Cellulose Based Surgical Threads from Oil Palm Empty Fruit Bunches in Wound Healing on Male Wistar Rats

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Abstract

The aim of this study was to elaborate a histological model of incisional skin wound healing against cellulose nanofiber based surgical threads from oil palm empty bunches on male wistar rats. Skin incisions were performed on rat femoral muscle, immediately sutured by cellulose nanofiber based surgical threads. Hematological analysis was performed on white blood cell. Histological sections of thigh skin tissue were stained by hematoxylin and eosin evaluated after surgery. White blood cell and wound healing process in tissues after surgery was compared to controls.

Keywords: cellulose nanofiber, surgical threads, wound healing.

Palm oil is the largest commodity produced by Indonesia as the world’s largest palm oil producer. Leading production of biomass in the form of oil palm empty fruit bunches (OPEFB) of 23% (Mandiri, 2012). Fibers of OPEFB contain cellulose 44.4%, hemicellulose 30.9% and lignin 14.2% which can be used as value added products (Sun \textit{et al}. 1999). Utilization of nanocellulose from OPEFB as a raw material for making surgical threads is evaluated in this study.

Materials and Methods

A total of 35 healthy male wistar rats aged 8-10 weeks weighing 150-200 g were distributed into seven groups of 5 animals each. No surgery was performed in control group. Surgical thread groups were silk (Group 1), nanocellulose (NC, Group 2); polyvinyl alcohol (PVA, Group 3); mixed of polyvinyl alcohol and bacterial cellulose (PVA-BC, Group 4); mixed of polyvinyl alcohol and nanocellulose (PVA-NC $\sim$ 80 : 20, Group 5); mixed of polyvinyl alcohol and nanocellulose (PVA-NC $\sim$ 70 : 30, Group 6), respectively.

On a day of surgery, the animals were anesthetized with diethyl ether. The 2.5 cm incisions were made under aseptic conditions on the right side femoral muscle and immediately sutured by 3 simple sutures. On day 5 post-operative, the peripheral blood was taken and the rats were sacrificed by diethyl ether inhalation. The hematological analysis was performed on white blood cell. The skin wounds were removed from the femoral (thigh area) skin. The tissue specimens were processed routinely for histological study and stained with hematoxylin-eosin for monitoring wound healing using tissue reaction parameters on different suture materials. The observation of polymorpho nuclear leukocytes, macrophages, fibroblast cells were performed by calculating per five square areas as per (Gal \textit{et al}. 2008), while the qualitative observation was carried out on formation of epithelial bridge and connective tissue, collagen fibre and granulomatous tissues (Sultana, \textit{et al}. 2009). Data of white blood cell count, PMNL, tissue macrophages and fibroblasts were obtained in duplicate and mean $\pm$ SD was calculated. A P-value $< 0.05$ was considered statistically significant.

Results and Discussion

During the post-surgery period, the animals remained healthy. On a day 5 post-surgery presence of coagulum, i.e. fibrous clot, was observed in all animals from the experimental groups.

The control rats, had normal white blood cell count (Faas \textit{et al}. 2003). The white blood cells count in experimental group 1 was the highest compared to other rats groups. The

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WBC, granulocytes, lymphocytes, and monocytes were recorded in the descending order of 1, 4, 5, 3, 2, and group 6 respectively (Fig 1).

Histological changes during wound healing in rats sutured different with surgical threads showed increase in the polymorphonuclear leukocytes, macrophages and fibroblasts in all experimental groups compared with control group (Fig. 2).

In general wound healing in rat group 1 to 6 showed increasing fibroblast cells and development of more extracellular matrix, fibrous tissue, collagen. The presence of macrophages in the wound, were observed in all the experimental groups indicating the healing process in the incised skin area (Fig. 3)

In general, some surgical threads tested in rat surgery did not produce ugly irritation in the suture area by scratching or biting and

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**Fig 1.** The hematological analysis of blood of each rat groups in surgical threads of 5 days after surgery and suturing. *, Θ, #, those symbols mean representative significantly different (p<0.05).

**Fig 2.** The histological changes through tissue reaction parameters during rat skin wound healing in surgical threads of 5 days after surgery and suturing. *, Θ, #(p<0.05).

**Fig 3.** The increase of inflammatory and granulation cells, collagen tissue on the suture wound area on rat skin tissue in the wound healing process using surgical threads [A-F(1-4); control 1-4].
they have resumed their normal appetite soon, observations on sutures show varying levels of recovery and tissue response. The wound healing process of rat skin was histomorphologically and chronologically described during the first five days. Evaluation histological differences at different time intervals of i.e. the first, third, fifth, seventh and tenth day by Connolly et al. (1997) observed an influence of various factors on the wound healing. The present findings concurs the histomorphological based studies of rat skin by (Marcelo et al. 2003).

Vidinský et al (2016) reported that the regeneration of injured epidermis was completed in five days after surgery and the inflammatory phase during the first three days of healing was fast between day one and day two concurring our finding. The proliferative phase started on the first day and peaked during day five and day six, which is slow in humans, where in this phase starts on the seventh day of wound healing (Kumar et al. 2003). The initiation of the maturation and remodeling phase of the healing process was observed after six days of wound healing (Kumar et al. loc cit). During the repair and remodeling phase of muscle healing. They are concurrent processes but at the same time supportive but also competitive with each other (Järvinen et al. 2005).

In conclusion, the use of surgical threads based on cellulose nanofiber from OPEFB could be applied to traumatic wounds with variations in the response of white blood cells and tissue reactions for each type of surgical thread in the wound healing process without significant differences in the duration of healing. Therefore, results of this work can serve as an experimental model for further research using external factors by which the wound healing can be favourably influenced.

**Summary**

Cellulose nanofiber based surgical threads from (OPEFB) were used suture materials in rat model. Six cellulose nanofiber based surgical threads and control group were evaluated for the wound healing response on white blood cell and granulation tissue. Proliferation and migration of white blood cell and granulation tissue components in wound healing process increased in sutures area compared to the control.

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