

Ascorbic Acid

= =
 (AA)
 AA (3.0mM)
 ouabain AA 가
 가 AA
 phloretin AA ouabain ouabain
 glutathione-bicarbonate-Ringer(GBR) AA
 15 AA
 (GBR) (p=0.027).
 가 Ouabain AA 가
 ouabain (19.9 vs. 40.5 μ m/hr). AA
 ouabain 가 (21.7 vs. 28.6 μ m/hr).
 Phloretin AA
 가 ouabain AA
 AA 가
 (41:1040~1046, 2000).

= Abstract =

Effect of Ascorbic Acid on Corneal Endothelial Function

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It has been reported that ascorbic acid(AA) appears to be actively taken up by the corneal endothelium and protect the endothelium against harmful effects of the oxidative reactions. To investigate the effect of ascorbic acid on the corneal endothelial function, rabbit's corneas were mounted in the in vitro specular microscope. Corneal endothelium was perfused with ascorbic acid, then switched to AA plus ouabain solution, and vice versa. Also, phloretin was perfused onto the endothelium with AA and ouabain. And corneal endothelium was perfused with GBR or AA solution followed by perfusion with ouabain. Corneal thickness was measured during the perfusion and the corneal swelling rate calculated. Corneal endothelial permeability was also measured after perfusion of ascorbic acid. Perfusion with AA showed no corneal swelling, but swelling rate was even lower than GBR control. Corneal endothelial permeability did not change upon AA perfusion. In corneas preperfused with ouabain, AA added to ouabain solution decreased corneal swelling rates induced by ouabain solution(19.9 vs. 40.5 μ m/hr). The corneas preperfused with AA also showed decreased swelling rates with subsequent perfusion of ouabain added to AA solution(21.7 vs. 28.6 μ m/hr). Phloretin inhibited the effect of AA. However, when ouabain was removed, the corneal swelling plateaued but did not return to baseline thickness in both AA and GBR perfusion. The results of this study showed that AA can increase corneal endothelial pump function and reduce corneal swelling caused by ouabain(J Korean Ophthalmol Soc 41:1040~1046, 2000).

Key Words : Ascorbic acid, Corneal endothelium, Corneal swelling rate, Ouabain, Phloretin

Ascorbic acid
1.0mM¹⁾ 가 ascorbic acid
20
ascorbic acid
2)
ascorbic acid가 H₂O₂ 1.
2~3kg 5
ascorbic acid pentothal sodium
Ascorbic acid 2~3mm
dual-
chambered specular microscope
ascorbic acid ouabain perfusion system
3) sodium 5) 가
ascorbic acid 가 Na/K pump 가
4) (,)
glutathione-

bicarbonate-ringer(GBR) 1 가 2
 GBR ascorbic acid
 NaCl 111.56mM, KCl 4.82mM, NaHCO₃
 29.20mM, glucose 5.01mM, CaCl₂ 2H₂O
 1.04mM, MgCl₂ 6H₂O 0.78mM, NaH₂PO₄
 0.86mM, glutathione 0.30mM
 pH 7.4 285mOsm

34°C Harvard pump
 0.1Mℓ/min

15~20mmHg가
 15

가
 4 가

15

2.

5

가 0.3Mℓ
 2.6×10⁻⁴M carboxyfluorescein(CF)
 30
 outflow

20Mℓ BSS 4°C 48
 CF가 (elu-
 ate) eluate CF

ascorbic acid
 GBR ascorbic acid 3.0mM

ascorbic acid(AA) ascorbic
 10⁻⁵M ouabain 2
 3.0mM ascorbic acid

10(1042)

ouabain
 3.0mM ascorbic acid
 10⁻⁶M ouabain 가
 GBR
 가 2 ouabain
 ouabain 가, ascorbic
 acid
 phloretin 0.5mM ascorbic acid
 ascorbic acid
 10⁻⁶M
 3.0mM
 ouabain
 ascorbic acid
 GBR ouabain

GBR ascorbic acid
 1.43±1.42μm/hr GBR
 6.15±0.33μm/hr
 (p=0.0274)(Fig. 1). ascorbic acid
 4.78±
 0.86×10⁻⁴cm/min 4.64±0.60×10⁻⁴
 cm/min (p>0.1)(Fig. 2).

