

ORIGINAL ARTICLE

Monitoring of glycolytic activity secondary to ischaemia in knee replacement surgery[☆]



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KEYWORDS

Arthroplasty;
Knee;
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Abstract

Objectives: To non-invasively assess tissue lesion secondary to ischaemia applied during knee replacement surgery. Secondary objectives: to assess whether this lesion correlates with the duration of ischaemia and whether instrumental and gender variables influence it.

Material and methods: Prospective cohort study. Pre and postoperative serum lactate levels have been determined as an indicator of glycolytic activity secondary to ischaemia in 88 patients. Serum lactate determination was performed by reactive strips of enzymatic–amperometric detection on capillary blood.

Results: Preoperative serum lactate levels (mean and SD): 2.467 ± 1.036 mmol/L. Postoperative serum lactate levels: 3.938 ± 2.018 mmol/L. Ischaemia time 102.98 ± 18.25 min. Postoperative serum lactate levels were significantly higher than preoperative lactate levels. There are no statistical differences according to the time that the ischaemia was prolonged, gender or type of instrumentation used.

Conclusions: In our study, postoperative serum lactate values were significantly higher than preoperative lactate values, with no correlation to the duration of ischaemia during knee replacement surgery.

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PALABRAS CLAVE

Artroplastia;
Rodilla;
Torniquete;
Lactato

Monitorización de la actividad glucolítica secundaria a isquemia en cirugía sustitutiva de rodilla

Resumen

Objetivos: Evaluar de forma no invasiva la lesión tisular secundaria a la isquemia aplicada durante la cirugía sustitutiva de rodilla. Objetivos secundarios: evaluar si dicha lesión se

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correlaciona con el tiempo que se prolonga la isquemia y la influencia de las variables instrumental y sexo.

Material y método: Estudio de cohortes prospectivo. Se han determinado los niveles pre- y postoperatorios de lactato sérico, como indicador de actividad glucolítica secundaria a isquemia, en 88 pacientes. Se han empleado tiras reactivas de detección enzimático-amperométrica sobre sangre capilar.

Resultados: Niveles preoperatorios de lactato sérico (media y DE): $2,467 \pm 1,036$ mmol/L. Niveles postoperatorios de lactato sérico: $3,938 \pm 2,018$ mmol/L. Tiempo de isquemia $102,98 \pm 18,25$ min. Los niveles postoperatorios de lactato sérico han sido significativamente mayores que los preoperatorios. No existen diferencias atendiendo a las variables tiempo que se prolonga la isquemia, sexo o tipo de instrumentación empleada.

Conclusiones: En nuestro estudio, los valores de lactato sérico postoperatorios han sido significativamente mayores que los preoperatorios, sin una correlación con el tiempo que se ha prolongado la isquemia durante la cirugía sustitutiva de rodilla.

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Introduction

The use of the ischaemia cuff in orthopaedic surgery is routine practice. Bloodless limb surgery was introduced by Johannes Friedrich August von Esmarch in 1873, using an elastic bandage. In 1908 Harvey Williams Cushing improved the technique with the introduction of the pneumatic tourniquet.

The ischaemic cuff in knee replacement surgery provides a bloodless surgical field, enabling anatomical dissection, the visualisation of structures and optimal surgical conditions,¹ with better bone penetration of the cement layer.² However, it is not free from potential risk, therefore there is controversy surrounding its use and we cannot conclude uniform recommendation with sufficient evidence from the different systematic reviews and meta-analyses.³⁻⁹ The published disadvantages of the ischaemic cuff during knee replacement surgery are: increased postoperative bleeding,⁴ increased incidence of thromboembolic complications,⁵ increased rate of neuromuscular¹⁰ or skin complications,¹¹ and delayed rehabilitation immediately after surgery.¹²

Ischaemia increases capillary permeability, causes alterations in coagulation and increases levels of proinflammatory cytokines. Added to the metabolic tissue alterations secondary to hypoxia is the increase in glycolytic activity and decreased pH in the tissues subjected to ischaemia. Muscular tissue is more likely to suffer metabolic injury due to ischaemia. The interruption of blood supply to the myocyte hinders oxidative phosphorylation in the mitochondria and inhibits the generation of aerobic energy. Muscle cells are forced to rely on anaerobic metabolism, and the production of adenosine triphosphate (ATP) is reduced. The continuous need for energy conditions ATP hydrolysis to adenosine diphosphate and the latter to adenosine monophosphate, whose metabolism plays an important role in the genesis of the so-called ischaemia-reperfusion syndrome. Anaerobic glycolysis causes an accumulation of lactate and protons, which triggers progressive acidification of the intracellular

medium. This acidification, together with the reduction of ATP, is responsible for the decreased activity of the Na^+/K^+ -ATPase and Ca^{2+} -ATPase pumps, which causes an increase in intracellular Na^+ and Ca^{2+} levels and, eventually, cellular lysis if the duration of ischaemia exceeds a critical level. With reperfusion, in tissues subjected to injury by ischaemia a series of agents come into play that will increase local damage and will extend the damage to the rest of the organism: the proinflammatory cytokines (interleukin 1 and 6, thromboxane A2 and tumour necrosis factor), the complement system, the activated polymorphonuclear leukocytes (basically neutrophils), oxygen free radicals and alteration of capillary permeability.

Some authors defend implanting knee prostheses without ischaemia,¹³ in order to prevent the vascular, neurological and metabolic complications described, but most orthopaedic surgeons choose to use it.

The primary objective of the study was to assess tissue damage secondary to ischaemia applied during knee replacement surgery in a non-invasive way (using an indirect, simple-to-determine indicator, such as serum lactate levels). Our secondary objectives were to assess whether this injury correlates with the duration of the ischaemia during the intervention and the influence of the instrumental and sex variables.

Material and method

A prospective, cohort study performed in a single centre that comprised testing for serum lactate levels in capillary blood preoperatively (5 min before expressing the limb to be operated and the application of ischaemia, and postoperatively (5 min after releasing the ischaemia) in 88 patients who had undergone knee replacement. All the interventions were performed by the same surgical team that comprised 2 senior surgeons, with wide experience in knee replacement surgery. The study followed the ethical principles for medical research on human beings of the World Medical Assembly,

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