A surgical approach in the management of mucormycosis in a trauma patient

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ABSTRACT

Mucormycosis as a consequence of trauma is a devastating complication; these infections are challenging to control, with a fatality rate approaching 96% in immunocompromised patients. We present a case where a proactive approach was successfully employed to treat mucormycosis following complex polytrauma. Aggressive repeated surgical debridement, in combination with appropriate antifungal therapy, proved successful in this instance. In our opinion, mucormycosis in trauma mandates an aggressive surgical approach. This prevents ascending dissemination of mucormycosis and certainly reduces the risk of patient mortality as a direct result. Anti-fungal therapy should be used secondarily as an adjunct together with surgical debridement, or as an alternative when surgical intervention is not feasible.

KEYWORDS

Mucormycosis – Invasive fungal wound infection – Trauma – *Rhizopus oryzae* – Treatment

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Introduction

Mucormycosis is considered the most aggressive and potentially fatal invasive fungal wound infection to occur in the trauma setting, despite aggressive therapy.¹ If further considerations, such as immunocompromise, acute kidney injury or rhabdomyolysis are taken into account, the resulting mortality rate climbs further.^{2–5} Dissemination of infection is generally fatal, with a mortality rate as high as 96%.^{4–5}

Brief report

A 21-year-old previously healthy male sustained polytrauma as a result of a motor vehicle accident (MVA). He sustained

multiple critical injuries, which are described in Table 1. On presentation, the patient had a Glasgow Coma Scale score of 3, a blood pressure of 96/33mmHg, a heart rate of 140beats/minute, a respiratory rate of 11 cycles/minute and a temperature of 35.0 celsius. Despite fluid resuscitation and the administration of blood products, the patient remained hypotensive and tachycardic. This prompted immediate management of his abdominal and pelvic injuries in the operating theatre, where he underwent laparotomy, splenectomy and packing of the extra-peritoneal pelvis and abdomen with surgical sponges. Given his general critical condition, the operation was terminated and he was transferred to the intensive care unit (ICU).

The patient's admission totalled 339 days, 87 of which were in the ICU; he underwent a series of procedures to address his injuries and associated complications, which are summarised in Table 2. Of relevance to this report, on day 3 of his admission he underwent open reduction and internal fixation of the pelvis and right acetabulum through a posterior Kocher-Langenbeck approach with bilateral percutaneous iliosacral screw fixation. Subsequently, the patient developed several episodes of pyrexia, which were unresponsive to broad-spectrum antibiotics. On routine physical examination, his right hip wound was noted to have a small opening expressing purulent discharge. Histopathological cultures were negative, as were blood cultures for signs of infection. On day 33, surgical exploration revealed frank pus in the pelvic wound tracking posteriorly to the right

Table 1 Summary of injuries

Part of body	Injury
Left lung	tension pneumothorax
Left side ribs	fractures 3–7
Left radius and ulna	Closed fractures
Right femur	Compound fracture grade II
Right knee	Compound fracture
Left tibia/fibula	Fractures
Right acetabulum	Fracture
Pelvis	Anterior posterior compression II
Abdomen	Multiple injuries
Left frontal lobe	Infarction

acetabular region, involving the hardware as well as the lateral thigh soft tissues. The devitalised tissue, including both gluteus medius and minimus, was eventually debrided completely; histopathological examination of this tissue identified the presence of *Mucor* species. The patient was commenced on intravenous amphotericin B 5mg/kg/day (on day 37) which was later changed to posaconazole suspension 200 mg every 4 hours (on day 52) to avoid aggravating the patient's renal injury.

Owing to the patient's poor condition and the invasive nature of mucormycosis, he required 28 operations alternating between aggressive surgical debridement and dressing changes. Negative-pressure wound dressings of the right hip/groin continued during the remainder of his admission in an attempt to control the infection and prevent dissemination. Of note, the average white cell count during his admission was 18,000/mm³ with the highest reported at 70,800/mm³. In Figure 1, a bone scan demonstrates the severity and extent of the infection.

The right hip became septic and the femoral head was ultimately removed; amphotericin B-impregnated polymethyl methacrylate (PMMA) beads were placed for dead-space management and to deliver high concentrations of antibiotics locally. In addition to repeated debridement and lavage, a negative-pressure dressing was placed over the wound and was consistently reviewed and changed appropriately.

During the patient's admission, he was generally restricted to bed, given the extent of his hip injury; however, he was permitted to mobilise using a wheelchair when appropriate. Full contact precautions were enforced throughout his admission to limit dissemination and/or superinfection. The patient's high body mass index assisted in achieving hip immobilisation, with the assistance of a Charnley pillow post-operatively. A final debridement of the right thigh wound, completed on day 223, revealed no evidence of gross infection; culture specimens were negative, as were the surgical margins on pathology. Thereafter, the antibiotic PMMA beads were removed, a PMMA acetabular spacer was inserted for dead-space management and the wound was closed

