Prevention of ethanol and aspirin-induced gastric mucosal lesions by paracetamol and salicylate in rats: role of endogenous prostaglandins

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SUMMARY Paracetamol or sodium salicylate given intragastrically 30 minutes before the administration of absolute ethanol or acidified aspirin dose-dependently reduced the formation of mucosal lesions. The generation of gastric mucosal prostaglandin-like activity increased with ethanol and was completely suppressed by acidified aspirin. Paracetamol or sodium salicylate given alone increased the generation of mucosal prostaglandin-like material. Indomethacin, the prostaglandin synthesis inhibitor, suppressed this effect and inhibited the protective influence of paracetamol or sodium salicylate on the production of gastric lesions.

Paracetamol and salicylic acid or its sodium salt are widely used as analgesics but, unlike aspirin, do not induce gastric mucosal damage and may not inhibit prostaglandins biosynthesis in gastric mucosa. Seegers et al. reported that paracetamol may reduce the formation of aspirin-induced mucosal damage in rats and suggested that this may be due to the stimulation of endogenous production of prostaglandins. Similarly, sodium salicylate inhibited the formation of ethanol-induced gastric lesions, suggesting that this substance may act as a mild irritant – that is, to increase prostaglandin biosynthesis. However, gastric mucosal prostaglandins were not measured in this study.

This study was designed to compare the protective effects of paracetamol and sodium salicylate against gastric mucosal lesions induced by ethanol or acidified aspirin and to examine the protective role of mucosal prostaglandins.

Methods

Wistar rats of either sex, weighing 140–200 g, were fasted for 24 hours before the study but had free access to water until four hours before the experiment when they were placed in individual Bolin cages with wide mesh bottoms to prevent coprophagy.

Production of gastric mucosal lesions by absolute ethanol or acidified aspirin

Drugs were administered intragastrically via a metal orogastric tube. At the end of the experiment the animals were killed, their stomachs were removed and opened along the greater curvature, and the mucosa was examined by an experienced investigator unaware of the treatment given. The surface of each gastric lesion was measured planimetrically to determine the total ulcer area, and expressed in mm² of mean ulcer area per rat in each tested group of animals. The mucosa of the oxyntic gland area was then prepared for the generation of prostaglandins according to the method described by Whittle.

Several groups of 10–20 rats were used in studies with absolute ethanol: (1) ethanol alone (1 ml), (2) paracetamol (10–80 mg/kg) followed 30 minutes later by ethanol, (3) indomethacin (5 mg/kg) followed 60 minutes later by paracetamol (80 mg/kg) and then 30 minutes later by ethanol, (4) sodium salicylate (10–80 mg/kg) followed 30 minutes later by absolute ethanol, (5) indomethacin (5 mg/kg) followed 60 minutes later by sodium salicylate (80 mg/kg) and then 30 minutes later by ethanol, (6) paracetamol alone (80 mg/kg), (7) sodium salicylate alone (80 mg/kg), (8) indomethacin alone (5 mg/kg), and (9) acidified aspirin alone (20 mg/kg).

In a series of experiments with gastric ulcers produced by acidified aspirin, the following intra-
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Results

**EFFECT OF PARACETAMOL AND SODIUM SALICYLATE ON ETHANOL-INDUCED GASTRIC LESIONS AND MUCOSAL GENERATION OF PGI2.**

All 20 control rats given absolute ethanol intra-gastrically developed severe mucosal damage in the oxyntic gland area as described previously.\textsuperscript{1} The antral portion was less affected, while the forestomach had no visible lesions. Mucosal lesions consisted of elongated bands of necrosis with the mean area amounting to 101.4±9.1 mm\textsuperscript{2} per rat (Fig. 1).

The generation of PGI2-like activity in oxyntic mucosa of untreated rats fasted for 24 hours averaged 221±35 ng/g. Ethanol increased the amounts of PGI2-like activity to 325±63 ng/g (Fig. 2).

Pretreatment of gastric mucosa with paracetamol or sodium salicylate at a dose of 80 mg/kg significantly (p<0.01) reduced ethanol-induced gastric lesions by about 97% and 85%, respectively (Fig. 1).

Lower doses of these agents caused smaller dose-dependent reduction in ethanol induced necrosis (Table 1). The doses causing 50% inhibition (ED\textsubscript{50}) were about 28 mg/kg for paracetamol and 8.7 mg/kg for sodium salicylate. The generation of PGI2 by oxyntic mucosa treated with ethanol plus paracetamol or sodium salicylate was not significantly different from that by mucosa from rats treated with ethanol alone (p>0.10, Fig. 2).

![Fig. 1](http://gut.bmj.com/)

Mean ulcer area (mm\textsuperscript{2})

- **100% Ethanol**
- **Paracetamol**
- **Indomethacin**
- **Sodium Salicylate**

* Significant (p<0.01) decrease below the control value obtained with ethanol alone. ** Significant (p<0.05) increase above value obtained with the combination of ethanol and paracetamol or sodium salicylate.
Fig. 2 Generation of PGI₂-like activity by oxyntic mucosa of 10 untreated rats and those given treatments described in Fig. 1. * Significant (p<0.01) decrease below the control value. ** Significant (p<0.05) increase above control value obtained in untreated rats.

