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Comparative study of chronic osteomyelitis treated with debridement with antibiotic beads with bone cement and debridement with antibiotic loaded calcium sulphate

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Abstract

Background: Calcium sulphate is bone void filler that is osteoconductive. It is entirely absorbed, and it aids in the remodelling and restoration of structural properties. After 12 weeks, it is biocompatible, bioactive, and resorbable. It's coupled with a variety of heat-stable antibiotics to form a resorbable delivery method for infections of the bones and soft tissues. Filling a bone cyst, benign bone lesions, and cavitary or segmental bone defects are all indications. The predominant component of inorganic substances in bones is calcium hydroxyapatite, a highly crystalline CP salt with a high degree of hardness. Phosphate and calcium ions are used by osteoblasts to make HA. Synthetic hydroxyapatite is a calcium phosphate that is biocompatible.

Methodology: Debridement with antibiotic embedded calcium sulphate was administered to 15 individuals and debridement with antibiotic beads was given to the remaining 15 patients who presented with osteomyelitis. Both sets of patients' investigations were submitted, and they were followed up on radiologically and functionally after three, six, twelve, and twenty-four weeks, respectively.

Results: When compared to patients who were treated with antibiotic beads, patients who were treated with antibiotic embedded calcium sulphate had a better and faster recovery rate. The calcium sulphate was

completely absorbed, but the antibiotic beads had to be surgically removed, necessitating a second surgery and an additional hospital stay. Patients treated with calcium sulphate experienced early functional and radiological healing, as well as a slower pace of recovery.

Conclusion: As a result, compared to antibiotic beads, calcium sulphate embedded antibiotic beads provide a better and faster functional and clinical outcome, absorbs entirely on its own, decreases hospital stay, and minimise the risk of re infection. As a result, in addition to surgical debridement and antibiotics, it might be recommended as a good therapy option for chronic osteomyelitis.

Keywords: Antibiotic, Foreign Body, PMMA,

Introduction

Osteomyelitis is a bone and marrow inflammation. Pyogenic organisms, tuberculosis, syphilis, a specific virus, or a foreign body could all be to blame [1]. Obesity, diabetes, and vascular diseases are most commonly seen in infancy and childhood, and are more prevalent in males. Pus on aspiration from affected bone, positive bacterial culture from bone tissue, irritability, local bone tenderness, and local temperature rise are all symptoms of acute osteomyelitis [2]. Decompression, pus evacuation, surgical debridement of affected bone with antibiotics, and structural bone reconstruction [3].

Recently, osteoconductive materials, in conjunction with antimicrobial agents, have been used to aid in dead space management [4]. Distraction osteogenesis has also been used extensively for lower limb involvement in recent years [5]. However, to the best of our knowledge, only a few studies have been published in the literature that used antibiotic carriers in conjunction with the principle of distraction osteogenesis. Calcium sulphate, calcium phosphate, and hydroxyapatite have all been used in the past [6].

When calcium sulphate is combined with a variety of heat stable antibiotics, it creates a resorbable delivery system for bone and soft tissue infections [7]. PMMA is a type of bone cement that is widely used. It is made out of a powdered polymer that is combined with a liquid monomer [8]. Due to free radical polymerization, it eventually forms a solid structure. While performing the surgery, keep in mind that the viscosity changes over a few minutes, transforming the powder into a durable solid mass [9]. When choosing antibiotics to mix with PMMA, factors like heat stability and hydrophilic nature should be considered. Gentamicin, vancomycin, and tobramycin are the most commonly prescribed antibiotics [10].

Antibiotic concentrations in local concentrations are more than 190 times higher than in systemic concentration delivery, allowing antibiotics to be delivered at levels well surpassing the minimal inhibitory concentrations [11-12]. PMMA and antibiotics are used to make antibiotic beads. It can serve as a biomaterial surface that bacteria like to cling to [13]. Recently, biodegradable antibiotic-impregnated (calcium sulphate) beads have been used, and the antibiotic release kinetics have been found to be favorable [14]. Cement -40 gm and antibiotics - Gentamycin 1-2 gm and Vancomycin 1-2 gm - make up the antibiotic bead mix. Tobramycin, penicillin, cephalosporin, and amikacin are among the antibiotics that can be employed. The gentamicin concentration stays the same for a month. The shape and size of the methylmethacylate utilised affects the antibiotic's distribution and duration of activity.

