

weakly correlated with the reopening pressure ( $r = 0.412$ ,  $p = 0.042$ ), and the normal saline guttae were correlated not with the opening pressure ( $r = -0.387$ ,  $p = 0.101$ ), but rather with the reopening pressure ( $r = -0.874$ ,  $p < 0.001$ ). Among the 19 patients, tube ligation (Kee 2001) was performed simultaneously with AGV implantation in two patients due to an intraoperative shallow anterior chamber.

In another 17 patients, excluding the above two patients with tube ligation (mean age,  $52.9 \pm 17.7$  years; 13 men, four women; preoperative mean IOP,  $41.8 \pm 9.5$  mmHg; day 1 postoperative mean IOP,  $9.6 \pm 5.4$  mmHg) the reopening pressure and day 1 postoperative IOP showed a strong positive correlation ( $r = 0.715$ ,  $p = 0.001$ ) and the normal saline guttae correlated negatively with the day 1 postoperative IOP (Pearson's correlation,  $r = -0.742$ ,  $p = 0.001$ ). Among the five patients with low (level-1) reopening pressure, four patients (80%) experienced hypotonic maculopathy ( $n = 1$ ), shallow anterior chamber ( $n = 2$ ) or choroidal effusion ( $n = 1$ ). Hypotonic maculopathy and choroidal effusion regressed spontaneously. However, in two cases of anterior chamber shallowing, viscoelastic injection was required to resolve an iridocorneal touch.

We suggest that careful subjective grading of the reopening pressure (when priming the tube) by an experienced surgeon is helpful in predicting early postoperative hypotonic complications. In addition, tube ligation may be useful to prevent hypotony-associated complications (Kee 2001). To confirm this possibility, a study with a larger patient population is necessary.

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## Characterization of the biological antioxidant potential in the vitreous fluid from patients with rhegmatogenous retinal detachment

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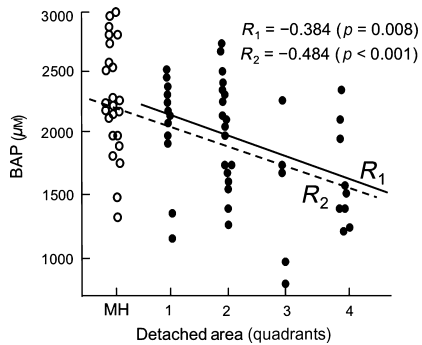
Editor,

Oxidative stress has been reported to cause cellular damage and play a role in triggering programmed cell death. In many vitreoretinal disorders, including proliferative diabetic retinopathy (PDR) (Yokoi et al. 2007), age-related macular degeneration (Rattner & Nathans

2006) and retinitis pigmentosa (Berson 1996), oxidative stress has been implicated in the development of retinal cellular damages (Carmody et al. 1999). Cederlund et al. (2013) previously reported an elevated vitreous level of oxidative stress biomarkers in their small group of patients with rhegmatogenous retinal detachment (RRD), in addition to showing that oxidative stress was related to the RRD severity. Research has also shown that antioxidant treatments can reduce photoreceptor cell death in experimental retinal detachment in animal models (Rostein et al. 2003). The results of these studies indicated that oxidative stress may play an important role in photoreceptor cell death in RRD. Our current study attempted to characterize the biological antioxidant potential (BAP) in the vitreous fluid of RRD by comparing the BAP in the vitreous fluid collected from patients with various vitreoretinal disorders including RRD and then statistically analysing the BAP in relation to the clinical features of RRD.

This study was approved by the Institutional Review Board of Hirosaki University Graduate School of Medicine. Undiluted vitreous fluid was obtained at the time of vitrectomy from RRD ( $n = 45$ ), PDR ( $n = 93$ ), retinal vein occlusion (RVO,  $n = 14$ ), epiretinal membrane (ERM,  $n = 18$ ) and macular hole (MH,  $n = 24$ ) patients. Biological antioxidant potential (BAP) values were determined by measuring the reducing potential determined by the conversion of  $\text{Fe}^{3+}$  to  $\text{Fe}^{2+}$  in thiocyanate solution (FREE™, Wismerll, Tokyo). Clinical features of RRD were analysed by examining medical records for the extent of the detachment, duration of symptoms, presence of proliferative vitreoretinopathy (PVR) or vitreous haemorrhage (VH), macular status (on or off), and patient age.

