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RESEARCH ARTICLE

# Effect of Sodium Valproate on Ouabain-Induced Arrhythmia in Isolated Guinea-Pig Atria

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**ABSTRACT**

Sodium valproate (SV), an antiepileptic drug has several mechanism of action. It inhibits voltage-sensitive $Na^+$ channels and reduces intracellular $Na^+$ accumulation. These actions are similar to that of both phenytoin and carbamazepine. We have investigated the direct cardiac action of SV and its effects on ouabain-induced arrhythmia in isolated guinea-pig atria. The guinea-pig atrium was dissected out and suspended in modified Krebs solution under physiologic conditions. Drug was added into the solution. The changes in rate and contractions were measured using a physiograph. SV (100-300 µg/ml) caused a dose-dependent decrease in contractile force of isolated guinea-pig atria (9-120%, $p<0.001$), but no change on the rate of contractions. Ouabain alone (1.2 µg/ml) produced arrhythmia at 10 min and asystole at 21 min. Pretreatment with SV (200 µg/ml) significantly increased time of onset of arrhythmia to 29 min and asystole to more than 38 min. SV may have a direct cardiac effect to reduce the membrane conductance through ion channels which may decrease ouabain toxicity in isolated guinea-pig atria.

**Keywords:** *Sodium valproate, Ouabain, Isolated atria*

Inhibiting voltage-regulated ion channels is a common mechanism of antiseizure drugs, so some antiepileptic drugs inhibit voltage-activated $Na^+$ channels and reduce the flow of $Ca^{2+}$ through T-type $Ca^{2+}$ channels [1]. Valproate is a simple monocarboxic acid that is used currently as one of the major antiepileptic drugs with efficacy for treatment of both generalized and partial seizure in adults and children. The drug is increasingly used for treatment of bipolar depressive illness and neuropathic pain and for prevention of migraine attacks. Valproate has several mechanisms of action that is probably contribute to its broad spectrum of antiepileptic effects [2]. It Inhibits voltage-sensitive sodium channels and prolongs recovery of voltage-activated sodium channels from inactivation [1]. It has been reported that valproate has an ability to reduce intracellular $Na^+$ accumulation in an activity-dependent manner [3].Valproate increases conductivity of $K^+$ resulting in neuron hyperpolarization, inhibits N-Methyl-D-aspartate (NMDA)-related transitory polarization in pyramidal cells and reduces NMDA-receptors-stimulated influx of $Ca^{2+}$ into hyppocampus cells [4].

The action of valproate is similar to that of phenytoin and carbamazepine [1]. It has been reported that carbamazepine is effective in terminating ventricular tachyarrhythmia produced by digitalis excess [5]. Thus, the effectiveness of valproate on ouabain-induced arrhythmia may be through similar action.

In the present study, it has attempted to determine whether sodium valproate has an effect in the prevention of ouabain-induced arrhythmia in isolated guinea-pig atria.

## MATERIALS AND METHODS

### *Animals*

Guinea-pigs of either sex weighing 450-600g were anaesthetized by ether and exsanguinated. The heart was rapidly removed; the auricles were dissected from the heart and suspended in a bath containing 50 ml of oxygenated modified Krebs solution at 36-37ºC, pH 7.4. The composition of solution in mM was as follows: NaCl 118.0, KCl 4.7, CaCl2 2.6, MgCl2 1.2, NaH2PO4 1.0, NaHCO3 25.0, glucose 11.1, EDTA 0.004 and ascorbic acid 0.11. After mounting, the preparation was allowed to stand for 30 min for equilibration. Solutions of drugs were prepared so that a constant volume of 0.5 ml for each dose was added to 50 ml of the bathing fluid. The rate and force of spontaneous contractions

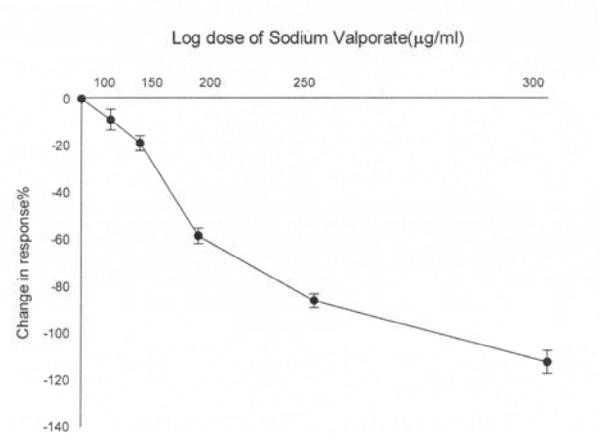


Fig 1. The effect of Sodium Valproate (100,150,200,250,300 µg/ml) on Contractile force of isolated guinea-pig atria. (n=7; Pvalue<0.001)

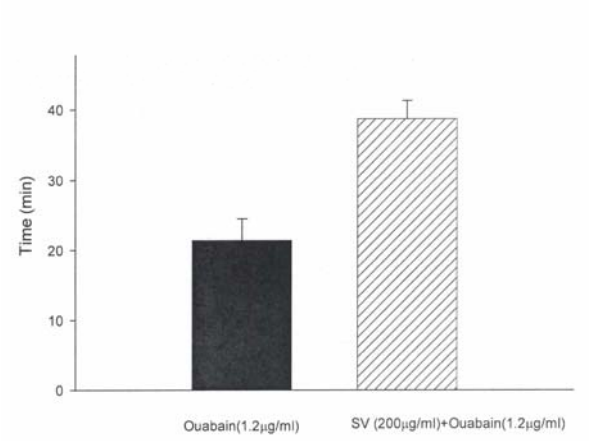


Fig 2. The mean time of asystole (n= 7; Pvalue<0.001)

were recorded isometrically with a photosensitive transducer on a Beckman RS Dynograph recorder. Seven atria were used for each experiment. The duration of spontaneous rhithmicity of guinea-pig atria preparations under our experiments conditions was 20-30 min [6].

