

Cortex and Cartilage Necrosis after Curettage with Combination of Phenol and High Speed Burr Adjuvant Thicker than Curettage only, Curettage and Phenol or Curettage and High Speed Burr Adjuvant on Distal Femoral Bovine Bone

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Abstract

Background: Curettage served as surgical management for benign tumor cases. The local recurrence rate of the tumor remains high without the use of adjuvant and the use of both chemical and mechanical adjuvants able to reduce it. However, excessive use of adjuvants may lead to complications, thus rational use of adjuvant is mandatory. This study aimed to explore the extent of cell death following the use of phenol, high speed burr, or combination.

Methods: This was a pure experimental research with post-test only control group design with a total of 28 bovine bones which divided into four groups. Group 1 served as control and treated with curettage only. Group 2 was treated with curettage and phenol as adjuvant. Group 3 treated with curettage and high speed burr adjuvant, while group 4 treated with curettage, phenol and high speed burr as adjuvants. All samples were examined microscopically to determine the thickness of necrosis in cortex and cartilage.

Results: The thickness of necrosis in all treatments group differ significantly when compared to control either in cortical or cartilage ($p = 0.001$ for all groups). No significant difference in necrotic thickness was found between phenol-treated group and high speed burr-treated group, both in cortical and cartilage ($p = 0.59$ and $p = 1.00$, respectively). Combination of phenol and high speed burr produced the thickest necrosis when compared with other group.

Conclusion: Addition of adjuvants after curettage produced deeper necrosis effect. The use of combination of adjuvants should be carefully chosen since this procedure produced the thickest necrotic depth which may cause complication.

Keywords: Necrosis; Curettage; Adjuvant; Phenol; High Speed Burr; Bovine

Abbreviations

GCT: Giant Cell Tumor; PMMA: Polymethylmethacrylate; SD: Standard Deviation

Introduction

Curettage is one of the treatment options for benign bone tumor cases. Curettage is performed by discarding the entirety of the macroscopically visible tumor mass, hence it still give rise to certain problems postcurettage. In the past, the surgery still resulted in high rate of local recurrence. Extended curettage technique with the use of mechanical or chemical adjuvant significantly decrease the recurrence rate and morbidity after surgery.

Intralesional curettage is the main option for benign bone tumor cases, majorly in giant cell tumor (GCT). Local recurrence rate reach 20% without the use of adjuvant [1]. This number may reduce with the use of adjuvants, for instance liquid nitrogen, phenol, hydrogen peroxide, bone cement or high speed burr. Several researchers reported recurrence rate after curettage with various local adjuvants. Zhen., *et al.* [2] reported local recurrence rate of 13% from total of 92 patients with the use of zinc oxide 50% after curettage, while Su., *et al.* [3] reported 18% local recurrence rate from 56 patients with phenol 90%. Study by Turcotte., *et al.* [4] found 19% local recurrence rate out of 62 patients with polymethylmethacrylate (PMMA). Malawer., *et al.* [5] reported 7.9% local recurrence rate from 102 patients with the use of liquid nitrogen adjuvant after curettage.

Mechanical adjuvant with high speed burr removed the tissue and produced heat that resulted in cells death [6]. Study by Niu., *et al.* [7] obtained the recurrence rate of 11.1% from 621 patients with GCT with mean follow up of 2.5 years.

In benign bone tumor management, it is necessary to consider the balance of possible recurrence along with post-surgery morbidity. Obsessive use of various adjuvants resulted in several complications e.g. blood vessel and nerve injury, pathological fracture and postoperative osteoarthritis [8,9]. Therefore, rational use of adjuvants is mandatory and data regarding cells death caused by various adjuvants is needed to prevent the complication.

To our knowledge, there still no data available regarding the extent of bone cells death with the use of adjuvant. We aimed to determine the extent of bone cells death following the use of adjuvants, either mechanical adjuvant (high speed burr) or chemical adjuvant (phenol) microscopically.

Materials and Methods

This pure experimental research with post-test only control group design conducted at laboratorium of Sanglah General Hospital, Denpasar, Bali, Indonesia. The total of 28 bovine bones divided into four groups. Group 1 or control was treated with curettage only. Group 2 was treated with curettage and phenol as adjuvant. Group 3 treated with curettage and high speed burr adjuvant, while group 4 treated with curettage, phenol and high speed burr as adjuvants. The inclusion criteria for samples were *Bos vondaicus* species, female, aged 6 - 7 years with weight range from 300 - 400 kg and healthy. Samples with deformity in the extremities was excluded.

Curettage was performed with currete, scoop or hoe-shaped instruments, either blunt or sharp. Curettage was done in meta-epiphysis anterior of distal femur with size of 2 x 2 cm. Before high speed burr was performed, the surface of the bone marked with permanent marker subsequently high speed burr was conducted with Black & Decker® 30,000 rpm. Round diamond with diameter of 2.1 mm was used as drill bit. High speed burr performed until all marker disappeared.

