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Regulation Mechanism of Sodium Balance through Vagus Nerve

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Summary

[Background] The purpose of this study is to investigate the effects of vagus nerve stimulation on the kidney injury (including effects on sodium regulation function).

[Methods] Cisplatin-induced nephropathy (25 mg/kg was intraperitoneally administered) was used for evaluating the effect of vagus nerve stimulation after injury. Electrical stimulation (5 Hz, 50 μA, 10 minutes) of the vagus nerve of the left neck was performed as vagus nerve stimulation. The degree of kidney injury was evaluated by using BUN, plasma creatinine, the degree of acute tubular necrosis by PAS staining, and the expression level of Kim-1 which is a marker of acute renal injury in the kidney. Changes in sodium regulation function were evaluated using FENa (% Na excretion rate).

[Results] When vagus nerve stimulation was performed the day after cisplatin administration, it was found that vagas nerve stimulation reduced kidney damage two days after vagas nerve stimulation. The nephroprotective effect of this vagus nerve stimulation disappeared by removing the spleen in advance. Further, it was confirmed that the kidney injury-reducing effect was also obtained by transferring α7 nicotinic acetylcholine receptor-stimulated macrophages the day after cisplatin administration. Analysis of plasma cytokines revealed that vagus nerve stimulation suppressed chemokines such as CCL2 induced by cisplatin. Flow cytometry showed that cisplatin-induced infiltration of immune cells centered on macrophages into the kidney was suppressed by vagus nerve stimulation. When vagus nerve stimulation was performed the day after cisplatin administration and kidney function and sodium metabolism were evaluated the next day, improvement in sodium reabsorption was observed, although no improvement in renal dysfunction was observed the day after vagus nerve stimulation.

[Conclusions] It has been shown that vagus nerve stimulation is effective even after kidney injury, reducing kidney damage or promoting healing. Macrophages stimulated with α7 nicotinic acetylcholine receptor were considered to be important for exerting this kidney protective effect.