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Original Article

The effects of ethyl-2-cyanoacrylate and butyl-2-cyanoacrylate in the process of bone healing in rats. A controlled experimental study☆

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ABSTRACT

Objective: Synthetic adhesives are used by various medical specialties, especially in surgery; however, studies reporting their use in orthopedic practice are scarce. The aim of this study was to compare the results in using ethyl-2-cyanoacrylate or butyl-2-cyanoacrylate in the treatment of fractures in rats.

Methods: This was an experimental prospective controlled study in 90 rats, with humerus, femur, and tibia fractures, treated with ethyl-2-cyanoacrylate (SB group; $n = 45$) or butyl-2-cyanoacrylate (HA group; $n = 45$). Biomechanical and histomorphometric analyses were performed at three different moments (60, 120, and 180 days); besides a clinical study performed weekly by measurement of the animals body mass.

Results: No differences were observed regarding body mass ($p = 0.07$). In both groups, there were no significant differences regarding maximum load ($p = 0.6$), yield point strength ($p = 0.6$), and stiffness coefficient ($p = 0.4$) of the femurs. The same was observed in tibias for maximum load ($p = 0.4$), yield point strength ($p = 0.7$), and stiffness coefficient ($p = 0.6$). The humerus from both groups had similar bone callus area ($p = 0.66$). In both groups, there were no statistical differences related to inflammatory cells ($p = 0.4$), osteoblasts ($p = 0.2$), and osteoclasts ($p = 0.2$).

Conclusion: Ethyl-2-cyanoacrylate was more effective than butyl-2-cyanoacrylate in the treatment of fractures in rats.

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Efeitos do etil-2-cianoacrilato e do butil-2-cianoacrilato no processo de consolidação óssea em ratos. Estudo experimental controlado

Palavras-chave:
Cianoacrilatos
Adesivos teciduais
Fraturas ósseas
Consolidação da fratura

RESUMO

Objetivo: Os adesivos sintéticos são usados em várias especialidades médicas cirúrgicas, contudo, os estudos que relatam seu uso na prática ortopédica são escassos. O objetivo deste trabalho foi comparar os resultados do uso do etil-2-cianoacrilato e do butil-2-cianoacrilato no tratamento de fraturas em ratos.

Métodos: Foi realizado um estudo experimental, prospectivo e controlado em 90 ratos com fraturas de úmero, fêmur e tíbia, tratados com etil-2-cianoacrilato (grupo SB; n = 45) ou butil-2-cianoacrilato (grupo HA; n = 45). Foram realizadas análises biomecânicas e histomorfométricas em três momentos (60, 120 e 180 dias), além do estudo clínico pela aferição semanal da massa corporal dos animais.

Resultados: Não foram observadas diferenças relacionadas à massa corporal dos animais (p = 0,07). Os fêmures de ambos os grupos não apresentaram diferença com relação à carga máxima (p = 0,6), limite de elasticidade (p = 0,6) e coeficiente de rigidez (p = 0,4). Analisando-se as tíbias, o mesmo foi observado com relação à carga máxima (p = 0,4), ao limite de elasticidade (p = 0,7) e ao coeficiente de rigidez (p = 0,6). Os úmeros de ambos os grupos apresentaram a mesma área de calo ósseo formado (p = 0,66). Em ambos os grupos, não houve diferença estatística relacionada ao número de osteoblastos (p = 0,2), osteoclastos (p = 0,2) e células inflamatórias (p = 0,4).

Conclusão: O etil-2-cianoacrilato foi mais eficaz do que o butil-2-cianoacrilato no tratamento de fraturas em ratos.

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Introduction

The use of synthetic adhesives in medical practice has drawn the attention of researchers worldwide. The ideal adhesive should have the following essential characteristics: fast adhesion to the tissue, low heat release, good adhesion even in an internal human environment, the ability to be sterilized and, especially, it should not have carcinogenic potential.[1]

In medicine, cyanoacrylates are well known for their bactericidal characteristics.[2] De Almeida Manzano et al.[3] reported the effective antimicrobial action of ethyl-2-cyanoacrylate against *Staphylococcus*, *Streptococcus*, *Escherichia coli*, and *Escherichia faecalis* strains. Shamiyeh et al.[4] and Coulthard et al.[5] did not observe any increase in infection rates after the use of cyanoacrylates. Regarding histotoxicity, several authors[6–13] have analyzed the inflammatory and carcinogenic effects of these adhesives, finding few or no deleterious effects to the human body.

The medical literature leaves no doubt as to the safety and efficacy of the use of these adhesives. However, there are few reports[14–17] on their use in the treatment of bone lesions.

In the case of intra-articular fractures, it is agreed that fixation must be anatomical. With the exception of large bones (femur, humerus, tibia, *etc.*), which must be reconstructed with the aid of metal implants, there is a great debate on the best treatment option for small and tubular bones.

Thus, considering the lack of publications on the subject in the various databases available, the possibility of opening new lines of research and, primarily, the goal of reducing financial costs, sequelae, and hospitalization time, this study is aimed at comparing the results of the use of ethyl-2-cyanoacrylate to butyl-2-cyanoacrylate in the treatment of fractures in rats.

Material and methods

All procedures were approved by the Ethics Committee on Animal Use of this institution under No. 1495/2014.

The sample size was determined prior to the start of the study, considering the α-risk (0.5%) and β-risk (80%), and the range of the variables, reaching a total of ten animals per group.

Ninety male Wistar rats (*Rattus novergicus albinus*) were used. At the beginning of the study, the rats were 60-days-old and, after being clinically evaluated and weighed, were housed in polypropylene cages, in an environment with a controlled temperature of 22 °C and a light–dark cycle of 12 h. Rodent feed and water were offered *ad libitum*.

The animals were randomly selected by the process of opaque and sealed envelopes[18,19] into two groups: Group SB ($n = 45$) and Group HA ($n = 45$).

Osteotomies were performed after intraperitoneal anesthesia (30 mg/kg of sodium pentobarbital 3%) and bilateral trichotomy along the humerus, femur, and tibia. Subsequently, the animals underwent regional asepsis with soap and water, followed by antisepsis with 0.2% chlorhexidine aqueous solution, and then were placed on a surgical table in the lateral decubitus position.

After fenestrated sterile drapes were placed, longitudinal incisions were made in the skin between the shoulder and

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