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An analysis of the intervention effect of perioperative evidence-based nursing on orthopedic trauma patients' vagal reflex

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Abstract. – OBJECTIVE: to discuss the application value of evidence-based nursing (EBN) on orthopedic trauma patients' perioperative vagus reflex intervention effect.

PATIENTS AND METHODS: Eighty-six patients were selected, who were hospitalized in orthopedics department of our hospital because of trauma from March, 2013 to March, 2014. Then, they were divided into the control group (n = 41 cases) and the treatment group (n = 45 cases) according to random number table after obtaining the consent of the Hospital Ethics Committee and the informed consent of the patients as well as their relatives. Control group patients were treated with conventional nursing before, during and after operation, and treatment group patients were treated with EBN. Then, the incidence of vagal reflex on the two groups of patients was compared. HRV frequency domain was applied to analyze the differences of autonomic nervous function changes on the two groups of patients, and ELISA test was taken to detect the differences of the concentration change of serum TNF-α and IL-6.

RESULTS: The prevalence of vagal reflex on patients in treatment group was significantly lower than that in the control group, with statistically significant difference ($p < 0.05$); low frequency (LF) and high frequency (HF) on patients from both groups decreased after treatment while LF/HF increased, and LF and HF on patients of the treatment group decreased more significantly and LF/HF increased more significantly than those of the control group, with statistically significant difference ($p < 0.05$); the concentration of TNF-α and IL-6 on both groups of patients after nursing also decreased, and the treatment group decreased more significantly, with statistically significant difference ($p < 0.05$).

CONCLUSIONS: EBN could reduce the prevalence of vagal reflex to some extent on perioperative orthopedic trauma patients. It might be because EBN could improve vagal tone and reduce the concentration of TNF-α and IL-6.

Key Words:
Evidence-based nursing, Orthopedic trauma, Perioperative period, Vagus, HRV frequency domain analysis.

Introduction

Nowadays, disability rate and lethality resulted from traffic accidents are higher than that from the chronic disease, such as cardiovascular and cerebrovascular diseases, and malignant tumor. Orthopedic trauma, because of its high morbidity, complicated pathology, more complication, poor prognosis, and high medical expense, has become a serious public health problem. The activation of body's stress response after orthopedic trauma, the activation or inhibition of autonomic nerves system (which includes sympathetic nerve and parasympathetic nerve) and endocrine (which include the hypothalamus, pituitary, and target endocrine gland axis), and inflammatory response (which includes inflammatory factors such as TNF-α and IL-6, and inflammatory cells, such as neutrophils and lymphocytes as well as extracellular matrix) would all be involved in the occurrence, progress, and prognosis of diseases[1,2]. Early and timely surgical treatment after orthopedic trauma is quite significant in the prognosis of the patients. Researches have shown that inflammatory responses after orthopedic trauma were related with vagal tone, which means that once the vagal tone increased, the inflammatory response would be mitigated so that prognosis could be improved[3,4]. EBN is a kind of science-based nursing model, which has significant effect in improving

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the patients' psychological state, and increasing the doctor–patient harmony[5]. This study further investigates the application value of EBN on orthopedic trauma patients' perioperative vagus reflex intervention effect.

Patients and Methods

General Material

Eighty-six patients were selected, who were hospitalized in orthopedics department of our hospital because of trauma from March, 2013 to March, 2014. All of the selected patients were diagnosed with a history of trauma and with physical signs of fracture, soft tissue injury, and neurovascular injury through clinical examination, and were confirmed through imaging x-ray, CT, or MRI. In this study, the 86 cases were divided into the control group (n = 41 cases) and the treatment group (n = 45 cases) according to random number table after obtaining the consent of the Hospital Ethics Committee and the informed consent of the patients as well as their relatives. In the control group, 26 cases were male while 15 cases were female, being aged from 28 to 73 years old, on average 43.6 ± 12.7 years old, 23 cases of traffic accident, 18 cases of falling damage, nine cases of upper limb injury, 12 cases of lower limb injury, six cases of head trauma, five cases of chest injury, eight cases of abdomen injury, and one case of pelvic injury. In the treatment group, 28 cases were male while 17 cases were female, being aged from 25 to 78 years old, on average 44.5 ± 13.3 years old, 26 cases of traffic accident, 19 cases of falling damage, nine cases of upper limb injury, 13 cases of lower limb injury, seven cases of head trauma, five cases of chest injury, nine cases of abdomen injury, and two cases of pelvic injury. Differences had no statistical significance ($p > 0.05$) after comparison on gender, age, trauma site, and trauma causes between the two groups of patients. Exclusion criteria: 1. Age < 18 years old, and ≥ 80 years old; 2. Malignant bone tumors, multiple injuries; 3. Hemorrhagic shock and severe infection in 24 h; 4. Serious liver and kidney dysfunction, disturbance of blood coagulation, pregnancy, severe neurosis and poor compliance, and patients who reject the study and so on.

