Outcomes of Scleral Buckling for Stage 4 Retinopathy of Prematurity in Thai Children

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Objective: *To evaluate the anatomical and visual results of a primary scleral buckling procedure for the treatment of stage 4A and 4B retinopathy of prematurity (ROP) in Thai patients.*
Material and Method: *The data of premature infants treated with a primary scleral buckling procedure for stage 4 ROP from December 2000 to May 2004 were retrospectively reviewed. The outcomes measures were anatomical success, visual outcomes, and refractive error at the end of follow-up.*
Results: *Sixteen eyes of ten patients underwent a scleral buckling procedure and had the mean follow-up period of 17.3 months (range 3-44 months). The anatomical success was 100% (8 of 8 eyes) in stag 4A and 50% (4 of 8 eyes) in stage 4B. At the end of the follow-up, the buckle was removed in 92% (11 of 12 eyes) of retina-attached eyes and showed a mean myopic refraction of -8.68 diopters (range -4.75 to 13.50). Favorable visual outcome was 50% (4 of 8 eyes) in stage 4A and 12.5% (1 of 8 eyes) in stage 4B.*
Conclusion: *Scleral buckling appears to play a role in reducing the progression from stage 4 to stage 5 ROP. The anatomical success rate was excellent but the visual results remain challenging for these cases.*

Keywords: *Scleral buckling, Retinopathy of prematurity, Thai patients*

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Recent advances in neonatal medicine have dramatically increased the survival rate of infants with low birth weight, with a concomitant increase in the incidence of retinopathy of prematurity (ROP). Although ROP generally regressed spontaneously, it was shown to progress to a threshold ROP in about 6% of infants with a body weight less than 1251 grams (g)[1].Despite the implementation of cryotherapy, ROP will progress beyond stage 3 in one-fourth of treated eyes resulting in severe visual loss[2-8]. The utility of scleral buckling for stage 4 and 5 ROP has been suggested in several series[9-17]. The authors retrospectively reviewed the presented cases undergoing a primary scleral buckling for tractional retinal detachment secondary to stage 4 ROP.

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Material and Method

From December 2000 to May 2004, 19 eyes of 12 infants in Songklanagarind Hospital, southern Thailand, underwent a primary scleral buckling procedure for tractional retinal detachment (TRD) secondary to ROP (Table 1). All TRDs included in the present study were classified according to the International Classification of Retinopathy of Prematurity (ICROP)[18] as stage 4A or 4B. Stage 4A represents a peripheral retinal detachment with foveal attachment and stage 4B represents a peripheral retinal detachment with foveal detachment. One case was lost to follow up postoperatively and another showed inadequate data so only 16 eyes of 10 patients were included in the present study.

The preoperative data included gestational age, birth weight, age at time of initial surgery, and if the peripheral ablation to the avascular retina had been performed preoperatively. At the time of operation, all infants underwent general anesthesia. Similar surgery was applied to all eyes with placement of a 2.5 mm

wide, 360 circumferential silicone band (Bausch & Lomb Surgical Inc., St. Louis, MO) on the episclera. The band was secured with 4-0 Dacron (Surgidac, US Surgical Corp., CT) scleral suture in each quadrant, and the ends of the band were sutured as end-to-end fashion with the same suture except in two eyes (No.2 and 3) in which the ends of the band were tightened and brought together in a Watzke sleeve. No eyes underwent subretinal fluid drainage. There was an iatrogenic retinal tear during scleral buckling procedure in one case (No.6) and successfully treated with cryopexy. Diode laser photocoagulation was applied to the avascular retina if the retinopathy was still active. All infants were followed from 3 to 44 months. Anatomical success was refined as reattachment of the retina with full attachment of the retina between temporal vascular arcades. The presence of macular ectopia after resolution of the detachment was not considered a failure. The encircling band was later removed if the authors believed that the retina would remain attached. This was done to promote eye growth and reduce the likelihood of intrusion of the band later in life. There was only one case (No.14) for which the operation was postponed as the patient was lost to follow up before buckle removal.

Cycloplegic refraction was performed at least one month after buckle removal. The technique used to evaluate grating acuity was the Teller acuity card procedure[19,20]. Visual acuity (VA) was scored as spatial frequency of the finest grating to which the infant showed a consistent fixation response and converted to Snellen equivalent. Treatment of amblyopia, if present, had been prescribed to the patients. Favorable functional outcome was defined as VA better than 20/200 and unfavorable functional outcome was equal or worse than 20/200, according to the CRYO-ROP study[21].

Statistical analysis

Odds ratio was used to evaluate the risk factors between preoperative characteristics and anatomical outcomes. P-value was calculated by Fisher's exact test when at least one cell of the sample size had an expected count less than 5. A p-value of less than 0.05 was considered statistically significant.