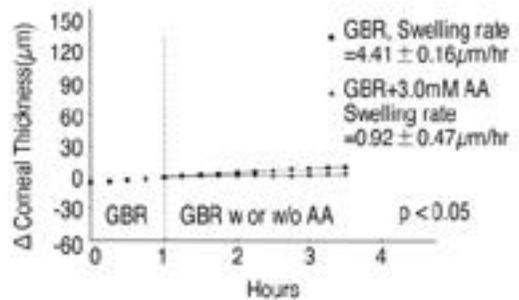


Figure 1. Rabbit corneal endothelial perfusion with ascorbic acid showed slightly low swelling rate compared to control cornea perfused with glutathione-bicarbonate-Ringer solution.

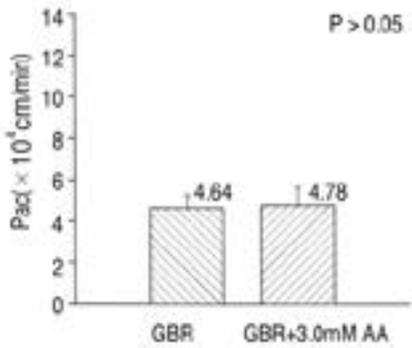


Figure 2. Rabbit corneal endothelial permeability after perfusion with ascorbic acid. No differences were found comparing to the perfusion with glutathione-bicarbonate-Ringer solution.

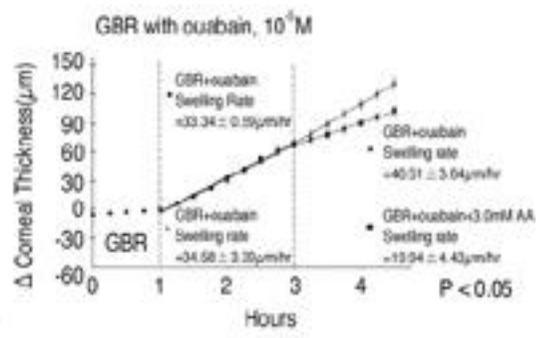


Figure 3. Rabbit corneal endothelial perfusion with ouabain for two hours, then switched to ascorbic acid plus ouabain solution. Corneal swelling rates were lower in corneas perfused with ouabain plus ascorbic acid than in those with ouabain only.

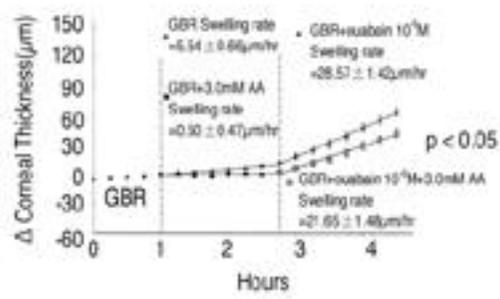


Figure 4. Rabbit corneal endothelial perfusion with ascorbic acid for two hours, then switched to ascorbic acid plus ouabain solution. Corneal swelling rates were lower in corneas perfused with ascorbic acid plus ouabain than in those with ouabain only.

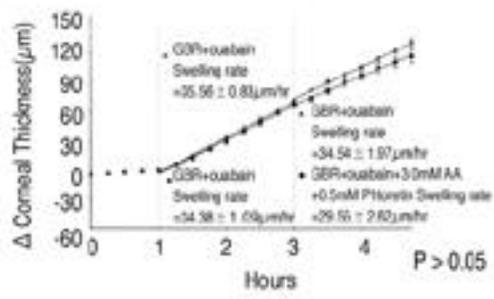


Figure 5. Rabbit corneal endothelial perfusion with ouabain for two hours, then switched to ouabain plus ascorbic acid and phloretin solution. Corneal swelling rates were not decreased in corneas perfused with ouabain plus ascorbic acid and phloretin.