Methods

All of the patients were given a disease evaluation by professionally experienced doctor and applied with a reasonable medical and surgical operation plan. After they were hospitalized, doctors immediately opened their venous channel, monitored their vital signs, actively conducted anti-shock, anti-infection, and complication prevention treatment. Then, control group patients were treated with conventional nursing, including preoperative health education, which required to educate the patients with relevant knowledge about their diseases, to ease or remove their fears with psychological nursing, and to alleviate their gastrointestinal reaction with diet nursing; intra operative cooperation was done, which required to observe the patients' vital signs and the patients were asked to transfer their attention at extubation; postoperative pressure bandaging on the puncture point and continuous electrocardiograph monitoring, and so on were conducted (Table I).

Observational Index

The occurrence of vagal reflex on the two groups of patients was compared. HRV frequency domain to analyze the differences of autonomic nervous function changes on the two groups of patients was applied, and ELISA to detect the differences of the concentration change of serum TNF-α and IL-6 was conducted.

Judgment indicators of vagal reflex: (1) Untoward effects, such as chest distress, short of breath, pale complexion, sweating, nausea, and vomiting. (2) Compared with the condition before decannulation, heart rate decreased by 10 times/min and blood pressure decreased by 15 mmHg. The occurrence of any one of the above two indicators could be considered as vagal reflex of clinical significance. By means of Holter recorder (model DIG 40, DME company, Madison Heigts, MI, USA) and HRV analysis software (version V1.1 Department of Applied Physics, University of Kuopio, Finland), patients' electrocardiogram under a quiet, prostrate state for 30 min between 7 o'clock to 9 o'clock in the morning was monitored. Discontinuously chose three time slots and took the average. Premature beat free 6-min RR interval to conduct hearth rate variability (HRV) analysis was selected, and the three frequency-domain indices, low frequency (LF), high frequency (HF), and LF/HF through automatic recursive method were obtained. Three milliliter of fasting venous blood was collected; it immediately was placed on ice for 60 min until natural coagulation. Then, centrifuged with 400 g for 15 min under 4°C, transferred the serum to another Ep tube, centrifuged again with 10,000 g for 5 min under 4°C and,

Table 1. The specifics to treat the treatment group patients with EBN.

Time	Nursing content	Nursing intervention	Nursing goals	Nurse signature
First day in hospital	Admission education	Introduce the ward environment, attending doctor and primary nurses, issue clinical pathway nursing plan, introduce clinical pathway of operation and treatment, and general in hospital time and costs, instruct patients to give up smoking and alcohol, inform them of the examination items, purposes and matters need attention.	To get the patients' understanding and cooperation	
Preoperation period (Days 4–5)	Preoperative directions	Make psychological nursing, teach patients to take deep breath, help them to cough up phlegm effectively and practice defecation and emiction on bed. Help them in quadriceps femoris exercise. Assist the patients in shower and dressing, improve their sleep quality, and make antibiotic skin test and safe medication education. Prepare skin, and ask the patients to fast for 12 h and avoid drinking for 6 h.	To make the patients keep stable emotions and accept operative treatment.	
	Life care	Abduce the affected limb to 30 degree neutral position and turn over the uninjured side. Provide dietary guidance and pain nursing.	To tolerate pains and have good sleep.	
Perioperative period (Days 6–8)	Life care and functional exercise	Monitor the patients' vital signs, give them medicine according to the doctor's advice, observe the condition of their wounds and drainage tubes. Help them in buttock raising, ankle stretch and plantar flexion, lengthening contraction of quadriceps femoris. Hold a pillow between the patients' two legs, massage hypogastrium clockwise, clip ureter and pull out in due time.	To keep draining fluid without pressure sores, and blood supply in the tip of affected limb favorable, promote defecation, prevent uroschesis.	
Early period of postoperation (Days 9–11)	Life care and functional exercise	Message gastrocnemius muscle, biceps femoris muscle, quadriceps femoris and knee and ankle joints from far and near. Use CPM to help them to do strength training, place a pillow below their knee and help them to do straight leg raising exercise, flex their hip 10–20 degree and raise buttock, make their affected limb prolapse and swing, and remove in bed. Help the patients to get in and out of bed, to go to the toilet, and pay attention to safety management and strengthen nutrition.		