Within two to four weeks, the PMMA is removed and replaced with a cancellous bone graft. Tetracyclines, fluoroquinolones, and polymyxin B are usually not used since they are heat stable and antibiotics are employed.

Antibiotic beads should be removed after 6 weeks since permanent implantation of beads has no effect, and removal of beads causes local tissue scarring and adhesions, which can lead to infection.

Materials and methods

Including Criteria and Patients' Information

Criteria for inclusion

- Age range: 11 to 85
- According to the Cierny Mader classification, type 3,4 grading.
- Informed consent from the patient

Criteria for exclusion

- Tumors of the bones
- Defects that are present at birth
- Surgical refusal

Our study included 30 patients, 20 (66.6 percent) of whom were male and 10 (33.34 percent) of whom were female. The patients' average age was 38 years. The initial diagnosis was closed fracture in 28 patients and open fracture in 2 patients, and the latter was further classified by the Gustilo and Anderson grading system. For the majority of the patients who presented with similar grade osteomyelitis, openly reducing the fracture and debriding it after internally fixing the fracture was done. Road traffic accidents and falls from great heights were the most common causes of injury. Rarely, a hand caught in machinery was also included.

Each patient's history was taken, a physical and local examination was performed, and routine tests were ordered. Pain, swelling, and sinus drainage are all common symptoms. All routine patient investigations were sent along with CRP. Along with the CT scan, an X-ray of the affected limb was obtained. Blood and urine cultures were also sent. Not every patient had an abnormal report, for example, CRP was not significantly elevated in some patients, but some patients showed signs of sepsis.

Surgical Exposure

Debridement with calcium sulphate including antibiotics -Group A

Under general anaesthesia or spinal anaesthesia, the patient is in a supine position or lateral or suitable position- scrubbing, painting, and draping was done. Standard surgical procedures were done so that affected bone could be exposed. Superficial dissection was done, muscles were retracted. Deep dissection were performed, fascia exposed with help of artery. Debridement was done till the bone was bleeding, pus discharge was detected while retracting muscle, pus was sent for culture and sensitivity, and nearby tissue was sent to histopathology. Wash was given with normal saline.

-5ml Caso4 paste coated with antibiotic (vancomycin 1gm) was created and shaped into beads, which were then inserted into the bone void spaces of the bone involved and covered with abgel.

External fixator was given in cases which compromised bone stability after debridement of the bone. Wound was closed in layers with vicryl 2-0 on the muscle and ethilon 2-0 on the skin, and a pin tract dressing was applied.

Figure 1: Pre operative photo of 14-year-old male with radius osteomyelitis.

a) Clinical photo of volar aspect of distal radius affected with osteomyelitis.

b) Clinical photo of comparison of both the forearm of the person affected with radius osteomyelitis

c) X ray image of right forearm osteomyelitis antero posterior view and lateral view.

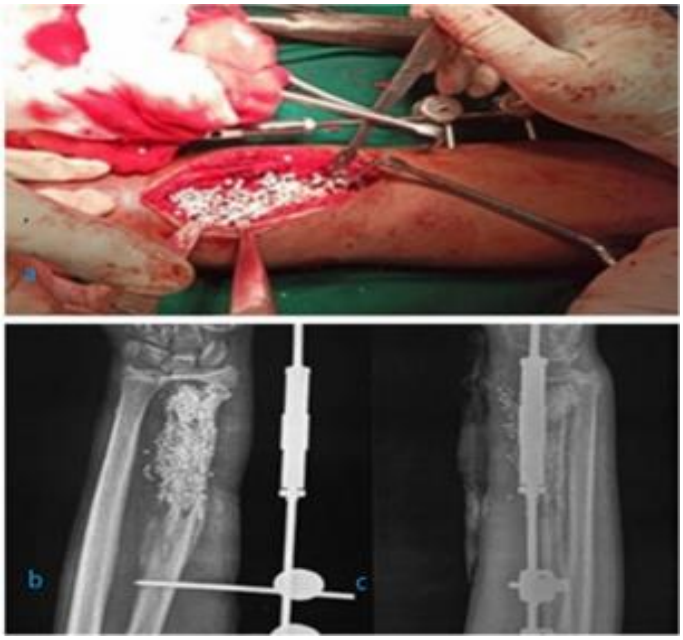


Figure 2: Operative and post operative image of radius osteomyelitis treated with calcium sulphate paste and antibiotic -post operative day zero.