Table 2 Procedure/intervention

Day	Intervention
0	Admission
1	Re-look laparotomy removal of packs
3	Re-look laparotomy washout right thigh wound
11	Open reduction and internal fixation pelvis + right acetabulum, bilateral sacroiliac screws
14	Laparotomy w/o stoma formation bowel resection
33	Re-look laparotomy
35	Laparotomy washout/vac dressing/debride right hip/leg wound
37	Commence intravenous amphotericin B 5 mg/kg/day
38	Laparotomy, washout of abdomen
44	Washout left wrist, incision and drainage and vac to right thigh
50	Washout and debridement and closure of right thigh wound
52	Change intravenous amphotericin B to posaconazole 200 mg orally every 4 hours
60	Washout/debridement right buttock
63	Washout ± closure right buttock wound
67	Washout ± closure right thigh (± vac)
77	Washout right hip and intrapelvic collection
80	Washout right buttock wound/excision arthroplasty/ vac change
85	Washout ± debridement ± vac dressing, change right thigh dressing
92	Washout/debridement/vac dressing change right thigh
106	Washout/removal of acetabular spacer/vac dressing to right buttock/thigh
119	Washout/debridement/removal of metal work/vac dressing change right hip
124	Change of dressings abdominal wound
129	Washout/debridement/vac dressing right hip-
138	Washout/change vac right hip
143	Washout/change vac right hip
153	Washout/debridement right hip wound
161	Washout/debridement of right hip wound
168	Washout debridement right hip wound
176	Transposition/muscle flap to right hip defect
186	Washout/debridement right hip wound
189	Washout/debridement right hip flap
193	Washout/debridement right hip flap
199	Change of vac dressing right hip wound
202	Wound debridement right hip/buttock/vac dressing
223	Washout + debride + close right hip wound
255	Removal of metalwork from pelvis
256	Discharge to auxiliary (step-down) medical service
339	End of admission; discharge to rehabilitation facility

primarily. The patient remained on intravenous systemic antifungal therapy as well as broad-spectrum antibiotic therapy throughout his admission. Concurrent management of other injuries and pathophysiology, including acute renal failure, ventilation difficulty and pain continued throughout his admission. His condition gradually improved and he was discharged (on day 256) to a medical auxiliary service for further management and supportive care. A radiograph of his initial injury is depicted in Figure 2a, together with a final radiograph of his right hip in Figure 2b.

On annual follow-up, the patient was continuing to take oral low-dose posaconazole 100 mg three times/day. He lives independent of family but still requires the assistance of a carer. He mobilises using a wheelchair and remains non-weight-bearing to date, using his upper limbs and occasionally a hoist for transfers.

Discussion

An underlying immune deficiency, from a pre-existing condition or when induced by trauma, predisposes the development of mucormycosis.⁶ We hypothesise that our patient acquired his right hip infection through direct contamination of his wounds by soil as the result of an MVA. Trauma patients

with confirmed mucormycosis (accounting for 34% of cases in one report) generally have open, grossly contaminated wounds.⁷ The majority of mucormycosis infections that occur in trauma have been documented among military casualties of war. However, more recently, cases have also been identified among civilians, most notably following MVA.⁸

Rhizopus oryzae is the most common pathogen isolated in mucormycosis.⁹ Rapid angio-invasion and resultant thrombosis are the hallmarks of mucormycosis infection. This effectively renders medical therapy impossible and encourages dissemination. The lack of sensitive diagnostic tests further increases the risk of dissemination. It should be acknowledged that pyrexia episodes, in our patient, were non-contributory in the diagnosis and management of his mucormycosis. The patient underwent multiple consecutive operations and procedures, which themselves result in pyrexia. Only when our patient's pyrexia failed to wane with the administration of broad-spectrum antibiotics did it warrant additional scrutiny. Furthermore, more sensitive markers of inflammation, the white cell count and repeated washouts and tissue specimens, were successfully used to accurately gauge and direct our management of the infection. Surgical debridement is the key to controlling and eliminating mucormycosis, but anti-fungal treatment is also typically

Figure 2a Radiograph of anteroposterior pelvis illustrating APCII fracture on admission (day 0)

Figure 2b Radiograph of anteroposterior pelvis depicting final resolution of treatment (day 239)

used in combination.⁹ Studies confirm amphotericin-B liposomal 3.0 mg/kg accompanied by aggressive surgical debridement, up to and including amputation, is reasonably

effective.¹⁰ Posaconazole, the use of which is cautioned, is an alternative when patients respond poorly to amphotericin B.¹¹ The use of negative-pressure wound dressings appears promising, as was the case in our patient.

Since the introduction of penicillin, very few infections do not respond favourably to antimicrobial therapy. The greatest challenge, apart from pathogen resistance, in administering antibiotic therapy is to ensure its adequate bioavailability at non-toxic doses with a relatively limited adverse-effect profile. In an immune-competent person, even a highly pathogenic infection can be well controlled principally with antimicrobial therapy alone. However, this is less likely in an immune-compromised individual. Mucormycosis is a highly aggressive infection that targets and destroys local vasculature, preventing the delivery of systemic antimicrobial therapy. As a consequence, aggressive surgical debridement or amputation plays a far more important role. This is akin to the principles of infection control first outlined by Orr¹² and Trueta,¹³ who faced similarly challenging chronic infections before the advent of antibiotics. Unable to employ effective antibiotic therapy, they were compelled to rely on meticulous debridement and amputation for their management.

Conclusion

Recent reports of military casualties succumbing to mucormycosis infection as a result of polytrauma demonstrate that this organism is not novel in a trauma setting. Similar reports from recent natural disasters also support this finding. A lack of sensitive diagnostic tests for the infection, coupled with a doubled mortality observed by a 5-day delay in treatment, makes diagnosis both challenging and vitally important.⁹ Medical therapy failed in our patient, and aggressive surgical debridement provided the only avenue for successful treatment. It is critical to note that this patient's young age offered no protection when his critical condition was taken into account. Surgical debridement is the key for patients afflicted with mucormycosis to have the best chance of controlling this infection.¹⁰ Other more radical options, such as hemipelvectomy or hemipectomy, can be considered to combat an ascending and potentially disseminating or uncontrolled infection.

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