Letter to the Editor

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Adequate time of initiation of continuous infusion of nitroglycerin for controlling pulmonary arterial pressure during ethanol embolotherapy of congenital arteriovenous malformation of the extremities

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Congenital arteriovenous malformation, although its pathogenesis remains elusive, is speculated to result from abnormal vasculogenesis and angiogenesis during early embryogenesis. It usually remains dormant until puberty and become evident at puberty or pregnancy due to hormonal changes, or as a result of trauma or surgical stress. After becoming symptomatic, the engorgement of congenital arteriovenous malformation increases throughout the lifetime without involution. It is now apparent that complete destruction of the nidus by transcatheter embolotherapy, combined with surgery or not, is one of the best approaches for successful treatment [1]. Among the embolic agents, absolute ethanol is considered the more effective agent because of the better possibility of a complete cure [2]. However, intravascular injection of absolute ethanol can cause detrimental cardiopulmonary complications including dysrhythmia, pulmonary hypertension, and even acute cardiopulmonary collapse [3]. Therefore, it is essential for an experienced anesthesiologist to monitor the fluctuating hemodynamic changes at every injection of absolute ethanol, for the safety of patients and better treatment outcomes.

We retrospectively evaluated whether initiation of a continuous infusion of nitroglycerin before the first administration of absolute ethanol is more effective in controlling the pulmonary arterial pressure (PAP) than its initiation after a bolus injection of absolute ethanol during the session. We also investigated which time point of nitroglycerine infusion would better moderate the severe hemodynamic changes at the end of the session, another critical period of greatly changing PAP.

After obtaining the approval of the Institutional Review Board of our hospital with a waiver of informed consent, this retrospective study was conducted in 24 patients who underwent ethanol embolotherapy from July 2003 to December 2010 at our hospital. Exclusion criteria were patients with cardiomyopathies, and moderate or severe pulmonary hypertension.

The following patients who had received a continuous infusion of nitroglycerin before and after a bolus injection of ethanol were retrospectively included in the present study: patients who received a continuous infusion of nitroglycerin (0.5−1.0 mg/kg/min) immediately after the induction of general anesthesia and before a large bolus injection of ethanol (more than 5 ml of bolus injections of absolute ethanol or more than 20 ml of total amount of absolute ethanol) (group P, n = 12); and patients who received a continuous infusion of nitroglycerin at the elevation of mean pulmonary artery pressure (PAP, 10 mmHg greater than the baseline values or higher than 25 mmHg) after the injections of absolute ethanol (group A, n = 12).

After the start of the bolus injection of absolute ethanol, the amount of the continuous infusion of nitroglycerin was adjusted within the range of 0.5−3.0 μg/kg/min, according to the elevation of the pulmonary arterial pressure in both groups.

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Table 1. Hemodynamic Parameters during Absolute Ethanol Embolotherapy

Pulmonary arterial pressure (mmHg)	$T_{baseline}$		$T_{highest}$		T_{final}		$T_{self\text{-}resp}$	
	Group P	Group A	Group P	Group A	Group P	Group A	Group P	Group A
Systolic	22.6 ± 4.3	24.1 ± 5.3	35.8 ± 8.5*	34.9 ± 8.5*	30.4 ± 5.1*	29.3 ± 8.1*	34.8 ± 4.4*,†	29.5 ± 5.4*
Mean	16.7 ± 2.8	17.9 ± 4.4	27.6 ± 5.7*	26.6 ± 5.0*	23.9 ± 4.0*	22.6 ± 6.2*	27.3 ± 3.7*,†	23.2 ± 3.8*
Diastolic	11.9 ± 3.3	13.2 ± 4.3	21.1 ± 3.8*	20.3 ± 4.4*	17.7 ± 4.9*	17.5 ± 5.0*	20.0 ± 4.4*	16.9 ± 4.8*

Data are presented as means ± SD. *P < 0.05 vs. baseline, †P < 0.05 vs. Group A of its relevant time. Group P: start continuous infusion of nitroglycerin before the initiation of a bolus injection of absolute ethanol, Group A: start continuous infusion of nitroglycerin after the initiation of a bolus injection of absolute ethanol. $T_{baseline}$: at 15 minutes after the induction of general anesthesia, $T_{highest}$: at the time the mean pulmonary arterial pressure reached the highest level during the session, T_{final}: at 10 minutes after the final injection of absolute ethanol, $T_{self\text{-}resp}$: at the time of restoration of the patient's spontaneous respirations.

