabilitation Institute is rehabilitation hospital mainly dedicated to patients with spinal cord injuries, with approximately 120 admissions per year for patients affected by pressure sores. Since 2011 a multidisciplinary management of pressure ulcers has been implemented and a dedicated team of plastic surgeons is committed to surgical treatment of grade III-IV lesions.

Complex pressure sores frequently involve the underlying bony structures and may be associated to osteomyelitis. Physical examination is not reliable in the diagnoses of osteomyelitis. The gold standard for the definite diagnosis of osteomyelitis is histology of bone biopsy and the identification of the causative microorganism by tissue culture. [4]

Previous studies have analyzed the usefulness of Magnetic Resonance Imaging (MRI) in the evaluation of osteomyelitis. Patients with SCI and pressure sores represent a difficult subgroup due to the frequent presence of heterotopic ossification in the pelvic bones, wide open wounds, scars for previous wounds, acute and chronic infection of the soft tissues.

In literature MRI for the diagnosis of osteomyelitis presents a sensitivity between 82% and 100% and a specificity between 75% and 96%, especially in the long bones. [5]

The objective of our study is to assess usefulness of magnetic resonance (MR) in pre-operative diagnosis of osteomyelitis of the pelvis in patients with spinal cord injury (SCI) and pressure ulcers.

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Materials and methods

We present a prospective, observational, single-centre study on adult (age ≥ 18 years) patients with spinal cord injury (SCI) undergoing surgical debridement and reconstruction for pressure ulcer of the pelvis (ischium or sacrum) at Montecatone Rehabilitation Institute from July 2013 to January 2016 (Table 1).

All patients included in the study underwent MRI study of the body part affected by pressure ulcer, during the 30 days before the scheduled surgery. Each MRI was evaluated independently by two radiologists, the two radiologists were blinded to each other. According to MRI findings, a diagnosis of osteomyelitis was established in presence of two or more of the following: i) cortical bone erosion, ii) abnormal signal of the marrow on T1-weighted and STIR images, iii) soft-tissue edema, iv) deep collections, v) heterotopic new bone, vi) hip effusion.

MRI was considered positive for osteomyelitis only when the two radiologists agreed on the diagnosis.

Surgical intervention was performed within 30 days from MRI, by the same surgical equipe. All the patients underwent surgical wide debridement of soft and bony tissue. The reconstruction was performed by local fasciocutaneous or musculo-cutaneous flaps.

During surgery, multiple bone and soft tissue specimens were collected and sent for culture and histopathological evaluation (at least 3 per type of tissue). Histopathological and culture analysis were performed in a single lab. The histopathological results of bony intra-operative specimens were regarded as the reference for the definitive diagnosis of osteomyelitis and were compared to MRI results.

Collected data included: demographics of the patient (age, sex); comorbidities (diabetes, venous thrombosis, solid tumour, renal failure); level and cause of spinal cord injury; site and stage of the pressure ulcer (assessed according to the European Pressure Ulcer Advisory Panel classification); MRI findings; results of histopathology of bone intra-operative samples.

Statistical analysis

Descriptive statistics were obtained for all the variables assessed in the study population. Mean and standard deviation were used for

normally distributed continuous variables, median and interquartile range for skewed distributions, proportions for categorical variables. MRI results were compared with histopathology of intra-operative bone biopsy, that represent the gold standard for diagnosis of osteomyelitis. Sensitivity, specificity positive and negative predictive value of MRI in diagnosing osteomyelitis were calculated. Analysis were performed with SPSS 20.0.

Results

During study period 85 patients were included in the study: 89% were males, median age was 48 years (IQR 36-63); 61 patients (72%) were paraplegic and 24 quadriplegics. Etiology of spinal cord injury was trauma in the majority of them (86%).

Pressure ulcers involved ischium in 58,8%, sacrum in 32,9%, 7 patients (8.2%) had ulcers in multiple sites.

Stage of lesion was IV in 79% of patients, III in 13% and in 7 cases (8%) lesion was deemed unstageable.

