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Research Article

Debridement with high speed burr reduce more colonies of *Staphylococcus aureus* in chronic osteomyelitis of rabbit's tibia compare to debridement with curettage

Su Djie To Rante[1]*, Henry Ricardo Handoyo[2]

[1]Nusa Cendana University, Dr. Wz. Johannes General Hospital, Kupang, Indonesia
[2]Department at Surabaya Orthopedi and Traumatology Hospital, Surabaya, Indonesia

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***Correspondence:**
Dr. Su Djie To Rante,
E-mail: drdjieto@yahoo.com

ABSTRACT

Background: Chronic osteomyelitis has been a difficult problem for the patient and for the treating physician. Chronic osteomyelitis is defined by most authors as osteomyelitis with symptoms that have been present for more than 1 month. Chronic osteomyelitis also defined by an infected dead bone within compromise soft tissue. An aggressive debridement and specific antibiotic treatment is first choice for chronic osteomyelitis. The purpose of this study was to assess the reduction in the number of colonies of *Staphylococcus aureus* after debridement with a high speed burr compared to debridement with curettage.
Methods: This study is an experimental study was designed using a randomized post-test only group design. A total of 42 rabbits inoculated his right tibia with 0.1 ml *Staphylococcus aureus* 10^7 CFU / ml, and then inserted with K-wire intramedullary. Two weeks after inoculation, chronic osteomyelitis occurs, grade 3 and 4 radiologically. Then 10 rabbits were sacrificed without debridement, colonies of germs counted as control, 16 rabbits was performed debridement with curettage and 16 rabbits was performed debridement with high speed burr. Three weeks after debridement, 32 rabbits was sacrificed and counted for final germs colonies.
Results: The results obtained from debridement with high speed burr and debridement with curettage, number of colonies of *Staphylococcus aureus* is less than the number of control's colonies, with a value of $p = 0.006$ ($p < 0.05$), debridement with a high speed burr also decrease the number of colonies of *Staphylococcus aureus* compared to debridement with curettage, with $p = 0.023$ ($p<0.05$), odds ratio of 9.000 (CI=95%). This is shows that this difference is statistically significant.
Conclusions: The data showed that debridement with a high speed burr more likely to decrease the number of colonies of germs that can be recommended as a method of debridement for chronic osteomyelitis.

Keywords: Debridement, High speed burr, Curettage, Chronic osteomyelitis

INTRODUCTION

Chronic osteomyelitis has been a difficult problem for the patient and for the treating physician. Recurence rate is still high and the patient needs more time in the hospital. Pain, limited of activities and deformity caused by infection has morbidity for the patient physically and psychologically. Goals of treatment are eradication of infection and return to physiological function. Osteomyelitis is defined as infection of the bone.[1] chronic osteomyelits is defined as osteomyelitis with symptoms that have been present for more than one months.[2] The hallmark of chronic osteomyelitis is infected dead bone within a compromised soft tissue envelope.[3]

Despite advances in both antibiotics and surgical treatment, the long-term recurrence rate remains approximately 20%-30%.[4] Treatment of chronic osteomyelitis include adequate drainage, thorough debridement, dead space management, soft tissue coverage and specific antibiotic treatment.[4,5] All the sequestrum has to be removed and all the necrosis tissue has to be curettage from the medulla.[6] Living tissue must be seeing in the resection border, with sign of bleeding spot (paprika sign).[1,4]

High speed burr is essensial for removing small nooks and crevices where pockets of disease hide. High speed burr had better control for debridement.[7] High speed burr also extend the curettage until normal bone.[8] *Staphylococcus aureus* is by far the most common pathogen causing acute hematogenous osteomyelitis in all age categories.[9] *Staphylococcus aureus* still the most common isolated pathogen in chronic osteomyelitis.[10] To diagnosis an infection inside the bone (chronic osteomyelitis) depend on isolated pathogen from culture of sample from bone lesion, blood or synovial fluid.[11]

From the above basis, high speed burr can be used for debridement of chronic osteomyelitis. A good local control can remove all the necrotic tissue compare to the curettage. The final result from debridement is reduce or remove focus of infection, that has to be proof by reduce or disappearence of colonies of *Staphylococcus aureus* in the culture of tissue.