ouabain 2
 ascorbic acid ouabain
 19.94 ± 4.43
 $\mu\text{m/hr}$, ouabain
 $40.51 \pm 3.64 \mu\text{m/hr}$ ascorbic
 acid
 ($p < 0.001$)(Fig. 3). ascorbic acid
 ouabain 가
 $21.65 \pm 1.48 \mu\text{m/hr}$, GBR
 ouabain
 $28.57 \pm 1.42 \mu\text{m/hr}$

ascorbic acid
 ($p < 0.001$)(Fig. 4).
 Ouabain 2
 ouabain $34.54 \pm 1.97 \mu\text{m/hr}$
 /hr ouabain ascorbic acid
 0.5mM phloretin
 $29.55 \pm 2.62 \mu\text{m/hr}$ ascorbic acid
 ($p > 0.05$)(Fig. 5).
 ouabain
 ascorbic acid $3.79 \pm$
 $2.85 \mu\text{m/hr}$, GBR

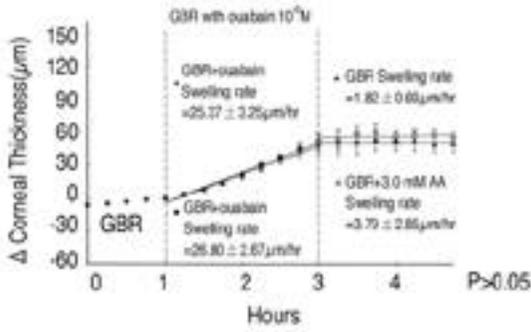


Figure 6. Rabbit corneal endothelial perfusion with ouabain for two hours, then switched to ascorbic acid or glutathione-bicarbonate-Ringer solution with ouabain. Corneal swelling was neither increased but nor returned to normal level.

1.82 ± 0.69 μm/hr

acid가 ouabain

(p>0.1)(Fig. 6).

superoxide dismutase catalase
가
ascorbic acid

. Ascorbic acid

. Ascorbic acid
20

acid
dehydro-L-ascorbic acid

Ascorbic acid
ascorbic acid
가 . ascorbic acid
acid riboflavin 가
1). 1996 Costagliola 6) excimer
laser H₂O₂ 가 ascorbic acid
reduced glutathione(GSH)
, oxidized glutathione(GSSG) 가
가 20
가
Ascorbic acid H₂O₂
7-9)
ascorbic acid
H₂O₂ 가
가 ,
ascorbic acid H₂O₂
, H₂O₂ (scavenger)
. Ascorbic acid
superoxide
10)
ascorbic acid H₂O₂
glucose가 glutathione
가 . 가
H₂O₂
H₂O₂ H₂O₂
11). H₂O₂ ascorbic acid
가 가 ascorbic acid
가 H₂O₂ 가
Ascorbic acid
12)
ascorbic acid 가
. Ascorbic Na
ascorbic acid가
dehydro-L-ascorbic acid가
dehydro-L-ascorbic acid

ascorbic acid
 ascorbic acid
¹³⁾ . ascorbic acid
 ouabain .
 Hou ¹⁴⁾ ascorbic acid
 가 sodi-
 um 가 Na/K 가
 ascorbic acid
 phloridzin phloretin
 Na 가 Na/K
 . Na 가 가
 Na-Ascorbate cotransporter
 Na-H exchanger
 amiloride-sensitive Na channel
¹⁴⁾ .
 ascorbic acid가
 ascorbic acid
 가
 가
 가 . Ouabain Na/K-ATPase
 ascorbic acid
 . phloretin
 ascorbic acid
 가 ascor-
 bic acid
 가 . ,
 ascorbic acid가
 Na/K
 .
 Ouabain
 ascorbic acid 가
 , Na/K- ATPase가
 Na/K- ATPase
 가 .

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