The two radiologists working independently and blinded to each other agreed on the diagnosis of osteomyelitis in 96% of the cases, which were considered positive for osteomyelitis.

According to pre-operative MR osteomyelitis was diagnosed in 45 cases. According to histopathology a definite diagnosis of osteomyelitis was performed in 40 patients.

According to intraoperative specimen cultures, the most common micro-organisms were *Staphylococcus aureus* (41,8% of the positive specimens), *Proteus mirabilis* (34,1% of the positive specimens), and *Pseudomonas aeruginosa* (16,5% of the positive specimens).

When compared to each other, MRI and histopathology findings were concordant in 61% of cases (52/85); 19 false positive (MR positive/histology negative) and 14 false negative (MR negative/histology positive) were found.

Sensitivity and specificity of MR in the diagnosis of osteomyelitis were 65% and 58%, respectively, with a positive predictive value of 58% and a negative predictive value of 65%.

Table 1. Demographic and clinical characteristics of the study population and comparison between patients with and without osteomyelitis

	All patients (n=85)	Patients without osteomyelitis (n=45)	Patients with osteomyelitis (n=40)	p
Age (ys)-median (IQR)	48 (36-63)	44 (26-61)	54 (42-65)	0.045
Male sex-n° (%)	76 (89)	40 (90)	36 (90)	0.868
Level of SCI-n° (%)				
Paraplegia	61 (72)	32 (71)	29 (72)	0.565
Quadriplegia	24 (28)	13 (29)	11 (27)	
Etiology of SCI-n° (%)				
Trauma	73 (89)	39 (87)	34 (85)	0.930
Vascular	5 (6)	2 (4.4)	3 (7.5)	
Other	7 (5)	4 (8.6)	3 (7.5)	
Comorbidities-n° (%)				
Diabetes	11 (13)	4 (9)	7 (17.5)	0.152
Venous thrombosis	7 (8.2)	1 (2.2)	6 (15)	
Solid tumour	5 (6)	3 (7)	2 (5)	
Renal failure	2 (2.4)	0 (0)	2 (5)	
Site of pressure ulcer-n° (%)				
Ischium	50 (58.8)	14 (16.4)	36 (42.3)	0.064
Sacrum	28 (32.9)	16 (18.8)	12 (14.11)	
Multiple	7 (8.2)	3 (3.5)	4 (4.7)	
Stage of pressure ulcer-n° (%)				
III	11 (13)	8 (18)	3 (7.5)	0.299
IV	67 (79)	33 (73)	34 (85)	
Unstageable	7 (8)	4 (9)	3 (7.5)	

Discussion

Pressure sores in SCI patients cause significant morbidity and are difficult to treat, particularly in case of osteomyelitis. In this study we investigate a single cohort of patients with SCI and pressure sore with potential osteomyelitis because SCI patients with high degree pressure sore, differently to non-SCI patients, always have surgical indication in order to allow the patient a social life.

Any pressure sore can be complicated by osteomyelitis, osteomyelitis can not be diagnosed clinically, in fact signs of infection can be due to soft tissue infection. Current imaging modalities employed in pressure sores with suspect osteomyelitis include ultrasound, osteoscintigraphy, plain films, computed tomography (CT), MRI and PET [6-16]. Ultrasound is not helpful for visualizing bone changes associated with osteomyelitis, nor can it detect associated surrounding soft-tissue infection, but it can be useful to detect fluid collection in joints or soft tissue. Osteoscintigraphy is reliable in excluding bony infection [14,15], but it is not specific for the diagnosis of osteomyelitis in presence of soft-tissues infection, orthopedic devices, trauma, healing fractures, arthritis, surgery, or diabetes [17].