METHODS

This study is an experimental study, a randomized post-test only control group design. By measuring the amount of *Staphylococcus aureus* in chronic osteomyelitis of rabbit's tibia after debridement with high speed burr compare to debridement with curettage.

A total of 42 New Zealand adult female rabbits weighting 2-3 kg, age 8-12 weeks, anesthesized with 35 mg/Kg body weight of ketamine and 5 mg/Kg body weight of xylazine, and then inoculated with *Staphylococcus aureus* ATCC 33591 0.1 ml (10^7 CFU/ml) in the right tibia, and inserted with a 2.5 mm stainless steel (K-Wire) intramedullary from proximal tibia and maintain for 2 weeks. The result is chronic osteomyelitis grade 3 or 4 radiologically.

Then 10 rabbits were sacrificed without debridement, colonies of germs counted as control, 16 rabbits was performed debridement with curettage and 16 rabbits was performed debridement with high speed burr. Three weeks after debridement, 32 rabbits was sacrificed and counted for final germs colonies.

The results was analyzed for statistical significance using SPSS 17.0 for Windows. Descriptive analysis and comparative analysis *Kruskal-Wallis* test was conducted for numeric variables and chi-square analysis was done for categorical variables.

RESULTS

Characteristic result from colonies count of *Staphylococcus aureus* are shown in the Table 1.

Table 1: Characteristic result of *Staphylococcus aureus* colonies count.

Group	Grade radiologically	Total colonies
Control	4	130
Control	3	0
Control	4	765
Control	4	62500
Control	4	650
Control	4	60
Control	4	815
Control	4	14133
Control	4	80566
Control	4	7100
Curettage	4	10
Curettage	4	320
Curettage	4	1260
Curettage	4	125
Curettage	4	30
Curettage	4	0
Curettage	4	943
Curettage	4	0
Curettage	4	40
Curettage	4	10
Curettage	4	30
Curettage	4	1105
Curettage	4	50
Curettage	4	170
Curettage	4	2320
Curettage	4	12250
High Speed Burr	4	0
High Speed Burr	4	0
High Speed Burr	4	0
High Speed Burr	3	0
High Speed Burr	4	1633
High Speed Burr	4	50
High Speed Burr	4	6155
High Speed Burr	4	0
High Speed Burr	4	280
High Speed Burr	4	2140
High Speed Burr	4	1496
High Speed Burr	4	587
High Speed Burr	3	0
High Speed Burr	3	0
High Speed Burr	4	0
High Speed Burr	4	0

There are three group of research. The control group that hasn't done debridement and experimental group that has done debridement with curettage and high speed burr. We can see from the table that in the curettage group there is a reduce of the *Staphylococcus aureus* colonies, but in the high speed burr group number of aseptic result is more common. The average of the colonies can be seen in the Table 2.

Table 2: Average of *Staphylococcus aureus* colonies in the.

Group	Colony count		
	Minimum	Maksimum	Mean
Control	0	80.566	16.671.90
Debridement with curettage	0	12.250	1166.44
Debridement with high speed burr	0	6155	771.31

Radiographic grade of chronic osteomyelitis can be seen in the Table 3.

Table 3: Radiologically criteria for chronic osteomyelitis grade in rabbit's bone.[12]

Grade	Radiographic Finding
0	Normal
1	Elevation or disruption of periosteum, or both, soft tissue swelling
2	<10% disruption of normal bone architcture
3	10% - 40% disruption of normal bone architcture
4	>40% disruption of normal bone architcture

Chronic osteomyelitis of the rabbit's tibia can be seen in the Figure 1. The lytic lesion in the middle of the implant shows an example of infection in the grade 3 (Figure 1A) and when litic lesion until the distal side is an example of infection in grade 4 (Figure 1B).