a) Intraoperative image of radius osteomyelitis treated with Calcium sulphate paste with antibiotic.

b) X ray of radius osteomyelitis treated with calcium sulphate paste and antibiotic bead along with external fixator in ap view.

c) X ray of radius osteomyelitis treated with calcium sulphate paste and antibiotic along with an external fixator in lateral view

Figure 3: Follow up case -Post operative image of patient with radius osteomyelitis treated with calcium sulphate and antibiotics.

a) Image showing dorsiflexion of wrist at post operative day 120.

b) Image showing x ray of forearm in anterior posterior and lateral view at post operative day 120.

c) Image showing palmar flexion at post operative day 120

Post operative management

The patient was given IV antibiotics following the procedure for postoperative management. The antibiotic was chosen based on the culture and sensitivity of the bacteria. Broad spectrum antibiotics were begun prior to the culture sensitivity results in cases where sepsis was a possibility. After 2 or 3 weeks, they were switched to oral antibiotics. During treatment, the ESR, q crp, and routine blood tests were also monitored. Antibiotics were given for a total of six weeks.

Dressings were applied when the wound was moistened and were done on a regular basis on post-operative days 2 and 8. At the outpatient department, radiographs were taken every 14 days for the first month and then every month after that. A physical examination was performed on the patient to assess limb function and manage any

issues that arose. The external fixator was withdrawn once the bridging callus and limb length were recovered on radiograph.

Debridement with Antibiotic bead -Group B

Antibiotic beads and bone cement were used to treat 15 of the 30 cases of chronic osteomyelitis. Scrubbing, painting, and draping were performed on the patient in a supine/lateral position under local anaesthesia. A suitable incision was created, superficial and deep dissection was performed, pus discharge was detected, aspirated and sent for pus culture and sensitivity, and nearby tissue was sent for histopathology.

In the open air, 40 gm of bone cement was mixed with 3 gm of antibiotic (vancomycin) using a spatula. With time, a doughy texture will emerge, which may then be formed into a bead shape. The beads can be strung on ss wire and inserted into the empty spot. The amount of beads is counted and recorded in the operative records, after which the same number is surgically removed. For a few weeks, the patient was maintained in an external fixator.

Figure 4: Pre operative x ray and operative image of a patient with femur osteomyelitis treated with antibiotic beads with bone cement a)Image showing antibiotic beads on a 16G stainless steel wire .b)Intraoperative image of distal femur osteomyelitis debridement .c) Pre operative x ray of femur osteomyelitis -operated case of right mid shaft femur fracture with intramedullary nail in situ.d) Intra operative image of femur osteomyelitis treated with antibiotic beads along with illzarov -external fixator.

Post op

The patient was given IV antibiotics based on culture and sensitivity for a period of 14 days, followed by oral antibiotics for 4 weeks. The complete blood count, esr, and crp levels were checked every two weeks for the first two weeks, then every two weeks for the next month, and then every month after that. In one case, re-infection was discovered, necessitating another debridement.