### *Drugs*

The following drugs were used: sodium valproate (Rouzdarou Pharmaceutical Co., Tehran, Iran) and ouabain (Sigma, ST.Louis ,USA).

### *Data Analysis*

Results were expressed as mean ± SE. Statistical significance was determined using student's t-test for paired data.

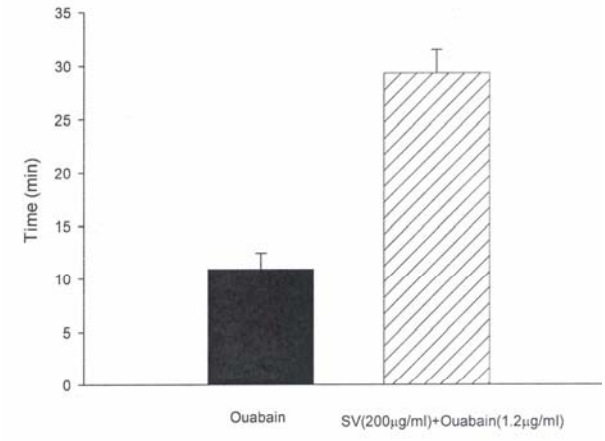


Fig 3. The mean time of arrhythmia (n= 7; Pvalue<0.001, ouabain concentration is equal to 1.2 µg/ml)

## RESULTS

Sodium valproate at a concentration of 100-300 µg/ml (n=30) caused a decrease in contractile force (9-120%) of the isolated guinea-pig atria in a dose-dependent manner ($p$<0.001 Fig.1), but SV had no effect on heart rate when measured for 30 min. SV alone was not arrhythmogenic.

Ouabain 1.2 µg/ml (n=7) alone produced arrhythmia after 10 minutes and asystole at 21 minutes (Fig.2, 3) respectively. Pretreatment with 200 µg/ml SV (n=7) significantly increased the onset of arrhythmia to 29 min ($p$<0.001, Fig.2) and asystole occurred at 38 min ($p$<0.001, Fig.3).The pattern of contractile force by SV +ouabain was more regular than that by ouabain alone.

## DISCUSSION

In guinea-pig atria in vitro, sodium valproate produced a significant decrease in the force of contractions ($p$<0.001).The observed effect was dose-dependent. The predominant mechanism of action of sodium valproate described in the literature is its action on ion channels like the other anticonvulsive agents (phenytoin and carbamazepine) [2]. Sodium valproate appears to inhibit the voltage-dependent $Na^+$ channel [7, 8].

Effects of sodium valproate on potassium and calcium homeostasis in the neurons have been observed. It inhibits calcium influx through NMDA receptors [9]. At high concentration valproate has been shown to increase membrane potassium conductance. Furthermore, low concentrations of valproate tend to hyperpolarize membrane. These findings have lead to speculation that valproate may exert an action through a direct effect on the potassium channels of the membrane [10].

In hyppocampal slices, it is suggested that SV interfere with $Ca^{2+}$ entry into nerve ending, reduces the [$Ca^{2+}$] and increases K-conductance, which would contribute to a decrease in synaptic transmission [11]. The negative inotropic action of SV in isolated guinea-pig atria is probably attributed to inhibition of cardiac $Na^+$ and $Ca^{2+}$ channels and hyperpolarization of membrane.

This ionic hypothesis helps to explain our results that SV may produce a direct cardiac action.

In our experiments, SV had no effect on the rate of contractions in isolated guinea-pig atria. This was similar to what observed by other investigators [12]. This effect of SV appears to be mediated through the inhibition of ionic current and probably a non specific effect due to stabilizing action of the membrane. As this molecule at high concentration has highly lipophylic properties, these effects might be the result of depolarization block by direct partition into cell membranes, which alters the transport [13]. This stabilizing action of SV may also help to explain the preventive effect of SV to ouabain-induced arrhythmia in isolated atria.

It has been reported that phenytoin inhibits the intoxication of cardiac tissue induced by ouabain [14]. Cardiac glycoside acts by inhibition of $Na^{+}$-$K^{+}$ pump. Thus, it increases $[Na+]_i$ and causing more $Ca^{2+}$ to enter the cardiac myocytes. Digitalis toxicity appears to be caused by excessive $Ca^{2+}$ influx into cardiac cells. In fact, both therapeutic and toxic effects of digitalis are due to myocardial $Ca^{2+}$ loading [15]. In conclusion, the effectiveness of SV in the prevention or delay of ouabain-induced arrhythmia in isolated atria may be through both its phenytoin-like activity and stabilizing action of the membrane which correct the ionic disturbance due to ouabain-toxicity.

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