Effects of Fullerene C_{60} Nanocomposites on Human Platelet Aggregation

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The effects of fullerene C_{60} nanocomposites on human platelet aggregation induced by ADP, ristocetin, and collagen were studied. The nanocomposite containing fullerene C_{60} in polyvinyl pyrrolidone solution did not change platelet aggregation, while fullerene C_{60} in crown ether and Twin-80 solutions inhibited ADP-induced platelet aggregation by 20 and 30%, respectively.

Key Words: *fullerene C_{60}; platelet aggregation; polyvinyl pyrrolidone; crown ethers; Twin-80*

Modern development of medical technologies in public health is closely related to the progress in development of nanotechnologies, which can play the key role in the efficiency of treatment of cardiovascular diseases and cancer in the nearest future. Materials developed on the basis of fullerenes and their composites are rather promising [3,6]. However, the data on the effects of fullerene C_{60} on platelet aggregation (PA), the main element of the platelet hemostasis clotting system, are contradictory. Some scientists think that fullerene C_{60} reduces PA [9], while others prove that it does not modulate the process [4,8].

We studied the effects of fullerene C_{60} nanocomposites on human PA.

MATERIALS AND METHODS

Solutions (0.02%) of fullerene C_{60} in nanocomposites were studied. Other components of the nanocomposites were polyvinyl pyrrolidone (PVP; mol. weight 8000±2000), Twin-80, and crown-ester (15-crown-5-ester) in 5% concentration. Solutions of fullerene C_{60} (Energy-Saving Technologies) were prepared as described previously [2]. All the studied solutions and nanocomposites were stabilized in 0.1 M phosphate buffer (pH 7.2). Platelets from 30 donor blood samples of the major immunohematological groups served as the test system. Induced PA in human platelet-rich plasma (PRP) was recorded on a Chrono-Log aggregometer [1] using ADP, ristocetin, and collagen in the standard concentrations as inductors. Before adding the PA inductors, the nanocomposite solution (0.02 ml) was added to PRP and this suspension was incubated in reaction tubes of the aggregometer at 37°C for 0, 5, and 10 min.

The results were statistically processed by Student's *t* test.

RESULTS

We used PVP, Twin-80, and crown-ester as components of nanocomposites because water solutions of fullerene C_{60} could not be used for PA studies [5]. Three series of experiments were carried out, each with platelets from blood specimens of 8 main im-

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munohematological groups, each series with a special control group.

In experimental series I we studied the effects of nanocomposite with fullerene C_{60} and PVP on PA.

Addition of the control specimen (PRP+PVP) and nanocomposite (fullerene C_{60}+PVP) to the incubation medium virtually did not change PA in the presence of all three aggregation inductors (Table 1).

Hemodez-H preparation containing PVP exhibits no untoward effects on human organism. Hence, the results of studies of the control specimen (PRO+PVP) suggest that under these experimental conditions fullerene C_{60} is inert towards human platelets.

In experimental series II we studied Twin-80, a surface-active dispersing agent as nanocomposite component, because Twin-80 is now used in pharmaceutical industry as drug component.

Twin-80 both as a component of the nanocomposite with fullerene and after addition to PRP significantly inhibited PA (Table 2). ADP-induced PA decreased most significantly (by 31%) and collagen-induced AP decreased to a lesser extent (by 19%).

In experimental series III we studied 15-crown 5-ether (hydrophobic cyclic polyester) as a nanocomposite component, because crown ethers and their composites are now assumed to be promising for medical use [7].

The data of these experiments in general indicate that crown ether in nanocomposite with fullerene and in combination with PRP significantly reduced PA

TABLE 1. Changes in Induced PA in PRP in the Presence of Fullerene C_{60} Nanocomposite Containing PVP (n=10)

Solution composition	PA percentage			PA rate, min^{-1}		
	with ADP	with ristocetin	with collagen	with ADP	with ristocetin	with collagen
PRP	79.2±2.9	85.9±2.5	79.9±3.1	55.6±1.9	70.8±3.0	66.0±4.3
PRP+PVP	78.5±2.8	86.1±2.5	80.1±3.2	53.2±1.8	69.2±3.2	63.8±4.1
PRP+C_{60}+PVP	79.7±2.7	84.1±2.9	80.4±3.3	51.3±1.7	68.1±3.1	62.7±3.9

TABLE 2. Changes in Induced PA in PRP in the Presence of Fullerene C_{60} Nanocomposite Containing Twin-80 (n=10)

Solution composition	PA percentage			PA rate, min^{-1}		
	with ADP	with ristocetin	with collagen	with ADP	with ristocetin	with collagen
PRP	76.8±3.5	81.5±2.6	71.4±1.2	61.2±4.2	67.2±3.2	52.0±2.5
PRP+Twin-80	46.2±3.7***	47.8±2.9***	51.6±2.2**	51.3±3.7	35.4±3.1***	15.2±1.8***
PRP+C_{60}+Twin-80	45.5±3.3***	46.6±2.4***	52.4±1.9**	52.5±3.5	34.2±2.8***	16.1±1.7***

Note. **p<0.01, ***p<0.001 in comparison with the control (PRP).

TABLE 3. Changes in Induced PA in PRP in the Presence of Fullerene C_{60} Nanocomposite Containing 15-Crown-5-Ester (n=10)

Solution composition	PA percentage			PA rate, min^{-1}		
	with ADP	with ristocetin	with collagen	with ADP	with ristocetin	with collagen
PRP	77.1±1.9	83.7±2.9	75.1±2.3	58.4±2.1	68.5±3.3	57.8±3.7
PRP+crown ether	54.1±2.1**	73.8±3.2	69.1±2.9	24.4±2.7***	44.5±2.9**	46.8±3.9
PRP+C_{60}+crown ether	54.6±2.2**	74.2±3.1*	70.2±2.2	25.2±2.3***	45.1±2.8**	57.0±3.6

Note. *p<0.05, **p<0.01, ***p<0.001 in comparison with the control (PRP).

(Table 3). ADP-induced PA decreased most markedly (by 23%), while ristocetin-induced AP decreased to a lesser extent (by 10%).

The effects detected in experimental series II and III may depend on the following factors.

First, it can be hypothesized that Twin-80 and crown ether differently interact with platelet surface elements, because they have different cyclic structure. This hypothesis is confirmed by different changes in PA rate with three PA inductors (Tables 2, 3).

Second, a direct chemical interaction between crown ether and ADP reagent cannot be excluded, due to which the quantity of ADP inductor decreases and ADP-induced PA is inhibited.

Third, similar data on PA reduction with different inductors can indicate similar mechanisms of action of Twin-80 and crown ether on biological objects.

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