CT and plain films require the use of radiation and are limited in their ability to predominantly show bone changes. Often an irregularity of bone surface is due to erosion, but the cause of erosion is impossible to determine (trauma, neoplasia, exposure, infection, poor vascularity). The overall reported sensitivity of CT and plain film to detect osteomyelitis is 61% and the specificity is up to 69%. [18]

PET is not available in all the hospitals and is very expensive, it is useful to detect infection but in the clinical practice it is usually not applied to SCI patients with ulcers. [19]

MRI has been recognized for its exceptional soft tissue bone marrow contrast resolution and multiplanar capability, which offers greater anatomical detail than CT or conventional plain films [19]. The sensitivity of MRI for the diagnosis of osteomyelitis has been reported between 82% and 100%, and specificity between 75% and 96%. [20]

Hencey in 1996 studied 37 male SCI patients for a total of 44 diagnostic and concluded that MRI is helpful in determining the depth and extent of soft tissue involvement underlying decubitus ulcers, and beneficial in planning proper therapy [21].

Huang performed 59 MR examinations in 44 paralyzed patients with clinically suspected acutely active osteomyelitis. 49 fulfilled the criteria for the diagnosis of osteomyelitis. Osteomyelitis was excluded by histologic results in 3 patients and clinical follow-up in 5 patients. The overall accuracy of MRI was 97% with a sensitivity 98% and specificity of 89%. [22]

In 2012 Lopez analyzed 37 patients with SCI underwent 41 MRI scan and reported a significant association between the prevalence of osteomyelitis and cortical bone erosion and abnormal marrow edema in T1-weighted scan. While deep collections, heterotopic new bone formation, and hip effusion were not of significant predictive value in assessing the risk of osteomyelitis. [13]

Previous studies show that MRI is useful in the diagnosis and monitoring of osteomyelitis. These studies state that MRI is able to diagnose the associated findings in spinal cord-injured patients, including fistulous tract, fluid collections, abscesses, and extent of ulcer and assessed that can guide surgeons for the resection [23-30].

In 2016 Brunel reported a poor agreement between biopsies and MRI (κ 0.2) [31]. In our series sensitivity and specificity of MRI

was not high, respectively 65% and 58%. We also reported an high negative predictive value of 65% and a positive predictive value of 58%. Considering these findings we believe that MRI is not useful in diagnosis and monitoring of osteomyelitis. In our experience MRI seems to be not cost-effective considering the higher costs of the exam, the limited availability, the risks linked to the use of contrast and the reported low accuracy of the results. The small sample size of our cohort and the single center design of the present study are a limitation of the study, in fact they may limit the possibility to generalize results due to possible bias. On the other hand the reduced inter-observer variability of the two blinded radiologists can be considered a strength of the study. As the knowledge in the field of diagnostic performance of MRI to identify osteomyelitis in SCI patients with pressure ulcers is limited, the study can provide useful information for clinical practice. In our opinion in SCI patients affected by pressure sores multiple bone biopsies are mandatory to have a microbiological and histological report, that is the gold standard for the diagnosis of osteomyelitis and allows to administer the correct antibiotic therapy (in terms of medications and time) and to plan a proper follow up (of the wound and blood tests). The bony surgical resection should always be wide (to treat eventual osteomyelitis), and only vital non exposed bone should be preserved.

Our results compare with the retrospective analysis reported by McCarthy in 2017 on 152 patients with pressure ulcer: test properties of MRI for diagnosis of osteomyelitis in patients with chronic pressure ulcers have limited ability to diagnose osteomyelitis and do not aid in surgical management, but do increase health-care expense. [32]

Recently Diffusion Weighted Magnetic Resonance Imaging [33-35] has been introduced as a new tool used not only to differentiate benign from malignant skeletal lesions, but also to detect osteomyelitis. This method seems to be promising, but on the other hand more is needed to evaluate whether a preoperative diagnosis of osteomyelitis may improve the final surgical outcome.

Conclusion

Based on our results MRI cannot be regarded as a reliable technique for the diagnosis of osteomyelitis in patients with SCI and pressure ulcers, all the patient should undergo a wide soft and bony tissues debridement as they were all affected by osteomyelitis. Further studies are needed to investigate this topic.

Conflicts of interest

None.

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