Biological antioxidant potential values ( $\mu\text{M}$ ) were  $1860.50 \pm 470.50$  in RRD,  $1647.76 \pm 460.53$  in PDR,  $1863.14 \pm 413.76$  in RVO,  $2169.23 \pm 594.01$  in ERM and  $2258.83 \pm 450.79$  in MH, respectively. Rhegmatogenous retinal detachment (RRD) exhibited a significantly lower BAP value than MH (ANOVA with *post hoc* Dunnett's T3 test,  $p = 0.012$ ), while PDR had a significantly smaller BAP than ERM



**Fig. 1.** Correlation between BAP and the extent of detachment. BAP is significantly correlated with the extent of the detachment in the RRD group (closed circle,  $R_1 = -0.384$ ,  $p = 0.008$ , Pearson's correlation coefficient). When BAP in the MH group is used as the control (= 0 quadrant, open circle), there is a significantly greater correlation between the BAP and the extent of the detachment ( $R_2 = -0.484$ ,  $p < 0.001$ ).

( $p = 0.019$ ) and MH ( $p < 0.001$ ). There were no statistically significant differences in the BAP values between RRD, PDR, RVO and ERM. For the clinical features, BAP values for the detached areas confined within 2 quadrants ( $2006.59 \pm 401.17$ ) were significantly greater than that extended over 3 quadrants ( $1568.33 \pm 474.82$ , Student's *t*-test,  $p = 0.002$ ). In addition, there was a statistically significant negative correlation between the BAP values and the extent of the detached area, with a Pearson's correlation coefficient of  $-0.384$  ( $p = 0.008$ ,  $R_1$  in Fig. 1). Furthermore, when the BAP values of the MH group were used as the controls (0 quadrant), there was an even stronger correlation, with a Pearson's correlation coefficient of  $-0.484$  ( $p < 0.001$ ,  $R_2$  in Fig. 1). There were no significant correlations noted between BAP and any other features examined.

Current results suggest that significantly increased oxidative stress was present in RRD compared to MH. Of the possible clinical features that could influence BAP in RRD, only the extent of the detachment was significantly correlated to the BAP with no significant relationships found for the duration, presence of PVR or VH, macular status and patient age. These results suggest that a detached retina by itself has a much greater influence on intravitreal BAP versus that of the presence of free haemoglobin. Thus, antioxidant treatments may be of benefit in retarding photoreceptor cell death during RRD.

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## A novel c.2T>A *NDP* missense mutation in a Chinese family with Norrie disease

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Editor,

Norrie disease (ND) is a rare X-linked recessive disorder characterized by bilateral congenital blindness in males due to deficient sprouting of the retinal vascular plexus during eye development. The majority of patients suffer from sensorineural hearing loss with an onset in childhood or early adulthood. Approximately 30–50% of patients show some degree of cognitive retardation. The Norrie disease pseudoglioma gene (*NDP*), located on chromosome Xp11.4, underlies ND. This gene encodes norrin that plays a critical role in retinal vascular development (Xu et al. 2004). Numerous *NDP* gene variants from several countries in various ethnic populations are reported in ND.

We accepted a Chinese family with ND with alterations in the *NDP* gene by molecular genetic testing and identified a novel mutation responsible for ND. A 7-year-old boy was referred to our department to our clinic because of the impaired vision in both eyes since childhood. He had normal reference psychomotor development and normal hearing ability. His right eye had leukoma of cornea and retina was invisible. The left eye had clear cornea with deep chamber and transparent lens. Fundus examination revealed retinal detachment and absence of visible retinal vascular (Fig. 1A,B). Ultrasound B-scan showed complete retinal detachment in right eye and tractional retinal detachment in the left eye (Fig. 1C,D). His 4-year-old brother failed to follow moving light stimuli after birth. Both of his eyes had opaque corneas, posterior synechiae and dense secondary cataract. We examined the eyes of their parents, both of them are normal, and other family members we investigated do not have impaired vision.

Sequence analysis of the *NDP* gene in the elder brother revealed a hemizygous variant at nucleotide position c.2T>A in exon 2, resulting in a missense mutation p.Met1Lys (Fig. 1E). Given this information, we tested *NDP* gene exon 2 of younger brother and their parents. His brother also carried this hemizygous variant (Fig. 1F) and the mother was heterozygous for the mutation (Fig. 1G). But this mutation was absent in his father (Fig. 1H). The present ND family shows a distinct genetic defect with a missense mutation at codon 2 of exon 2 of the *NDP* gene.