Evaluation of bilirubin as possible protective factor in the prevention of retinopathy of prematurity

Dan D Gatton, Joseph Gold, Ruth Axer-Siegel, Eliahu Wielunsky, Nora Naor, Ilana Nissenkorn

Abstract
Retinopathy of prematurity (ROP) appears to be a multifactorial disease, the prevention of which is probably impossible even with the most accurate methods of blood-gas monitoring and oxygen restrictions. The oxidative processes and consequent formation of free radicals are probably influenced by the availability of various antioxidants in the immature retina. Bilirubin, the end product of haem catabolism, has recently been regarded as a potential physiological antioxidant. In order to test the suggestion as to the possible effect of bilirubin in reducing the incidence of ROP, a retrospective study was undertaken of the medical records of 151 neonates born between 1984 to 1988 who weighed less than 1500 g. Of these, 78 had various degrees of ROP, whereas 73 had no ROP and served as a control group. The daily mean bilirubin values were analysed in accordance with gestational age and birth weight as well as the severity of ROP, and the results were compared with those obtained for the control group. The results showed no correlation between bilirubin levels and severity of ROP in all subgroups of gestational age and birth weight. These findings indicate that there is no apparent protective effect of bilirubin on the development of ROP.

During the past few decades there have been dramatic advances in the care of critically ill newborn babies, resulting in the greatly improved survival of infants with extremely low birth weights. Phelps' estimated that 30–35% of infants with a birth weight of 1000 g or less will develop cicatircial retinopathy of prematurity, with 8% becoming blind. As ROP appears to be a multifactorial disease, it is possible prevention, even by the most accurate methods of monitoring blood gases and oxygen restriction, has been assumed to be impossible. However, the search for possible influencing factors continues.

Current data indicate that oxidative processes in the tissues may be of vital importance in the initiation of the disease. These oxidative processes and the consequent formation of free radicals are probably influenced by the availability of various antioxidants in the immature retina. Stocker et al. have shown that bilirubin is a potential physiological antioxidant. The preliminary data collected by Heyman et al. suggested that bilirubin may play a protective role in the prevention of ROP. We report here the findings of a retrospective study carried out to evaluate the possible correlation between bilirubin levels and severity of ROP as related to gestational age and birth weight in a group of neonates weighing less than 1500 g.

Patients and methods
We reviewed the medical records of all neonates with a gestational age of 34 weeks or less and weighing less than 1500 g who were admitted to the neonatal intensive care unit from January 1984 to December 1988: 151 premature infants met these criteria. ROP was found in 78, whereas 73 had no ROP and served as controls.

Table 1: Infant groups according to ROP stage and gestation age

<table>
<thead>
<tr>
<th>Gestational age (wks)</th>
<th>Stage of ROP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤27</td>
<td>7</td>
<td>40</td>
</tr>
<tr>
<td>≤28</td>
<td>8</td>
<td>55</td>
</tr>
<tr>
<td>≤29</td>
<td>17</td>
<td>23</td>
</tr>
<tr>
<td>≤30</td>
<td>28</td>
<td>96</td>
</tr>
<tr>
<td>≤31</td>
<td>43</td>
<td>115</td>
</tr>
<tr>
<td>≤32</td>
<td>52</td>
<td>128</td>
</tr>
<tr>
<td>≤33</td>
<td>64</td>
<td>140</td>
</tr>
<tr>
<td>≤34</td>
<td>73</td>
<td>151</td>
</tr>
</tbody>
</table>

Table 2: Infant groups according to ROP stage and birth weight

<table>
<thead>
<tr>
<th>Birth weight (g)</th>
<th>Stage of ROP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;750</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>&lt;1000</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>&lt;1250</td>
<td>33</td>
<td>96</td>
</tr>
<tr>
<td>&lt;1500</td>
<td>73</td>
<td>151</td>
</tr>
</tbody>
</table>

Results
The mean bilirubin level of the first 14 days of life were calculated. These values were plotted in the different ROP, gestational age and birth weight subgroups. The data were analysed statistically by Student's t test.

Table 3: Infant groups according to ROP stage and birth weight

<table>
<thead>
<tr>
<th>Birth weight (g)</th>
<th>Stage of ROP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<tr>
<td>&lt;1500</td>
<td>73</td>
<td>151</td>
</tr>
</tbody>
</table>

Accepted for publication
14 February 1991
more, comparison of the bilirubin levels in the various ROP stage groups revealed no statistically significant difference between patients with no ROP and patients with ROP stages 1, 2, and 3 (p>0.05) (Fig 2). In the gestational age subgroups of less than 27 to 34 weeks mean bilirubin levels ranged between 5.99 and 6.27 mg/dl (102 and 107 μmol/l) in the various ROP stages. In the birth weight subgroups of less than 750 to 1500 g the mean bilirubin levels ranged between 4.83 and 5.99 mg/dl (83 and 102 μmol/l). These data show no statistically significant difference between the various gestational age and birth weight subgroups (p>0.05).

Fig 3 serves as an example of this trend in gestational age subgroup of 27 weeks and less, and Fig 4 is an example of the mean daily bilirubin levels in the birth weight subgroup of less than 1250 g.

These results show that the bilirubin level pattern was very similar in all groups of gestational age and birth weight.

Discussion
It has recently been suggested that endothelial cell damage in the retina is caused by oxygen-derived free radicals, which are probably more harmful in premature infants owing to lower levels of antioxidants in the immature retina.

In a post-mortem study of the vitreous humour of premature babies with respiratory distress syndrome Saugstad and Tognum found high levels of hypoxanthine. This was believed to be not only a sign of hypoxia but also a potential generator of oxygen radicals. Bilirubin, the end product of haem catabolism in mammals, is generally regarded as a potentially cytotoxic lipid-soluble waste product that needs to be excreted. However, the data presented by Stocker et al support the concept of a beneficial role of bilirubin as a physiological, chain-breaking antioxidant.

Heyman et al subsequently raised the question whether bilirubin might have a protective effect in the prevention of ROP. They found that in neonates with ROP (stages 2, 3, or 4) bilirubin levels from day 4 were considerably lower than those in neonates with stage 1 ROP or no ROP, and suggested that bilirubin may have a protective effect in the prevention of ROP.

Our retrospective study of premature neonates, weighing less than 1500 g and with gestational age of 34 weeks or less, shows a very similar pattern of mean bilirubin levels during the first 14 days of life among infants with stages 1, 2, and 3 ROP as well as infants with no ROP. There were no statistically significant differences in bilirubin levels when considered in relation to severity of ROP, gestational age, or birth weight. These results therefore do not support the concept that bilirubin is a possible protective factor in the prevention of ROP. Furthermore, we assume that bilirubin levels in the first days of life in premature babies are probably not correlated with the development of ROP. As the main pathological effect of ROP is ischaemia of peripheral retinal areas due to impaired blood supply, it is reasonable to assume that bilirubin levels in the affected regions are low. It is therefore possible that these low
bilirubin levels may be insufficient for the antioxidative potential effect of bilirubin.

Another explanation of the undetected antioxidative effect of bilirubin may be due to the fact that this report reviewed bilirubin levels in the first 14 days of life, a period in which bilirubin is known to be physiologically high. As ROP tends to not appear before 6 weeks of age, it is possible that the time interval between the decrease to normal bilirubin levels and the appearance of ROP is long enough to diminish its protective effect in preventing the disease.

This study was presented in partial fulfilment of the requirements of Tel Aviv University Sackler Faculty of Medicine for the MD degree of Joseph Gold.

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Br J Ophthalmol 1991 75: 532-534
doi: 10.1136/bjo.75.9.532

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