Table continued

Table I. *(Continued).* The specifics to treat the treatment group patients with EBN.

Time	Nursing content	Nursing intervention	Nursing goals	Nurse signature
Middle and later period of postoperation (Days 12–15)	Life care and functional exercise	Enhance the patients' quadriceps strength, prevent rotation and adduction of hip joint, and keep the affected limb from heavy weight. Swing their shank on bedside, do position swift training on bedside and make upright bedside training. Make the lower limb touch the ground without weight, walk with auxiliary walking device, stand on the healthy leg, then turn to stand with the help of parallel bar, walking frame and double crutches.	To prevent falls and dislocation, to keep balanced standing and practice walking.	
Discharging guide	Functional exercise and joint protection	To lie on the back and ride empty bicycle, practice transfer in the balancer, do walking training firstly with the help of parallel bar, then the walker, double crutch, single crutch, till finally no crutch at all. Hip flex shall be controlled within 90 degrees in three months. Hip joint adduction and internal rotation shall be prohibited within 6 months after operation until it gradually transits to full weight. Running, jumping and heavy things lifting shall be prohibited.	To recover joint functions, improve life quality, protect prosthesis, and extend the life of the prosthesis.	

then, stored under −70°C for inspection. Sandwich method ELISA kit was used on both TNF-α and IL-6 (eBioscience Corporation, San Diego, CA, USA) and the operation was conducted strictly in accordance with the kit specification.

Statistical Analisys

SPSS 17.0 software package (SPSS Inc., Chicago, IL, USA) was used to make statistical treatment of relevant data, case number or percentage was used to express enumeration data, χ^2 test and Fisher exact propability were used to test comparisons among groups; mean ± standard deviation was used to express measurement data, *t*-test was used to make comparisons among groups. $p < 0.05$ was regarded as statistical significance.

Results

Comparison of Vagal Reflex Prevalence on Both Groups of Patients

Both the intraoperative and postoperative vagal reflex prevalences of the treatment group were lower than those of the control group, and difference has statistical significance ($p < 0.05$) (Table II).

Comparison of Autonomic Nerve Function Change in Both Groups of Patients

The difference of low frequency (LF), high frequency (HF), and LF/HF on both groups of patients before operation had no statistical significance ($p > 0.05$); LF and HF on patients from both groups decreased after operation while LF/HF increased, and LF and HF on patients of the treatment group decreased more significantly and LF/HF increased more significantly than those of the control group. Differences have statistically significance ($p < 0.05$) (Table III).

Comparison of the Concentration of TNF-α and IL-6 on Both Groups of Patients

Difference of the concentration of TNF-α and IL-6 between the two groups of patients before operation has no statistical significance ($p > 0.05$); the concentration of TNF-α and IL-6 on both groups of patients after operation decreased, and the treatment group decreased more than the control group. Differences had statistical significance ($p < 0.05$) (Table IV).

Table II. Comparison of vagal reflex prevalence between both groups of patients [case (%)].