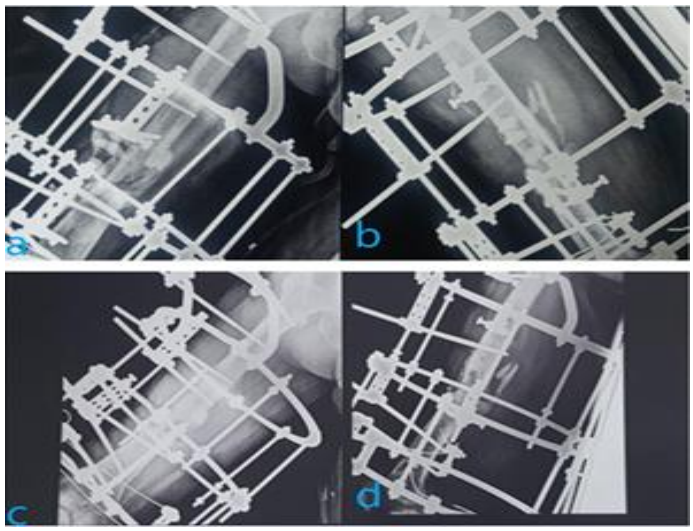


Figure 5: Post operative x ray photo of osteomyelitis treated with antibiotic beads and bone cement.

a) and b) Post operative x ray photo ap and lateral view of osteomyelitis treated with antibiotic beads and bone cement at post operative day 40.

c) and d) Post operative x ray photo ap and lateral view of osteomyelitis treated with antibiotic beads and bone cement at post operative day 120 after antibiotic bead removal.

Results

Group A was treatment of chronic osteomyelitis with calcium sulphate and antibiotics and group B was

treatment of chronic osteomyelitis with antibiotic beads and bone cement. The average bone defect was discovered to be 7 cm using radiography.

All patients were followed up on, and the average follow-up period was 12 months.

All patients had access to their laboratory results and radiographs. With osteomyelitis, the total sample size was 30. 15 of them were subjected to calcium sulphate debridement, while the remaining 15 were subjected to antibiotic bead debridement. Bone union was successful in 30 patients. The average duration of external fixation was 8 months (range from 3to 12 months). The average external fixation index in our study was 1.7mon/cm, which is defined as duration in months divided by total centimetre transported. Group A was debrided with calcium sulphate, while Group B was debrided with antibiotic beads.

Union occurred at a slightly faster rate in Group A than in Group B, and infection occurred at a slightly higher rate in Group B than in Group A.

Analysis of the Data

EpiInfo v7.2.4 (CDC EpiInfo, https:// www.cdc.gov/ epiinfo/ index. html) and MedCalc (MedCalc Statistical Software version 18.2.1 (MedCalc Software, Ostend, Belgium; http://www.medcalc.org; 2018) were used to analyse the data. Categorical variables are counted in percentages and expressed in terms of frequency. Mean (Standard Deviation, SD) and Median for continuous variables (Interquartile Range, IQR). The Shapiro-Francia test confirmed the normal distribution. The statistical significance was tested using an independent sample t test. $P < 0.05$ is judged statistically significant at the 95 percent confidence level in all of the tests performed.

Table 1: Table showing age, sex, grade of infection, complication, outcome and side affected.

		Group A (%)	Group B (%)	95% CI Group A (%)	95%CI Group B (%)
Age	11-30	26.6	6.6	7.79-55.10	0.17-31.95
	31-50	33.3	39.9	11.82 -61.62	16.34-67.71
	51-65	26.6	26.4	7.79-55.1	7.79-55.1
	66-80	13.3	26.4	1.66-40.46	7.79-55.1
Sex	Male	46.6	53.3	26.59-78.73	21.27-73.41
	Female	53.3	46.6	21.27-73.41	26.59-78.73
Grade of infection	Grade-3	40	46.6	16.34-67.71	21.27-73.41
	Grade -4	60	53.3	32.29 -83.66	26.59 -78.73
Complications	Reinfection	6.66	13.32	0.17-31.95	1.66-40.46
Outcome	Excellent	53.33	40	26.59-78.73	16.34-67.71
	Moderate	26.67	33.33	7.79-55.10	11.82-61.62
	Poor	20	26.67	4.33-48.09	7.79-55.10
Side affected	Left	53.33	46.67	26.59-78.73	26.59-78.73
	Right	46.67	53.33	21.27-73.41	21.27-73.41

Table 2: Table showing healing time in weeks, days to attain full range of motion and hospital stay in days.