Indomethacin 5 mg/kg given intragastrically 60 minutes before the combination of ethanol plus paracetamol or sodium salicylate increased significantly (p<0.05) the area of mucosal lesions above the values obtained with the combination alone (Fig. 1). The inhibition by indomethacin of protection by paracetamol against ethanol-induced damage was complete, and protection by sodium salicylate was reduced by about 50%. The pretreatment with indomethacin or acified aspirin increased significantly (p<0.05) the mean area of the ethanol-induced lesions by about 30% and 24%, respectively (Table 1). Indomethacin or acidified aspirin alone or in combination with other drugs almost completely suppressed the generation of PGI₂-like activity (Fig. 2, Table 2).

Table 1  Effect of pretreatment with various doses of paracetamol, sodium salicylate, indomethacin, or acidified aspirin on ethanol-induced gastric lesions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. of rats</th>
<th>Mean lesion area (mm²)</th>
<th>Change from control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Ethanol</td>
<td>20</td>
<td>101.4±9.5</td>
<td>—</td>
</tr>
<tr>
<td>Control</td>
<td>10</td>
<td>61.18±8.3</td>
<td>—</td>
</tr>
<tr>
<td>+ Paracetamol</td>
<td>80</td>
<td>2.75±0.9</td>
<td>—</td>
</tr>
<tr>
<td>20</td>
<td>6</td>
<td>10.04±5.4</td>
<td>—</td>
</tr>
<tr>
<td>+ Sodium salicylate</td>
<td>10</td>
<td>56.42±5.1</td>
<td>—</td>
</tr>
<tr>
<td>20</td>
<td>6</td>
<td>56.42±5.1</td>
<td>—</td>
</tr>
<tr>
<td>+ Indomethacin</td>
<td>5</td>
<td>2.75±0.9</td>
<td>—</td>
</tr>
<tr>
<td>20</td>
<td>6</td>
<td>131.8±11.5</td>
<td>—</td>
</tr>
<tr>
<td>+ Acidified aspirin</td>
<td>20</td>
<td>125.7±8.8</td>
<td>—</td>
</tr>
</tbody>
</table>

* Significant (p<0.05) change from control value.

** Effect of pretreatment with various doses of paracetamol, sodium salicylate, indomethacin, or acidified aspirin on ethanol-induced gastric lesions.

** Effect of paracetamol, sodium salicylate, indomethacin, or acidified aspirin alone given for 4-5 hours on ulcer formation and generation of PGI₂-like activity in oxyntic mucosa

<table>
<thead>
<tr>
<th>Pretreatment</th>
<th>No. of rats</th>
<th>Mean ulcer area (mm²)</th>
<th>Generation of PGI₂ (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paracetamol</td>
<td>80</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Sodium salicylate</td>
<td>80</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Indomethacin</td>
<td>5</td>
<td>6</td>
<td>3.38±1.2</td>
</tr>
<tr>
<td>Acidified aspirin</td>
<td>20</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Figs. 3 Mean ulcer area of gastric ulcers induced by acidified aspirin given intragastrically alone or in combination with paracetamol or sodium salicylate with and without pretreatment with indomethacin. Each column represents mean±SEM of results in six to 20 rats.

* Significant (p<0.05) decrease below control value with acidified aspirin alone. ** Significant (p<0.05) increase above value obtained in rats treated with combination of acidified aspirin and sodium salicylate or paracetamol.
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Indomethacin (5 mg/kg) or acidified aspirin (20 mg/kg) given intragastrically 30 minutes before the standard dose of acidified aspirin slightly increased the mean ulcer area. These small doses of indomethacin or acidified aspirin given intragastrically alone caused little or no change in gastric mucosa but suppressed the generation of PGI₂ by about 100% and 96% of control values found in untreated mucosa (Table 2).

Discussion

This study demonstrates that paracetamol and sodium salicylate, which by themselves increase the generation of mucosal prostaglandins, dose-dependently reduced gastric mucosal damage induced by absolute ethanol or acidified aspirin.

Gastric mucosa of rats² 7-9 and other species 10 11 can form PGE₂ and PGI₂ and, in rats, PGI₂ production predominates.²

Two different models of gastric lesions were produced in this study. With ethanol,¹ the gastric mucosa showed large areas of necrosis confined mostly to the oxyntic portion and exhibited an increased capability of generating PGI₂-like material. The damage was presumably due to direct action of ethanol on the mucosa and obviously did not result from the deficiency of mucosal prostaglandins. The increased generation of PGI₂-like material by ethanol may have been due to cellular trauma and mucosal necrosis. Exogenous prostaglandins, however, given in substantial amounts just before the administration of absolute ethanol dose-dependently protected the mucosa against damage by ethanol.¹ Our present finding, that paracetamol or sodium salicylate inhibited ethanol-induced mucosal necrosis, may be due to stimulation of mucosal generation of prostaglandins. This possibility is supported by our finding that indomethacin prevented the protective effect of paracetamol and sodium salicylate and suppressed mucosal generation of prostaglandins.

Gastric lesions with acidified aspirin intragastrically consisted of multiple erosions and frank bleeding ulcerations in the oxyntic mucosa. There was almost complete inhibition, however, of the mucosal generation of prostaglandins. Loss of normal protection by endogenous prostaglandins is considered to be the major factor in the pathogenesis of acidified aspirin-induced gastric ulcerations.² ⁷ Protection by paracetamol or sodium salicylate against aspirin-induced gastric ulcerations cannot be simply attributed to mucosal generation of prostaglandins, however, because PGI₂ synthesis was almost totally inhibited by acidified aspirin. Perhaps stimulation of synthesis before administra-

References


7 Whittle BJR. Potential endogenous inhibitor of...


