

Comparative study of the effects of magnesium and taurine on electrical parameters of natural and artificial membranes

VI. Study of the antagonism between ethanol, magnesium and taurine on the human amnion

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Zusammenfassung

Der Antagonismus zwischen Ethanol, Mg und Taurin wurde unter präventiven (Mg und Taurin vor Ethanol-Gaben) und kurativen Aspekten (umgekehrte Reihenfolge) auf den Transfer von Ionen durch das menschliche Amnion untersucht mittels der entsprechenden transmembranären Konduktivität. Mg hatte nur auf der mütterlichen Seite einen prophylaktischen Effekt; Taurin war wirksamer, auch auf der fötalen Seite. Auf beiden Seiten des Amnions besaß Mg einen geringen kurativen Effekt im Gegensatz zu Taurin, das wirkungslos war. Die Studie zeigt gleiche, aber auch unterschiedliche Membran-Effekte von Mg und Taurin auf.

Summary

The antagonism between ethanol, magnesium and taurine was studied, in preventive action (Mg and taurine are added before ethanol) and in curative action (after ethanol), on the ionic transfer through the human amnion, expressed by the transamniotic conductance measure. Whereas Mg induces a prophylactic effect on the maternal side only, taurine evokes an identical but higher action and besides exerts a prophylactic action on the fetal side. On the both sides, Mg exerts a low curative action after ethanol damage, but taurine has not significant curative action.

This study shows similarities and discrepancies between the action of Mg and taurine on the membrane.

Résumé

L'antagonisme entre alcool, magnésium et taurine a été étudié en action préventive (Mg ou taurine ajoutés avant l'alcool) et en action curative (addition après l'alcool) sur le transfert des ions (exprimé par la mesure de la conductance totale) à travers l'amnion humain isolé. Mg induit un effet prophylactique uniquement sur la face maternelle tandis que la taurine évoque cet effet plus intense sur les deux faces. Mg a une légère action curative des dommages dûs à l'alcool sur les deux faces, tandis que la taurine n'a aucune action significative.

Cette étude montre des similarités mais aussi des discordances entre l'action de Mg et de la taurine sur la membrane.

Introduction

At physiological concentrations, the magnesium and the taurine have similar effects on the ions transfer through the isolated human amnion, they have a compensatory effect, i.e., they both increase the transamniotic conductance G_t [1, 2]. The organism may supply the Mg deficiency by stabilizing the taurine mobilization and the taurine may increase the magnesium effects [3, 4]. Thus, in the amnion, Mg and taurine have an identical and compensatory effect on the paracellular ionic pathway; but, in the leaky amniotic membrane, the permeation way is double: paracellular and transcellular [5]. Further studies [6, 7] of the mechanisms of this apparently identical stabilizing action have shown that Mg acts on all the ways: enzymatic and non enzy-

matic cellular pathways and paracellular pathway; on the contrary, taurine only acts on non enzymatic cellular component and paracellular component. Moreover, the study of the antagonism with regard to several polluting metals [8, 9] shows a competitive effect of Mg vs Pb and Cd and a non competitive effect of taurine vs Cd only. Thus, Mg and taurine have not a compensatory effect on all the electrical properties of the amnion.

Chronic *in utero* exposure to ethanol can produce malformations, growth deficiency and central nervous system abnormalities in humans and experimental animals. The cluster of particular facial features, growth deficiency and mental retardation observed in the children of some chronic alcoholic mothers has been referred to as the fetal alcohol syndrome [10]. Moreover, the ethanol addition decreases the ionic transfer through the isolated human amnion [11].

The relations between alcoholism, magnesium and taurine are well established: chronic alcoholism is an important cause of secondary magnesium deficit and the stress of the alcoholic weaning increases the loss of taurine [12].

In this work, the antagonism between magnesium, taurine and ethanol has been studied on the ionic amnion permeability to induce the preventive and curative

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effects of Mg and taurine with regard to damages of ethanol ingestion.

Material and methods

The human amnion, isolated from the placental zone of the amniotic sac, was sampled and put in between two Ussing chambers containing Hanks' solution at pH 7,4 and $37 \pm 1^\circ \text{C}$, according to the device of *Guiet-Bara* and *Bara* [13].

The ions transfer was estimated by the measure of the transamniotic conductance G_t on the maternal (MS) and on the fetal sides (FS). G_t was measured by observing the transmembrane potential difference when a direct current (100 μA) was passed across the whole tissue, this potential difference was recorded with two agar-agar salt bridges placed 1,3–1,5 mm from each side of the tissue while electrical current was passed across the tissue by means of Ag/AgCl electrodes and was measured on a Schlumberger electrometer.

The composition of the Hanks' solution used in the experiments was (mM/l): NaCl 150, KCl 6, MgSO_4 0,5, MgCl_2 0,5, CaCl_2 1, Na_2HPO_4 - KH_2PO_4 - NaHCO_3 1, glucose 5,5.