	Group A Mean (SD)	Group B Mean (SD)	Independent samples t test
Healing time in Weeks	17.4 (1.59)	20.73 (1.22)	t = 6.424, df = 28, p< 0.001
Days to attain full range of motion	107.46 (6.16)	121.93 (3.91)	t = 7.672, df = 28, p< 0.001
Hospital stay in days – Mean (SD)	15.46 (1.95)	23.13 (1.99)	t = 10.619, df = 28, p< 0.001

Graph

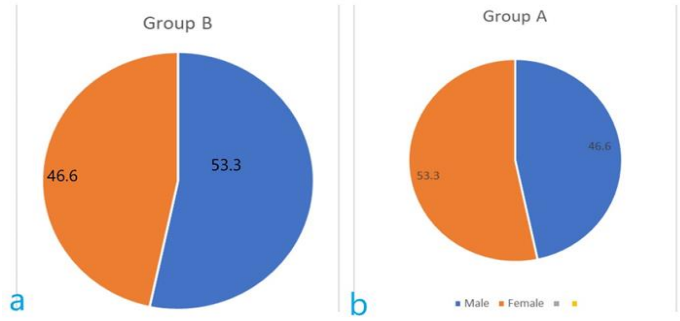
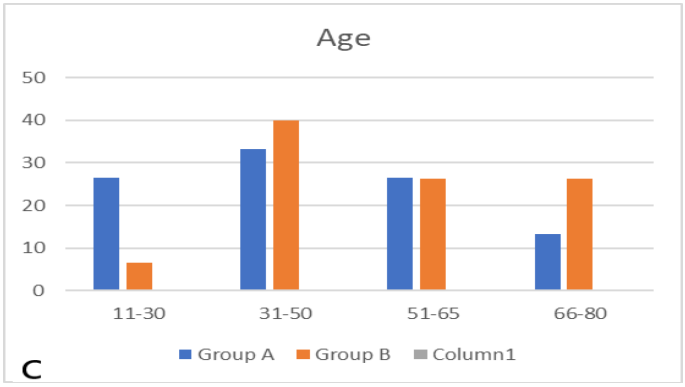


Figure 6 a: Pie chart representing the sex ratio of patients involved in the study for osteomyelitis treated with antibiotic beads with bone cement.

b: Pie chart representing the sex ratio of patients involved in study of osteomyelitis treated with calcium sulphate and antibiotic



c: Bar diagram showing no of patients in both group A and B in different age groups involved in the study.

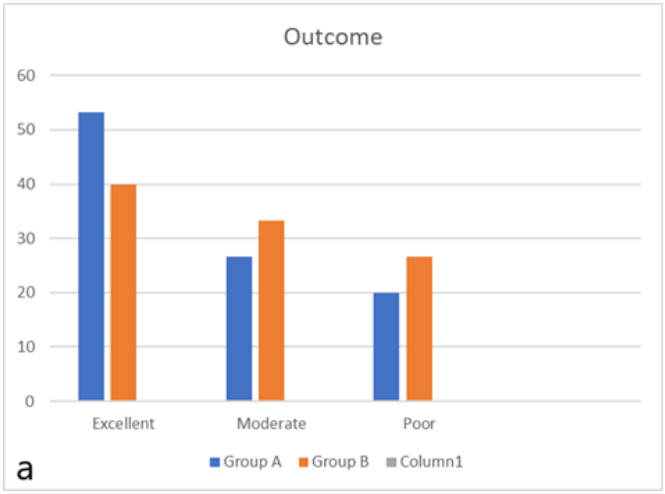
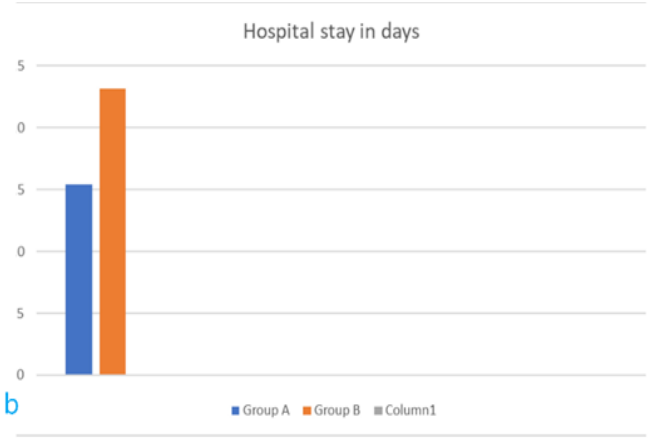


Figure 7 a: Bar diagram showing outcome of group A and group B



b: Bar diagram showing hospital stay in group A and group B.