Group	Case	Reflex prevalence	
		Preoperation	Postoperation
The control group	41	5 (12.20)	3 (7.32)
The treatment group	45	3 (6.67)	1 (2.22)
χ^2		3.351	3.946
p		0.026	0.024

Discussion

The body's stress reaction after trauma increased, neuroendocrine system was activated, hormones such as corticotrophin-releasing hormone, glucocorticoid, catecholamines, and noradrenaline were expanded extraordinary, the sympathetic nervous system activity increased significantly while vagal tone significantly reduced. Research has shown that autonomic nerve function was closely related to inflammatory response[6]. Wang et al (Nature 2003; 421: 384-388) have discovered that tThe application of nicotine or direct current to stimulate vagus could significantly reduce the concentration of TNF-α and HMGB-1 in the serum of sepsis mice, and inhibit the tissue injuries and death. This kind of neuronal signaling was defined as "cholinergic anti-inflammatory pathway". Vagus reflex's effect in adjusting inflammatory response could be achieved by adjusting the distribution of lymphocytes, changing body fluid and cellular immune function and also influencing the number of Thl/Th2 cytokines[7,8].

Early surgical treatment on orthopedic trauma patients could significantly improve the clinical effect and long-term prognosis, but a low early vagal tone would also affect the surgical effect[9]. EBN was a complete set of nursing care plan, which was made out on the basis of the latest currently available research and the nurses' abilities. It had given full consideration to the actual situation of patients and combined the patients' individual demands, past clinical experience, and the existing research conclusions together, thus could be used as basis for clinical nursing deci-

Table III. Comparison of autonomic nerve function change in both groups of patients.

Group	LF (ν)		HF (ν)		LF/HF	
	Preoperation	Postoperation	Preoperation	Postoperation	Preoperation	Postoperation
The control group	72.12 ± 23.64	58.67 ± 16.65	24.16 ± 5.54	18.64 ± 3.8	8.47 ± 1.23	9.36 ± 1.03
The treatment group	73.44 ± 19.46	43.29 ± 15.48	25.31 ± 6.37	14.48 ± 7.5	8.31 ± 1.24	12.38 ± 2.14
t	0.324	3.026	0.364	3.625	0.715	3.128
p	0.512	0.027	0.932	0.012	0.658	0.023

Table IV. Comparison of the concentration of TNF-α and IL-6 on both groups of patients.

Group		TNF-α (pg/ml)		IL-6 (pg/ml)	
		Preoperation	Postoperation	Preoperation	Postoperation
The control group		18.37 ± 6.28	13.24 ± 4.06	124.32 ± 43.51	94.72 ± 35.01
The treatment group		19.64 ± 5.29	8.15 ± 2.14	135.28 ± 54.26	72.15 ± 32.67
t	0.123	4.025	0.915	4.328	
p	0.814	<0.001	0.726	<0.001	

sion. EBN was a practicing process that clinical nurses carried out while nursing intervention on patients[10]. As modern medicine develops continuously, EBN has already become one important trend for current nursing development. The clinical application of EBN could greatly improve clinical treatment effects[11].

From this study, we could come to that: the occurrence of vagal reflex on patients in treatment group was significantly lower than that of the control group, with statistically significant difference; LF and HF on patients from both groups decreased after treatment while LF/HF increased, and LF and HF on patients of the treatment group decreased more significantly and LF/HF increased more significantly than those of the control group, with statistically significant difference. The concentration of TNF-α and IL-6 on both groups of patients after nursing also decreased, and the treatment group decreased more significantly, with statistically significant difference. Features of vasovagal reflexes: the decline of heart rate and blood pressure, nausea, vomiting, cold sweats, palpitation, chest distress and even cold limbs and pale complexion, etc. Causes of vasovagal reflexes: (1) in early period, patients were lost in an extreme panic state, the body's autonomic nerve dysfunctioned, sympathetic nerve got extremely excited, secretion of catecholamine increased, vasoconstriction stimulated, myocardial contraction strengthened, negative feedback to adjust the carotid sinus pressure sensors, and further led to the reduction of vagal tone and the enhancement of reflex[12,13]. (2) Intraoperative stimulation on blood vessels and nerves. (3) A large amount of vagal endings were distributed around blood vessels, and any improper nursing would retract, stimulate the vagus on the vascular wall[14,15]. (4) Excessive local dressing pressure resulted from postoperative external fixation and drainage tube pulling out, and increased or interrupted local blood flow would lead to the increase of artery tension on pressure point, the expansion of blood vessels, the excitability of receptor, and finally the induction of vagal reflex[16]. (5) Traumatic shock, septic shock and reperfusion injury could stimulate hypothalamus to secrete vasopressin, cause vascular smooth muscle to contract, and finally result in vagal reflex[17]. (6) Position factors and so on. Professional, detailed EBN modality (as described in the above form) could significantly reduce the appearance of vagal reflex[17,18].

