Disordered gas exchange in the blood caused by nasal tamponade

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SUMMARY

The authors have examined the pH, the pCO_2, the pO_2, and the oxygen saturation of the blood of patients upon whom endonasal surgery followed by tamponing of the nose had been performed. The gas values were examined on the second postoperative day and two days after the tampons had been removed. It was found that the blood pH remained within normal limits, whereas during the acute obstruction the pO_2 values were diminished, the pCO_2 values were increased, and the oxygen saturation of the blood was noticeably diminished. The authors recommend carefulness if the noses of patients with cardiorespiratory insufficiency are to be tamponed.

THE nose is the beginning of the respiratory system. The passageways composing it serve to conduct the atmospheric air into the alveolar region and to expell carbon dioxide from it back into the atmosphere. This course of air streams in two opposite direction is due to the difference between the pressures in the atmosphere and in the respiratory system. The thus effected breathing is regulated by the respiratory centre, the chemoreceptors, the Hering-Breuer's reflexes and the muscular receptors (Guyton, 1969).

Besides being the beginning and end of the in and outleading systems the nose performs a large number of more or less known functions. It is also the origin of the respiratory reflexes important for the regular course of the breathing. The conditions for these reflexes to arise are the unobstructed nasal cavities and their healthy mucosa. Under such conditions the air stream is able to stimulate the nerve endings of the trigeminus in the nasal mucosa and to initiate the reflex action, which the trigeminus transmits to the respiratory centre and on to the vagus nerve, the phrenic nerve and into the intercostal nerves. The result of this transmission is calm, deep and sufficient breathing. (Lüscher, 1930; Sercer, 1940 and Stangl, 1971).

If the nose is obstructed then this mechanism is excluded.

In the examinations in question the following question was posed:

What disorders will occur in the gas exchange between the atmosphere and the alveolar sacks of a patient with acute and complete nasal obstruction lasting a

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number of days and owing to the tamponing of the nasal cavities after an endonasal surgical intervention.

For the experiment we selected patients without affections of the lower respiratory passages and without any disorders of the cardiac functions. The only complaint of the selected patients was affected nasal breathing owing to a broken septum, to total nasal deformation, or nasal polyposis, the conditions which had been the causes of the surgical interventions. The blood gases were determined in 24 patients, 19 of whom were men and 5 women. Their ages varied between 24 and 40 years.

The following parameters were determined: the pH of the blood, the pO_2, the pCO_2, and the oxygen saturation of the blood. The gases were determined the day after the surgical interventions and the nasal tamponade, and on the second day after the tampons had been removed. The samples were taken from a finger after warming it in very warm water for half an hour. We consider that the blood samples thus taken were suitable for the experiment though there is an insignificant difference between the pO_2 values of capillary blood and the samples obtained by puncturing an artery. The gas analyses were performed on an apparatus called Il 213-Analizatore digitale di pH, pCO_2, pO_2.

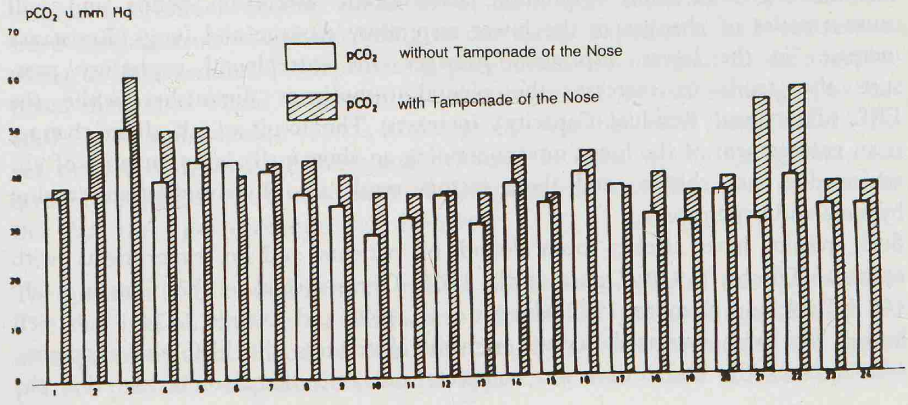
		pCO_2	pO_2	SO_2
1	M.F.	39,3	71	96.5
		36,8	**76,8**	**97**
2	H.R.	50,2	63,9	92
		37,2	**76,4**	**95,2**
3	K.F.	60,7	69,1	94,3
		50.5	**74,7**	**94**
4	P.J.	50,2	68,9	93
		40,1	**75**	**95,2**
5	C.F.	51,2	66,9	91,2
		44,2	**74,2**	**94,4**
6	G.Z.	41,4	74,6	94,2
		43,8	**81,8**	**95,6**
7	L.D.	43,5	75,3	95
		42	**75,3**	**95**
8	F.M.	44	65,9	92
		37,2	**90,5**	**96,4**
9	N.I.	40,7	66	94,3
		35,4	**68**	**92,2**
10	F.S.	37,3	79,8	96,3
		28,8	**76,9**	**99,5**
11	S.S.	37,1	80,5	96
		32,2	**82**	**96,3**
12	P.K.I.	37,7	80,3	96,3
		37,1	**84,2**	**96,1**