Magnesium chloride and taurine were added either on the MS or on the FS at various concentrations.

The results are expressed as means \pm SD. Statistical comparisons were carried out by conventional paired data analysis.

Results

1. Effects of ethanol on the transamniotic conductance G_t

The addition of ethanol on the MS or on the FS decreases quickly G_t . The percentages of G_t decrease are expressed in the Tab. 1.

Tab. 1: Percentages of G_t decrease when ethanol is added on the maternal and fetal sides of the amniotic membrane

Ethanol concentrations	Maternal side (%)	Fetal side (%)
0,4 g/l	$10,0 \pm 0,3$	$15,0 \pm 0,6$
0,8 g/l	$16,5 \pm 1,2$	$19,2 \pm 1,3$
4,0 g/l	$21,5 \pm 1,6$	$26,5 \pm 1,5$

2. Preventive action of magnesium and taurine (Fig. 1)

In this study, 5 mM/l of magnesium or taurine were added in the Hanks' solution

before the addition of ethanol at the concentration equal to 0,4 g/l, 0,8 g/l and 4 g/l, and the percentage of G_t decrease was calculated.

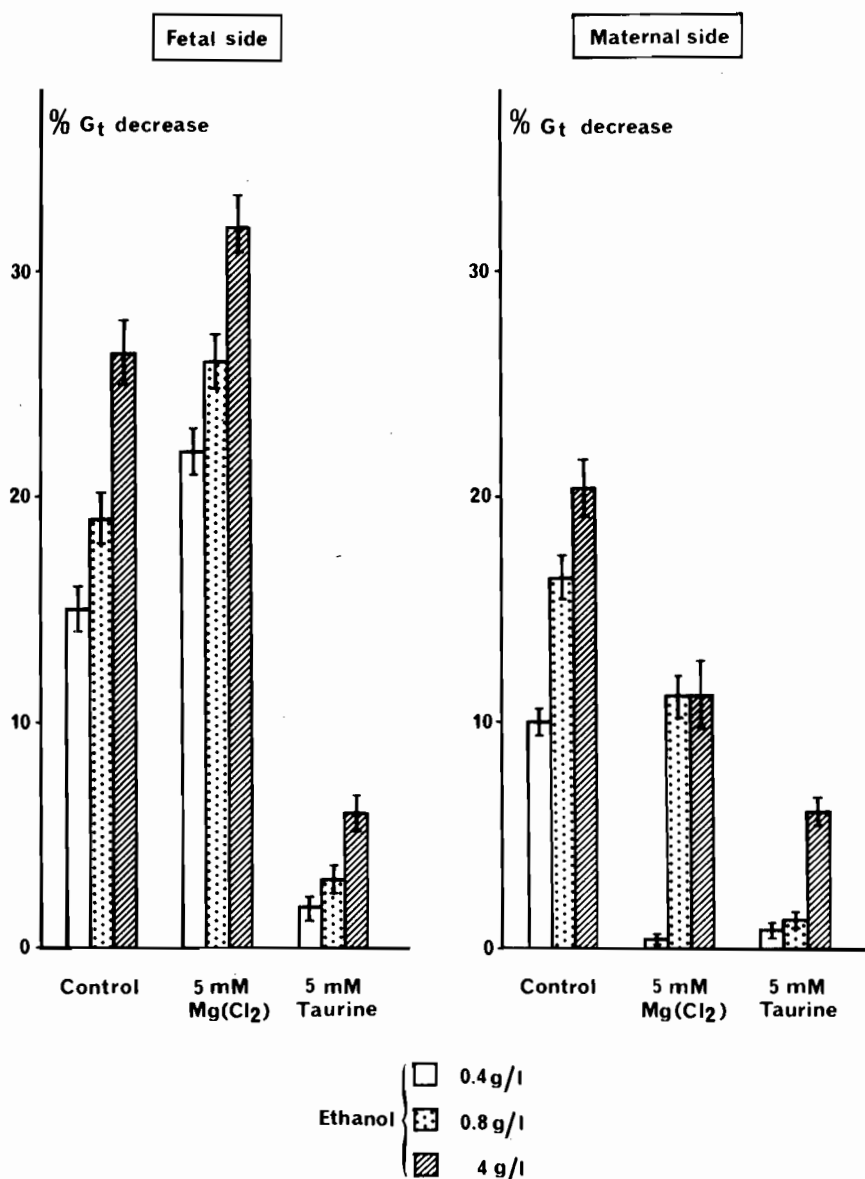


Fig. 1: Preventive action: effect of 5 mM/L of Mg or taurine (TA), added in the Hanks' solution before the ethanol addition, on G_t , expressed by the percentage of G_t decrease

The fig. 1 shows:

On the FS: *) 5 mM/l Mg increase significantly ($p < 0,01$) the percentage of G_t decrease: the ethanol noxious effects are intensified by Mg.