Conclusions

EBN could reduce the occurrence of vagal reflex to some extent on perioperative orthopedic trauma patients. It might be because EBN could improve vagal tone and reduce the concentration of TNF-α and IL-6.

Conflict of Interest

The Authors declare that they have no conflict of interests.

References

1) Hiraki T, Baker W, Greenberg JH. Efect of vagus Nerve stimulation during transient focal cerebral ischemia on chronic outcome in rats. J Neurosci Res 2012; 90: 887-894.
2) Borovikova LV, Lvanova S, Zhang M, Yang H, Botchkina GI, Watkins LR, Wang H, Abumrad N, Eaton JW, Tracey KJet al. Vagus nerve stimulation attenuates the systemic inflammatory response to endotoxin. Nature 2000; 405: 458-462.
3) Tracy KJ. The inflammation reflex. Nature 2002; 420: 853-859.
4) Jiang Y, Li L, Liu B, Zhang Y, Chen Q, Li C. Vagus nerve stimulation alleviates cerebral ischemia and reperfusion injury via endogenous cholinergic pathway in rat. PLoS One 2014; 9: e102342.
5) Berthoud HR, Neuhuber WI. Functional and chemical anatomy of the afferent vagat system. Auton Neurosci 2000; 85: 98-101.
6) Goehler LE, Gaykema RP, Hansen MK, Anderson K, Maier SF, Watkins LR. Vagal immune to brain communication: a visceral chemosensory pathway. Auton Neurosci 2000; 85: 49-59.
7) Wu Y, Guo SW. Peroxisome proliferator-activated receptor-gamma and retinoid X receptor agonists synergistically suppress proliferation of immortalized endometrial stromal cells. Fertil Steril 2009; 91: 2142-2147.
8) Steinman L. Elaborate interactions between immune and nervous systems. Nat Immunol 2004; 5: 575-581.
9) Pavtov VA, Wang H, Czura CJ, Friedman SG, Tracey KJ. The cholinergic anti-inflammatory pathway: a missing link in neuroimmunomodulation. Mol Med 2003; 9: 125-134.
10) Espirito Santo A, Choquette A. Experience of adapting and implementing an evidence-based nursing guideline for prevention of diaper dermatitis in a paediatric oncology setting. Int J Evid Based Health 2013; 11: 121-127.
11) Hermann GE, Emch GS, Tovar CA, Rogers RC. c-Fos generation in the dorsal vagal complex after

systemic endotoxin is not dependent on the vagus nerve. Am J Physiol Regul Integr Comp Physiol 2001; 280: R289-R299.

12) Jiang Y, Li L, Liu B, Zhang Y, Chen Q, Li C. PPAR^3 upregulation induced by vagus nerve stimulation exerts anti-inflammatory effect in cerebral ischemia/reperfusion rats. Med Sci Monit 2015; 21: 268-275.

13) Burman ME, Robinson B, Hart AM. Linking evidence-based nursing practice and patient-centered care through patient preferences. Nurs Adm Q 2013; 37: 231-241.

14) Tecoma ES, Iragui VJ. Vagus nerve stimulation use and effect in epilepsy: What have we learned? Epilepsy Behav 2006; 8: 127-136.

15) Cheyuo C, Jacob A, Wu R, Zhou M, Coppa GF, Wang P. The parasympathetic nervous system in the quest for stroke therapeutics. J Cereb Blood Flow Metab 2011; 31: 1187-1195.

16) Kennedy PA, Schallert G. Practical issues and concepts in vagus nerve stimulation: A nursing review. J Neurosci Nurs 2001; 33: 105-112.

17) Ay I, Lu J, Ay H, Gregory Sorensen A. Vagus nerve stimulation reduces infarct size in rat focal cerebral ischemia. Neurosci Lett 2009; 459: 147-151.

18) Kapadia R, Yi JH, Vemuganti R. Mechanisms of anti-infammatory and neuroprotective actions of PPAR-gamma agonists. Front Biosci 2008; 13: 1813-1826.