We compared the PAPs of the baseline, at the time the pulmonary arterial pressure reached the highest during the session, 10 minutes after the final bolus injection of absolute ethanol, and after restoration of the patient's spontaneous respirations between group A and P. We also compared the difference between the PAPs obtained 10 minutes after the final injection and the baseline, the difference between the hemodynamic values obtained after restoration of the patient's spontaneous respirations and the baseline, and 10 minutes after the final injection of absolute ethanol between the two groups, respectively.

The mean volume of absolute ethanol (5.7 ± 2.5 ml in the group P vs 3.5 ± 1.3 ml in the group A, P < 0.05) and mean total amount of absolute ethanol (32.4 ± 12.8 ml in the group P vs 14.8 ± 6.9 ml in group A, P < 0.05) injected into the patients of group P were significantly larger than those of group A. Six patients developed pulmonary hypertension (elevation of mean pulmonary arterial pressure of more than 25 mmHg) in both groups during the session. Baseline measurements of PAPs showed no statistically significant differences between the groups. Compared with the baseline measurement, the systolic, mean and diastolic PAPs were significantly elevated at the time of the mean pulmonary arterial pressure reaching the highest level at the final injection and the restoration of patient's spontaneous respirations in both groups. However, the systolic and mean PAPs of group P at the period of restoration of the patient's spontaneous respirations were statistically significantly higher than those of group A (Table 1).

Ethanol embolotherapy requires general anesthesia because of the pain caused by the injection of absolute ethanol into the nidus. After Yakes et al. [4] reported the successful use of absolute ethanol in the treatment of inoperable congenital vascular malformation, there were strong debates over its use. One of the main objections was that direct bolus injection of absolute ethanol into the nidus can cause severe pulmonary arterial hypertension, even catastrophic cardiovascular collapse. The changes of PAP during the session of embolotherapy can be very critical. Moreover, PAP can be elevated by changes of venous return, hypercapnia and tracheal irritation by the endotracheal tube during the recovery period [5]. Although the total amount and the amount of single bolus injection of absolute ethanol administered in group P were significantly larger than those of group A, this study shows that early initiation of a continuous infusion of nitroglycerin before the start of a bolus injection of absolute ethanol is more effective in attenuating the elevation of the PAPs during ethanol embolotherapy of arteriovenous malformation than starting the infusion after the hemodynamic changes have already occurred. During the session, the changes of PAPs were comparable between the groups. However, there were more significant elevations of the mean PAP in group P at the period of recovery than in group A. Perhaps the accumulating effect of a larger amount of total absolute ethanol requires more aggressive management in alleviating elevations of mean pulmonary arterial pressures in group P.

In conclusion, this study shows that early initiation of a continuous infusion of nitroglycerin before the start of a bolus injection of absolute ethanol is beneficial in attenuating the pulmonary arterial pressure during ethanol embolotherapy. Furthermore, despite the better moderation of hemodynamic changes with early nitroglycerine infusion, caution is needed during recovery from anesthesia if the patient has received larger doses of absolute ethanol during the session.

References

1. Hyodoh H, Hori M, Akiba H, Tamakawa M, Hyodoh K, Hareyama M. Peripheral vascular malformations: imaging, treatment approaches, and therapeutic issues. Radiographics 2005; 25 Suppl 1: S159-71.
2. Do YS, Yakes WF, Shin SW, Lee BB, Kim DI, Liu WC, et al. Ethanol embolization of arteriovenous malformations: interim results. Radiology 2005; 235: 674-82.
3. Lee BB. Advanced management of congenital vascular malformations (CVM). Int Angiol 2002; 21: 209-13.
4. Yakes WF, Rossi P, Odink H. How I do it. Arteriovenous malformation management. Cardiovasc Intervent Radiol 1996; 19: 65-71.
5. Mitchell SE, Shah AM, Schwengel D. Pulmonary artery pressure changes during ethanol embolization procedures to treat vascular malformations: can cardiovascular collapse be predicted? J Vasc Interv Radiol 2006; 17: 253-62.