On the MS: 5 mM/l Mg or taurine reduce significantly ($p < 0,01$) the percentage of G_t decrease and the antagonism of taurine vs ethanol is greater than that of Mg.

The increase of Mg or taurine concentration (10 mM/l) does not modify the effects observed at 5 mM/l.

3. Curative action of magnesium and taurine

In this study, 0,4 g/l of ethanol was added on the FS (G_t was reduced to 15%) or on the MS (G_t was reduced to 10%). Then, increasing concentrations of Mg or taurine (1, 4, 8 mM/l) were added on the FS or on the MS and the percentage of G_t variation was calculated. There are three cases of responses:

- % $G_t > 0$: Mg or taurine have a curative effect
- % $G_t = 0$: Mg or taurine have not effect
- % $G_t < 0$: Mg or taurine intensify the noxious effect of ethanol

The fig. 2 shows that:

Mg presents a low but significant ($p < 0,01$) curative action after ethanol damage on the FS and on the MS. The percentage of G_t decrease is reduced on the FS (11%) and on the MS (8,5%). The curative action is not a function of the Mg concentration.

The taurine has no significant ($p = 0,45$) curative action on the FS and on the MS.

*) 5 mM/l taurine diminishes the percentage of G_t decrease: the taurine prevents the membrane against the ethanol noxious effects.

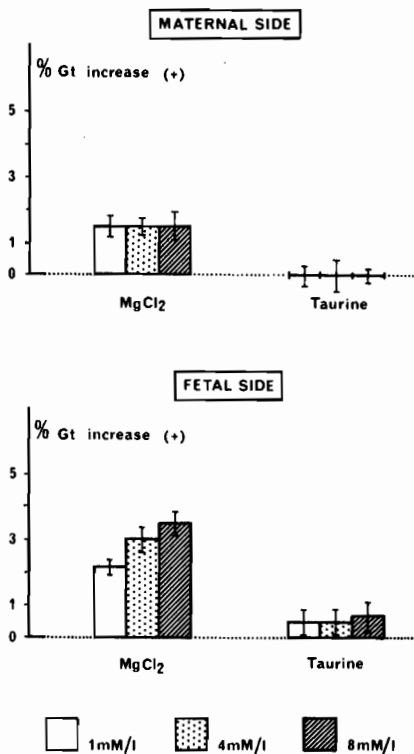


Fig. 2: Curative action: effect of increasing concentrations of Mg or taurine (TA) on G_t after addition of 0,4 g/l of ethanol which reduced G_t of 15% on the FS and 10% on the MS. The sign + of the percentage indicates a curative action

Discussion

Like Mg, the taurine possesses important membrane cellular properties. Either Mg or taurine possesses powerful membrane stabilizing properties. This is true of all types of membranes [4, 14]. The stabilizing properties of Mg are due to its structural role [15]. Mg is necessary to the insertion of proteins into membranes and to the formation of the phospholipids with parallel electrostatic polarizing effects. But Mg is also an activator of ATPase, i.e. of $\text{Na}^+ - \text{K}^+$ ATPase which controls the active Na pump. Reversely, the taurine appears to be most often without effect on this $\text{Na}^+ - \text{K}^+$ ATPase. But the zwitterionic structure of the taurine alters the cation affinity of the phospholipids membranes, thus determining conformational changes.

The preventive studies of the antagonism between ethanol, Mg and taurine display a prophylactic effect of Mg and taurine. Whereas Mg induces a prophylactic effect on the maternal side only, the taurine evokes an identical but higher action and besides exerts a prophylactic action on the fetal side. The differential effect of Mg on the two amniotic faces is explained by the direct action of Mg on the amniotic conductance: no action on the FS, action by screening-binding effect on the MS [16]: Mg ions are fixed on the MS but not on the FS.

The preventive action of the taurine is absolute when the ethanol concentration is equal to 0,4 g/l and 0,8 g/l on the both sides. This effect is found again only with Mg when the ethanol concentration is equal to 0,4 g/l on the maternal side.

These data show the stabilizing membrane properties of Mg and taurine which protect the amnion sites against the ethanol damage, but indicate a compensatory effect (taurine is a Mg-like) and also differences in the magnesium and taurine action.

When the structure and the permeability of the amniotic membrane has been modified by ethanol addition, which decreases quickly the ionic transfer, the magnesium ions exert a low curative effect on the both sides whereas the taurine has not significant action. Indeed, the transamniotic conductance is increased by Mg addition, i.e., Mg is competitive with regard to ethanol at the sites level on the membrane surface, but the taurine don't may displace ethanol from these sites. In this case, there is not a compensatory action between magnesium and taurine.

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Conclusion

The study of the antagonism between ethanol, magnesium and taurine displays similarities and discrepancies between the action of magnesium and taurine on the amniotic membrane and limits the compensatory replacement of magnesium by taurine.

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