Table 1
pCO_2, pO_2, SO_2 (Oxygen saturation) with tamponade and without tamponade of the nose.

		pCO_2	pO_2	SO_2
		37,9	74,6	95,1
13	P. S. R.	**30,5**	**91,3**	**96,7**
		44,3	64,3	93,3
14	F. G.	**38,5**	**73,1**	**94,8**
		36,5	76,8	94,4
15	Ś. B.	**34,5**	**83,6**	**95,8**
		44,8	77,8	95,6
16	K. K.	**40,3**	**76,7**	**94,8**
		37,5	71	93,6
17	K. D.	**38,2**	**76,4**	**95,8**
		40,1	74,5	95,9
18	Ś. S.	**32,2**	**89,7**	**96,7**
		36,6	81,9	96,8
19	P. I.	**30,6**	**81,8**	**96**
		39,5	58	93,1
20	P. I.	**36,8**	**65,5**	**93**
		54,8	59,5	86,2
21	Ś. S.	**30,7**	**76,4**	**94,8**
		57	82,8	96,7
22	G. F.	**39,6**	**89,5**	**97,8**
		38,4	73,7	94,7
23	G. D.	**34,3**	**76,3**	**95,4**
		37,9	66,2	9[illegible]
24	V. B.	**34,3**	**73,7**	**94,7**

Table 2
pCO_2, pO_2, SO_2 (Oxygen saturation) with tamponade and without tamponade of the nose.

Figure 1.



RESULTS

The analysis of the results shown in tables and graphs reveals the following facts. (Table 1, Tables 2, Figure 1).

The partial CO_2 pressure was increased during the acute nasal obstruction in 20 patients, in 3 it remained unchanged, while in 1 it was somewhat diminished. The biggest difference between the pCO_2-s during the obstruction and after freeing the nasal cavities was 24.1 mmHg.

During the obstruction the partial oxygen pressure (pO_2) was diminished in 21 patients, it remained at the same level in 1 patient, and was increased in 2 patients. The biggest difference between the pO_2 values during the nasal obstruction and after the tampons removed amounted to 24.6 mmHg.

The oxygen saturation of the blood during the nasal obstruction was diminished in 14 patients, remained at the same level in 7, and was somewhat increased in 3 patients. The biggest difference between the obstructed and free breathing amounted to 8.6 per cent. The blood pH was within normal limits in all patients.

DISCUSSION

Ventilation is the most important component in the process of the gas exchange between the atmosphere and the alveolar region. It can proceed orderly if the respiratory passages and organs as a whole are in a state of anatomic and physiological integrity (Guyton, 1969; Sercer, 1940 and Stangl, 1971). If obstructions occur at any level of the respiratory passages the ventilation is disturbed, and with it the exchange of gases.

In our examinations — as mentioned — we were interested in the role of nasal obstruction in disturbing the regular exchange of the gases in the blood. For the group of examinees we selected only fairly young people in whom it was impossible to find any disorder of the lower respiratory passages and lungs either by anamnestic or clinical examinations. The disturbed gas exchange was thus only conditioned by the nasal obstruction, which was acute and complete.

In the introduction it is mentioned that the nose as the beginning of the respiratory passages is also the origin of the respiratory reflexes. If obstruction excludes the nose from respiration, nasothoracic areflexion occurs and will cause a series of changes in the lower respiratory passage and lungs. Resistance increases in the lower respiratory passages, the intrepleural expiratory pressure also tends to increase, the pleural compliance diminishes while the FRC (Functional Residual Capacity) increases. The result of all those changes is an enlargement of the lungs now containing an abnormally large quantity of air, which does not change, and these factors result into hypoventilation causing hypoxia and hypercapnia.

Such results have already been found in patients and in experiments with animals (Lüscher, 1930; Ogura et al., 1964; Ohnishi et al., 1972; Cassisi et al., 1971; Cook and Komorn, 1972; Cvetnic et al., 1974 and Cvetnic, 1974). It is well known that with increased degrees of nasal obstruction the FRC also augments. In our cases the obstruction was complete and it is therefore certain that the

FRC reached its highest value. Owing to it was the distribution of the ventilation, which even in perfectly healthy lungs and totally unobstructed respiratory passages is not uniform, still more distrubed. The upper parts of the lungs are known to be less ventilated than the lower ones owing to the difference between the interpleural pressures in the upper and lower parts of the interpleural voids (Lüscher, 1930; Sercer, 1940; Stangl, 1971; Ogura et al., 1964 and Cvetnic et al., 1974). In the upper parts namely are the pressures higher than in the lower ones, as Milic-Emili has already found (Stangl, 1971). The enlargement of the lungs is therefore bigger in its upper parts. The same cause leads also to an increase in the FRC.