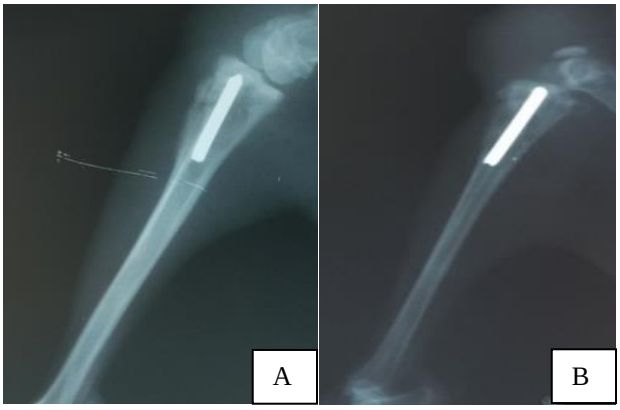

Figure 1: Radiography picture of chronic osteomyelitis; (A) Grade 3; (B) Grade 4.

Clinical pictures after debridement with curettage can be seen in Figure 2A and debridement with high speed burr can be seen in the Figure 2B.

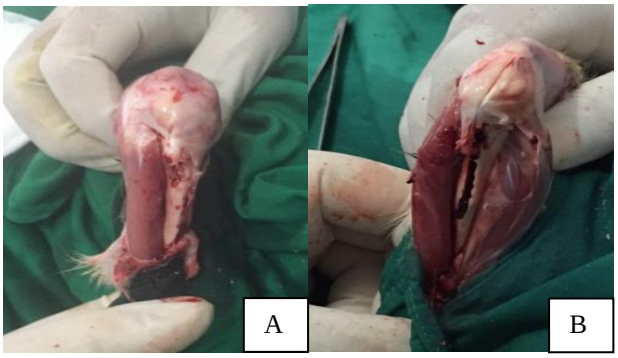

Figure 2: (2A) Clinical pictures after debridement with curettage; (2B) Debridement with high speed burr.

Analysis for numeric variables significance test for unpaired groups was Kruskal-Wallis test for not normally distributed data can be seen in the Table 4.

Table 4: Kruskal-Wallis test.

Group	N	Df	Asymp.Sig
Control	10	2	0.034
Debridement with curretage	16		
Debridement with high speed burr	16		
Total	42		

The main purpose of debridement is an aseptic union of the bone. The result of debridement can be classified to aseptic (no growth) and growth. We can see in the table 5, Chi-Square test compare debridement group to the control group. In Table 6 we can see Chi-Square test for compare debridement with high speed burr and curettage and also Odd ratio.

DISCUSSION

Chronic osteomyelitis is one of the most frustrated morbidity treated by physician and feel by patient. The episode of recurrence has made longer hospital stay and psychologic burden for the patient. Treatments of choice for eradication of infection are thorough debridement and antibiotic management. One of the promising ways of debridement is high speed burr. This research hasn't done before, that is why this research was conducted in New Zealand rabbits.

Chronic osteomyelitis model of rabitt's tibia first described by Schemen and then modified by Norden in 1970, using sclerotic agent (5% Sodium Morrhuate) injected with 18G needle followed by inoculation of Staphylococcus aureus. Insertion of foreign metal implant

described by Andriole in 1973, he made fracture of tibia bone and then using stainless steel pin for fixation. Moriarty using the same technique but without fracture.[13] Rabbit is the most common animal using for subject of research, in this case chronic osteomyelitis.[14,15] rabbits is an intermediate size animal, they possess distinct versatility and relatively easy to handle, manipulate and maintain. Consequently rabbits are relatively inexpensive. While their size lends itself to easy maintenance, their bone remains large enough to perform screw and plate fixation. The medullary canal of both the tibia and femur can easily accommodate a modified nail and are sizeable enough to house implants. We use female rabbits because of low agressivity.[16]

Table 5: Chi-square analysis for compare debridement group with control group.