Phenol 90% was used in this research. Eight milliliters of phenol poured to the curettaged bone and the not-submerged area was applied with swab to expose it with phenol. After 15 minutes, phenol was removed and rinsed with 0.9% NaCl three times. In the group 4, the curettaged bone was first treated with high speed burr then followed with adjuvant phenol.

Histopathology examination was performed to determine the necrosis thickness of cortical and cartilage bone. To assess necrosis thickness in cortical bone, samples from proximal side of the bone were obtained with size of 2 cm x 1 cm x 0.5 cm. While samples from distal side of the bone were obtained with similar size to assess necrosis thickness in cartilage bone. The samples cut longitudinally to assess the thickness of necrosis with light microscope. Necrosis in cortex and cartilage tissue characterized by the change in matrix color, growth or the disappearance of osteocyte’s nucleus in cortex or chondrocytes. The result of necrosis presented in milimeter.

All data analyzed with SPSS. Continuous data presented as either mean ± standard deviation (SD) if the data was distributed normally or median (minimum-maximum) if the data without normal distribution. Shapiro-Wilk test was used to determine the normality of data. To determine the difference between the thickness of necrosis between groups, oneway ANOVA was used if the data was distributed normally and all parametric requirements were met. Kruskal-Wallis test was used if the data without normal distribution. Post Hoc analysis with Mann-Whitney test was used to determine the difference.

Results and Discussion

The data obtained were analyzed descriptively and the result presented in table 1. No necrotic cells were found in control group.

Categories	Treatment	Mean	Minimum	Maximum
Cortex	Control	0	0	0
	Phenol	1.43	1.00	2.00
	Speed burr	1.29	1.00	2.00
	Combination	3.57	3.00	4.00
Cartilage	Control	0	0	0
	Phenol	1.71	1.00	2.00
	Speed burr	1.71	1.00	2.00
	Combination	3.71	3.00	4.00

Table 1: Descriptive analysis of necrosis thickness in cortex and cartilage.

Analysis of normality of data with Shapiro-Wilk found that all data were without normal distribution. The necrotic thickness either in cortex or cartilage significantly difference between groups (Table 2). The use of adjuvant produced significant necrosis to the cells when compared with control group. However, there was no significant difference of necrosis thickness between phenol-treated and high speed burr-treated group, both in cortex and cartilage (p = 0.59 and p = 1.00, respectively). Combination of phenol and high speed burr produced significant necrosis thickness compared with all group. The results presented in table 2, figure 1, and figure 2.

		n	Median (minimum-maximum)	Mean ± SD	p
Necrotic thickness in cortex	Control	7	0 (0 - 0)	0	< 0.001
	Phenol	7	1 (1 - 2)	1.43 ± 0.53	
	Speed burr	7	1 (1 - 2)	1.29 ± 0.49	
	Combination	7	4 (3 - 4)	3.57 ± 0.53	
Necrotic thickness in cartilage	Control	7	0 (0 - 0)	0	< 0.001
	Phenol	7	2 (1 - 2)	1.71 ± 0.49	
	Speed burr	7	2 (1 - 2)	1.71 ± 0.49	
	Combination	7	4 (3 - 4)	3.71 ± 0.49	

Table 2: Comparability analysis of necrosis thickness in cortex and cartilage.

*Kruskal-Wallis

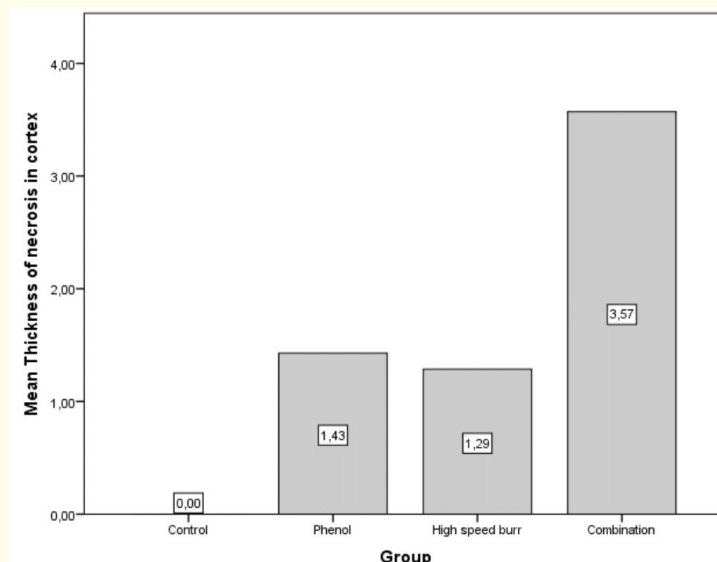


Figure 1: Necrotic thickness in cortex between group. Post-hoc analysis with Mann-Whitney: control vs phenol $p = 0.001$; control vs speed burr $p = 0.001$; control vs combination $p = 0.001$; phenol vs speed burr $p = 0.59$; phenol vs combination $p = 0.001$; speed burr vs combination $p = 0.001$.