Minor obstructions to the passage through the respiratory tract are compensated by the organism by intensifying the work of the respiratory musculature. Hypoventilation is compensated by hyperfunctions of the individual parts of the alveoli. This, however, refers only to the regulation of the pCO_2, which means that an uneven ventilation need not lead to the retention of CO_2 as well. Different is the situation regarding the regulation of the oxygen saturation of the blood. To this end there are also compensating mechanisms but their power is limited. A low pO_2 in the less ventilated alveoli provokes vasoconstriction of the arterioles in this part of the blood stream and consequent resistance to the blood and diverting it to well and hyperventilated alveoli. An increased pCO_2 in the not and insufficiently ventilated alveoli causes bronchospasm, which increases the resistance to the air stream, and thus the air is distributed to the well and hyperventilated alveoli with good perfusion. An increased pO_2 in the hyperventilated alveoli, however, can raise the oxygen saturation of the blood only minimally because of the laws expressed in the curve of oxygen dissociation (Stangl, 1971 and Cvetnic et al., 1974).

If after the above said we now return to our group of examinees we can affirm that the disturbance in the gas exchange was exclusively caused by the nasal obstruction. This is also proved by the normalization of the gas values after the respiratory cavities were freed from obstruction.

The blood gases of this group of patients had not been determined before the surgical intervention because almost all of them were suffering only from one-sided nasal obstruction and, according to our earlier experience, such obstruction, owing to the mentioned compensating possibilities, do not lead to such respirational changes as would cause manifest disturbances of the gas exchange (Cvetnic et al., 1974 and Cvetnic, 1974). In our group, who had been found healthy but for the affected nasal breathing and belonged to rather young age groups, was certainly possessed of a maximum of compensating capacities. Yet in spite of this fact their gas exchange was disturbed.

The question that imposes itself is: what is the practical value of our examination? The fact that an acute nasal obstruction disturbs the gas exchange between the atmosphere and the blood of otherwise healthy people means that in clinical practice particular importance is to be asigned to acute nasal obstruction. Here

we particularly think of cases where the nose has to be tamponed because of epistaxis. Such patients usually belong to older age groups with changes in their cardiorespiratory systems. Because of hypoventilation, hypoxis may cause a cerebral insult or cardiac infarct, as some authors have indicated (Cassisi et al., 1971 and Cook and Komorn, 1972).

In conclusion of our examinations we may affirm that acute nasal obstruction disturbs the gas exchange between the atmosphere and the alveolar region. The partial CO_2 pressure increases, the partial O_2 pressure decreases and the oxigen saturation of the blood is somewhat diminished. The cause of these changes is the hypoventilation conditioned by the nasothoracic areflexion owing to nasal tamponade.
This insight warns the physician when because of epistaxis the necessity arises to tamponade the noses of patients with insufficient cardiorespiratory systems.

ZUSAMMENFASSUNG

Es handelt sich um eine Gruppe von Patienten, die einer Nasenoperation unterzogen wurden, nach der später eine Tamponade folgte. Tag nach der Operation wurde ihr Blut-pH, pCO_2, pO_2 und Sauerstoffsaturation im Blut überprüft. Diese Probe wurde zwei Tage nach der Tamponbeseitigung wiederholt. Es wurde festgestellt, dass pH des Blutes normal geblieben ist, dass pO_2 während der akuten Obstruktion senkte und pCO_2 stieg, und dass die Sauerstoffsaturation im Blut merklich geringer war. Bei den Patienten mit einer Herz und Atmungsinsufizienz ist Vorsicht zu empfehlen, wenn es sich um Nasentamponierung handelt.

RÉSUMÉ

Chez les patients soumis à une chirurgie endonasale suivie d'un tamponnement, les auteurs notent les éléments suivants: ph, pCO_2, pO_2 et saturation en O_2 du sang circulant. Ces valeurs sont appréciées au deuxième jour post-opératoire et deux jours après le retrait du tamponnement. On trouve que le ph sanguin reste dans des limites normales; tandis que, pendant la période aigue de l'obstruction, la pO_2 diminue, et la pCO_2 augmente, et la saturation en O_2 diminue notablement. Les auteurs recommandent les plus grandes précautions lorsqu'un patient atteint d'insuffisance cardio-respiratoire doit subir un tamponnement endo-nasal.

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