		Colony count		Total	Chi-square test
		No growth	Growth		
Control	Total sample	1	9	10	0,006
	%	10 %	90 %	100%	
Curettage	Total sample	2	14	16	
	%	12.5 %	87.5 %	100%	
High Speed Burr	Total sample	9	7	16	
	%	56.3 %	43.7	100%	
Total	Total sample	12	30	42	
	%	28.6 %	71.4 %	100%	

Before comparative analysis, we work on normality test and the result was the colony count of *Staphylococcus aureus* not distribution normally, $p<0.05$ ($p=0.000$). We used nonparametric test for more than 2 groups, which is *Kruskal-Wallis test*. In statistical analysis with *Kruskal-Wallis* we found that this difference is statistically significant between control group, debridement with curettage and debridement with high speed burr group, $p=0.034$ ($p<0.05$). Colony count of *Staphylococcus aureus* in debridement group compare to control group shows result of Chi-Square test $p = 0.006$ ($p<0.05$), statistically significant. Also there is a significant relationship between colony counts of *Staphylococcus aureus* in chronic osteomyelitis of rabbit's tibia that has done debridement with *high speed burr* compare to debridement with curettage. The result is *Chi-Square test* $p = 0.023$ ($p<0.05$), with Odds Ratio is 9.000 (CI=95%) Debridement with high speed burr reduces more colonies of *Staphylococcus aureus* nine times if compare to debridement with curettage.

Table 6: Chi-square test for compare debridement with high speed burr to debridement with.

	No growth	Growth	Total	Chi-square test
High Speed Burr	9 (56.3%)	7 (43.7%)	16 (100%)	0.023
Curettage	2 (12.5%)	14 (87.5%)	16 (100%)	
				OR 9.000

These results support the hypothesis of research. Debridements with high speed burr reduce more colonies of *Staphylococcus aureus* compare to debridement with curettage. High speed burr is essential for removing small nooks and crevices where pockets of disease hide. High speed burr had better control for debridement.[8] High speed burr also extend the curettage until normal bone.[9] Living tissue must be seeing in the resection border, with sign of bleeding spot (paprika sign).[1,4]

Quantitative counts of *Staphylococcus aureus* colony forming units per gram of tibial bone were determined for all study groups. After animals were sacrificed, the tibias were stripped free of all soft tissue, the proximal and distal ends of the tibias were removed, and the implant-containing marrow was separated carefully from the bone as a cohesive unit.

We take 1 cm of proximal tibia bone and pulverized and the final product was weighed. Physiologic 0.9% saline was added to the pulverized bone in a 3:1 ratio (3 mL saline/g bone) and the suspension was vortexed for 5 minutes. Five, 10-fold dilutions of each of the saline-bone suspension were prepared with sterile 0.9% (weight to volume) NaCl solution. Twenty microliter samples of each of the five dilutions were spotted onto blood agar

plates and incubated at 37°C for 24 hours. Colony forming units then were counted for each tibia sample. The mean log of the colony forming units for the five plates and the mean *Staphylococcus aureus* concentration for each treatment group was calculated.[12] The best indicator of healing of chronic osteomyelitis is there is no growth of the pathogen.

In this research, we don't use an antibiotic in treatment of chronic osteomyelitis, because we only want to know the effectivity of debridement to reduce the colony of pathogen. Antibiotic standard treatment is given parenteral for 6 weeks after definitive debridement surgery.[17] In one study, total of 93 patients, with chronic osteomyelitis, underwent single-stage, aggressive surgical debridement and appropriate soft-tissue coverage. Culture-specific intravenous antibiotics were given for five to seven days, followed by oral therapy for six weeks. These 93 patients were compared with 22 consecutive patients treated previously who had the same surgical management, but received culture-specific intravenous antibiotics for six weeks. Treatment was successful in 91% of patients, regardless of the organism involved. There was no difference in outcome in terms of these variables when the series were compared. This study conclude that the long-term administration of intravenous antibiotics is not necessary to achieve a high rate of clinical resolution of wound drainage for adult patients with chronic osteomyelitis.[18]

High speed burr also reduce risk of fracture.[6] High speed burr also has Gyroscopic effect, it to rotate about an axis perpendicular to both the torque and the angular momentum, has a profound effect on the resulting stability lobes, especially at very high speeds; also it makes the lobes wider but at the same time lowers the minimum stability boundary. It makes high speed drilling causes less temperature increase than standard drilling speed.[9]

CONCLUSION

Debridement with curettage and debridement with high speed burr reduce more colonies of *Staphylococcus aureus* compare to control group. Debridement with high speed burr reduces more colonies of *Staphylococcus aureus* compare to debridement with curettage. Debridement with high speed burr reduces colonies of *Staphylococcus aureus* nine times compare to debridement with curettage.

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