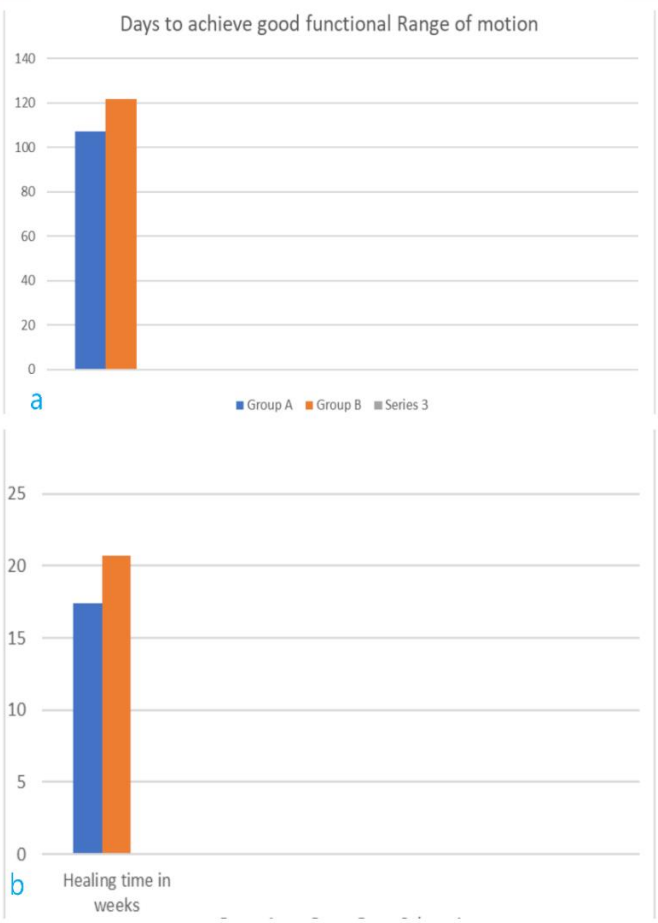


Figure 8 a: Bar diagram showing days to reach functional range of motion in group A and group B.

b:Bar diagram showing healing time in weeks for group A and group B.

Discussion

Chronic osteomyelitis is characterised by non-traumatic pain and swelling at the site of infection, as well as a discharging sinus that lasts for more than 12 weeks. We can confirm an infected cavity with sequestrum and involucrum using x-rays. Improperly treated or untreated acute osteomyelitis, open fractures, and poor host factors all contribute to chronic osteomyelitis that is difficult to treat. Bacteria adhere intracellularly in osteoblasts, can undergo phenotypic alteration and become more resistant to antimicrobials, adhere to collagen, and inhibit proteolytic activity in the presence of infection, all of which contribute to chronic osteomyelitis that is difficult to treat. Chronic osteomyelitis is typically treated surgically, which includes the removal of dead space, dead bone, and tissues.

As part of the surgical procedure, sinus tract excision, sequestrectomy, saucerisation, and cavity curettage are performed. Antibiotic beads combined with bone cement deliver antibiotics for an extended period of time. Biodegradable agents, such as calcium sulphate, have a greater advantage because they require only one surgery and do not need to be removed because they are absorbed, whereas antibiotic beads with bone cement require an additional surgery for removal, and it also increases the risk of infection, local tissue scarring, adherence, and biofilm formation due to the stainless-steel wire used to keep the antibiotic beads in place.

30 individuals were diagnosed with osteomyelitis, 15 of them were treated with calcium sulphate and antibiotics, while the other 15 were treated with antibiotic beads and bone cement, as well as debridement. The age range chosen was 11 to 80. On admission, x-rays were done, and a crp was sent along with regular investigations. Following surgery, dressings were applied anytime there was a leak, IV antibiotics were started and given for 14 days, and sutures were removed. The average hospital stay for calcium sulphate induced antibiotic beads was 15 days, compared to 23 days for antibiotic beads. Oral antibiotics were given for another four weeks. X-rays were taken at 2, 6, 12, and 24 weeks to follow up on the patients.

