The Neuroprotective Effect of Coumaric Acid on Spinal Cord Ischemia/Reperfusion Injury in Rats

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Introduction

Coumaric acid (CA), assumed in the polyphenolic compounds, is synthesized from cinnamic acid by means of the P450-dependent 4-cinnamic acid hydroxylase enzyme (Kong et al., 2013). The main sources of CA are chocolate; apples and pears; beans, soybeans, potato, and tomato; and tea, coffee, wine, and beer (King and Young, 1999).

In our study, the antioxidant and protective effects of CA on SCIR damage in rats were investigated. With this aim, both the effects of CA on SOD activity and MDA and NRF1 levels after SCIR were analyzed. Additionally, the dead neurons and the immunopositive cells were counted in spinal cord histological samples. Toluidine -blue staining was used to evaluate general histological examination, and hipoxia-inducible factor-1a (HIF1-a) and nuclear factor kappa B (NF-kappa B) primary antibodies were used to label and evaluate these proteins immunohistochemically.

Methods

In this study, we used 32 male Sprague-Dawley rats. Group I: Sham-operated control group: Laparotomy and infrarenal abdominal aorta dissection was completed, but occlusion was not performed. Group II: A single-dose 1 ml intraperitoneal vehicle (isotonic NaCl 0.9%) was administered to rats following 20 min spinal cord ischemia and 24 h reperfusion (ischemia group). Group III: Intraperitoneal CA (single-dose 100 mg/kg body weight) was administered to rats following 20 min spinal cord ischemia, reperfusion was performed 24 h after ischemia, and rats were sacrificed 24 h after ischemia (ischemia+CA group). Group IV: Intraperitoneal methylprednisolone (single-dose 30 mg/kg body weight) was administered to rats following 20 min spinal cord ischemia, reperfusion was performed 24 h after ischemia, and rats were sacrificed 24 h after ischemia (ischemia+MP group). Spinal cord ischemia was induced by cross-clamping the aorta with mini aneurysm clips of 70 g closing force between just below the left renal artery and just proximal to the aortic bifurcation.

Results

The ischemia+coumaric acid group was compared with the ischemia group, a significant decrease in malondialdehyde and levels was observed ($p<0.05$). Nuclear respiratory factor 1 level and superoxide dismutase activity of the ischemia+coumaric acid group were significantly higher than ischemia group ($p<0.05$). In histopathological samples, the ischemia+coumaric acid group is compared with ischemia group, there was a significant increase in numbers of normal neurons ($p<0.05$). In immunohistochemical staining, hipoxia-inducible factor-1a and NF-kappa B immunopositive neurons were significantly decreased in ischemia+coumaric acid group compared with ischemia group ($p<0.05$). The neurological deficit scores of ischemia+coumaric acid group were significantly higher than ischemia group at 24 h ($p<0.05$).

Conclusions

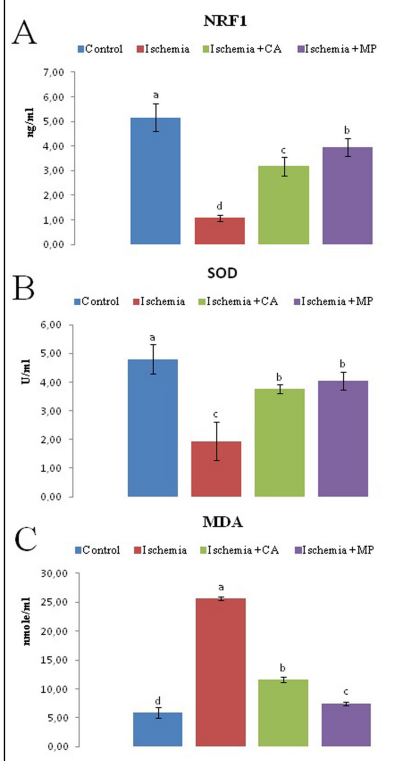
Our study demonstrated the antioxidant effects of CA. However, it has some limitations. Future studies could augment the number of rats in each group and the time period for neurological assessment, and they could investigate the dose-dependent results; delaying neurological and histopathological assessment for more than 24 h after SCIR injury may show better treatment effects. Also, preconditioning in a similar model may have additive effects. Further studies based on our findings may further clarify the potential benefits of this promising medication for SCIR injury.

References

King A, Young G (1999) Characteristics and occurrence of phenolic phytochemicals. Journal of the American Dietetic Association 99:213-218.

Kong CS, Jeong CH, Choi JS, Kim KJ, Jeong JW (2013) Antiangiogenic effects of p-coumaric acid in human endothelial cells. Phytotherapy research : PTR 27:317-323.

Figure 1



The effects of CA on changes in tissue NRF1 levels,c $p < 0.05$, significantly different compared to other groups.a,b,d b: The effects of CA on changes in tissue enzyme activities of SOD. Ischemia+CA group is not significantly different from ischemia+MP group,b $p > 0.05$ but significantly different compared to control groupa and ischemia group,c $p < 0.05$. c: The effects of CA on changes in tissue MDA levels. All groups are significantly different compared to each other, $p < 0.05$.