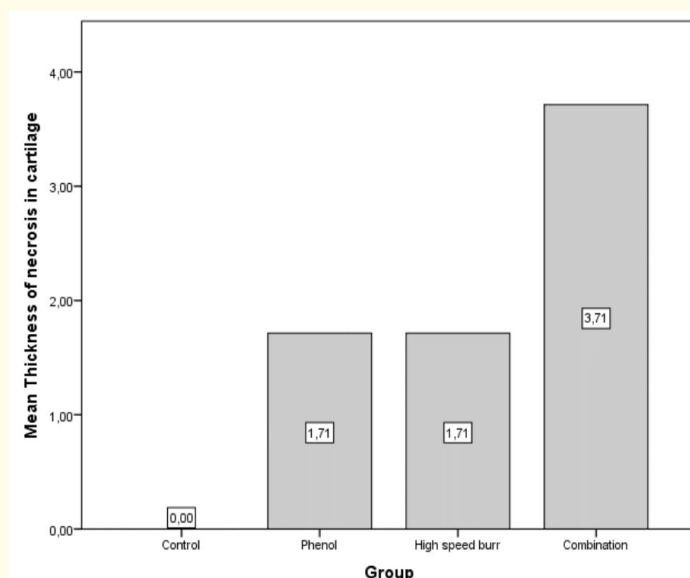


Figure 2: Necrotic thickness in cartilage between group. Post-hoc analysis with Mann-Whitney: control vs phenol $p = 0.001$; control vs speed burr $p = 0.001$; control vs combination $p = 0.001$; phenol vs speed burr $p = 1.00$; phenol vs combination $p = 0.001$; speed burr vs combination $p = 0.001$.

Various researches had been conducted to determine the recurrence rate of benign bone tumor after curettage with or without the use of adjuvants [6,10,11]. However, research to determine the effect of various adjuvants to surrounding cells is still required. This research aimed to explore necrosis thickness after the use of phenol, high speed burr, and both. Bovine bones were chosen as samples for its easiness to obtain and the thickness of its cortex similar to human bones [12]. Bovine bone obtained from female adult aged 6 - 7 years old since epiphyseal growth has closed.

The result of the current research found that the thickness of necrosis after the use of phenol as adjuvant significantly higher compared with control, but not when compared with group treated with high speed burr.

Phenol has characteristic of bacteriostatic and bacteriocidal in concentration of 0.1 - 1% and > 1%, respectively. This occurs through cytotoxic effect via protein denaturation and impairment in membrane cell permeability. Concentration above 3% has the characteristic of necrogenic and this effect was utilized as adjuvants after curettage of bone tumor [8,13]. Lang, *et al.* [14] found the difference in necrosis thickness of bone marrow cells of cow's spine with the use of different phenol concentration. Phenol concentration of 10%, 25%, 50%, 75%, and 90% resulted in necrosis thickness of 235, 398, 630, 747, and 566 μ , respectively [14].

This research showed that the thickness of necrosis in group treated with high speed burr as mechanical adjuvant was significantly higher compared with control, both in cortex and cartilage tissue ($p = 0.001$). However, the thickness of necrosis was not significantly different when compared with phenol-treated group. Mechanical adjuvant with high speed burr was used to remove the remaining tumor. This procedure is good to remove the remaining tumor located at narrow angles [13].

Besides for its mechanical effect to remove visible remaining tumor, the thermal effect produced from this procedure also kills tumor cells through denaturation of protein and impairment in permeability of cells [6]. Study by Eriksson, *et al.* [15] found the required temperature to induce bone tissue injury was 47°C for 1 minute. However, several factors affect the temperature produced from the effect of drilling i.e. diameter of drill bit, material of drill bit, and its velocity [16-18]. Thompson [19] found similar result, in which the increase in the burr's velocity may increase the temperature of bone. However, this raised temperature is limited only at 10,000 rpm. The temperature of bone did not increase significantly in velocity above 10,000 rpm [17,20].

The application of adjuvants either with phenol, high speed burr, or combination of phenol and high speed burr resulted in thicker necrosis area microscopically when compared with control. This result is in accordance with other researches that the use of adjuvants after curettage is able to decrease the recurrence rate than without application of adjuvant [10,11]. Current result showed that the use of combination of phenol and high speed burr produced the thickest necrotic area, however rational use of adjuvants is recommended since excessive use of adjuvants may result in several complications [8,9]. Combination of phenol and high speed burr as adjuvants should be avoided if after curettage the cortex is thin or near to cartilage.

This is the first study to explore the thickness of necrosis following the use of various adjuvants and combination of adjuvant. Despite the results obtained, our study was subject to limitation. The samples of this research utilize normal bone, therefore the effect of necrosis after the application of adjuvant in pathologic bone is still not certain.

Conclusion

The use of phenol, high speed burr, or combination of phenol and high speed burr as adjuvants produced deeper necrotic area to the tissue. The combination of phenol and high speed burr resulted in the thickest necrotic depth and its application should be carefully chosen.

Conflict of Interest

All authors declare that there are no conflict of interest regarding this work.

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