In a study of 193 cases of chronic osteomyelitis treated with antibiotic-loaded calcium sulphate over a 3.7-year period by Fergueson et al, infection was cured in 191 cases, whereas re infection occurred 10.3 months after the operation. Another investigation of treating chronic

osteomyelitis with antibiotic beads and PMMA by Masri et al., 1998; Hsieh et al., 2006, found that the antibiotic concentration remained above the MIC for several months after antibiotic beads were implanted at the diseased location. In a study of 72 individuals with persistent osteomyelitis, 36 were treated with closed lavage while the remaining 36 were treated with antibiotic beads. When compared to osteomyelitis treated with closed lavage, the average length of hospital stay, the average time of surgery, and the cure rate and bacteria removal were all higher in the group treated with antibiotic beads.

Conclusion

Based on the above factors, we may conclude that group A has better outcomes than group B, that is osteomyelitis treated with stimulant/calcium sulphate and debridement has better results than osteomyelitis treated with antibiotic beads and bone cement. Based on the information presented above, we can conclude that debridement with calcium sulphate does not necessitate additional surgery because it dissolves in the bone over time, whereas procedures with antibiotic beads will almost certainly necessitate additional surgery other than debridement to simply remove the antibiotic beads because they do not dissolve like calcium sulphate beads. This lengthens the hospital stay and increases the risk of infection as a result of the additional hospitalisation and operation.

In comparison to antibiotic beads, the range of motion is also full, albeit a bit earlier in the case of calcium sulphate beads.

References

1. Nade S: Acute hematogenous osteomyelitis in infancy and childhood. J Bone Joint Surg 1983;65B:109

2. Song KM, Sloboda JF: Acute hematogenous osteomyelitis in children. J Am Acad Orthop Surg2001; 9:166

3. Morrey BF, Peterson HA. Hematogenous pyogenic osteomyelitis in children. OrthopClin North Am1975; 6:935-951

4. Peltola H, Vahvanen V. A comparative study of osteomyelitis and purulent arthritis with special reference to a etiology and recovery. Infection 1984; 12:75-79

5. Toolan BC. Current concepts review: Orth biologics, Foot Ankle Int. 2006;27(7):561-567.

6. Matthews SJ, Nikolaou VS, Giannoudis PV. Innovations in osteosynthesis and fracture care. Injury. 2008; 39:827-838.

7. Kolk A, Handschel J, Drescher W, et al. Current trends and future perspectives of bone substitute materials -- from space holders to innovative biomaterials.) Craniomaxillofac Surg. 2012; 40:706-718, BMC.

8. Cierny G, Mader JT. Adult chronic osteomyelitis. Orthopedics. 1984; 7:1557-1564.

9. Cierny G, Mader JT. Adult chronic osteomyelitis. An review. In: D'Ambrosia RD, Marier RL (eds). Orthopaedic infections. Thorofare, NJ: Slack; 1989. pp. 31-48

10. Badie AA, Arafa MS: One-stage surgery for adult chronic osteomyelitis: con-comitant use of antibiotic-loaded calcium sulphate and bone marrow aspirate, Int Orthop 43:1061, 2018

11. Chen HC, Wuerdeman MF, Chang JH, et al.: The role of whole-body magnetic resonance imaging in diagnosing chronic recurrent multifocal osteomyelitis, Radiol Case Rep 13:485, 2018.

12. Falip C, Alison M, Boutry N, et al.: Chronic recurrent multifocal osteomyelitis (CRMO): a

longitudinal case series review, Pediatr Radiol 43:355,2013.

13. Cotetzee AS; Regeneration of bone in presence of calcium sulfate. Arch Otolaryngol 1980; 106:405-409.

14. Kelly CM et al: The use of a surgical grade calcium sulfate as a bone graft substitute: Results of a multicenter trial. Clin Orthop 2001; 382:42-50