Results

Sixteen eyes of 10 infants were treated by scleral buckle from December 2000 to May 2004 (Table 1). Half of the eyes (8 eyes) were stage 4A and the others were stage 4B (8 eyes). Gestational age at birth and birth weight ranged from 24-36 weeks (mean 28.0 weeks) and 500-1600 g (mean 1009.5 g), respectively. Nine (56.25%) from 16 eyes received cryotherapy or indirect diode laser photocoagulation as peripheral ablation prior to surgery. Average postmenstrual age at the time of surgery was 39.6 weeks (32-49 weeks). In the same episode of scleral buckling surgery, cryotherapy was added for peripheral ablation in two eyes (12.5%) and treated the iatrogenic retinal break in one of these two eyes. Indirect diode laser photocoagulation was applied in five eyes (31.25%). Anatomical success was achieved in all eyes (8 eyes) in stage 4A and four (50%) from eight eyes in stage 4B. It was noted that two eyes of stage 4B occurred in zone I (No.4 and 5).

The encircling band was later removed from 11 of the 12 eyes that succeeded in retinal reattachment. Average time of removal was 6.68 months (range 4.5-11 months) postoperatively. All retinas remained attached after removal of the buckle and refraction demonstrated with mean spherical equivalent of -8.68 diopters (D) (-4.75 to -13.50 D). The follow-up time ranged from 3 months to 44 months (mean 17.3 months). At the end of the follow-up, favorable visual outcome was achieved in four eyes (50%) of stage 4A and 1 eye (12.5%) of stage 4B.

Four preoperative characteristics were evaluated for the effect on anatomical success (stage 4A, gestational age $\leq$ 24 weeks, birth weight $\leq$ 900 g and prior treatments) by using odds ratio and p-value (Table 2). The results showed that odds ratio of two characteristics (gestational age and prior treatments) were higher than 1.0. Nevertheless, p-value could not demonstrate any statistical significance.

Discussion

Retinopathy of prematurity continues to be a frequent cause of visual loss despite advances in treatment offered by laser or cryotherapy ablation of nonperfused retina as outlined by the Cryotherapy for Retinopathy of Prematurity (CRYO-ROP) Cooperative Group[21]. In stage 4 ROP, the mechanism of retinal detachment is a tractional force that occurs as maturing mesenchymal cells contract just anterior to the fibrovascular shunt[22,23]. The goals of scleral buckling in this acute stage are to reattach the retina and to halt or reduce the progression from stage 4A or 4B to stage 5 ROP[18].

The success of scleral buckling for stage 4 ROP is well documented[11-13]. Using the new classification of ROP, Trese[22] reported the reattachment rate of 70% (12 of 17 eyes) and 75% (6 of 8 eyes) by Hinz

Table 1. Patient Data

No.	Laterality	Stage	GA (wk)	BW (g)	Prior treatment	Postmenstrual age of surgery (wk)	Follow up time (mo)	Additional procedure during scleral buckling	Anatomical results	Age of buckle removal (mo)	Final VA	Cycloplegic refraction
1	RE	4B	28	900	-	42	44	-	attached*	8	20/160	-4.50-1.00x20
2	RE	4B	24	600	Cryo	32	8	-	attached*	8	20/280	-6.00-3.00x180
3	LE	4A	24	600	Cryo	32	8	-	attached*	8	20/270	-12.00-3.00x180
4	RE	4B**	24	1015	-	32	15	-	total RD	N/A	PL	N/A
5	LE	4B**	24	1015	-	32	15	-	total RD	N/A	no PL	N/A
6	RE	4A	27	940	Cryo	42	10	Cryo	attached* with RET	10	20/100	-8.50-1.50x180
7	LE	4A	27	940	Cryo	42	10	Cryo	attached*	10	20/180	-8.00-2.00x180
8	RE	4A	30	1550	-	39	11	LIO	attached	13	20/89	-6.50-2.00x180
9	LE	4A	30	1550	-	39	11	LIO	attached with LET	13	20/89	-9.50-2.75x180
10	LE	4A	31	1600	LIO	38	12	LIO	attached*	9	PJ	-4.50
11	RE	4A	28	760	-	49	13	LIO	attached*	6	20/270	-5.00-2.00x160
12	LE	4A	28	760	-	49	13	LIO	attached*	6	20/1000	-8.50-1.50x45
13	RE	4B	36	1350	Cryo	47	33	-	attached* with RXT	10	20/270	-11.25-2.75x170
14	RE	4B	26	880	LIO	33	24	-	attached* with RET	N/A	PL	-18.00-4.00x110
15	RE	4B	26	500	LIO, Cryo	42	3	-	total RD	N/A	?PL	N/A
16	LE	4B	26	500	LIO, Cryo	42	3	-	total RD	N/A	?PL	N/A

GA = gestational age, BW = birth weight, VA = visual acuity, RE = right eye, LE = left eye, Cryo = cryotherapy, LIO = indirect laser photocoagulation, RD = retinal detachment, RET = right esotropia, LET = left esotropia, RXT = right exotropia, PL = light perception, PJ = light projection,
? = questionable, N/A = not available, wk = week, g = gram, mo = month
* retina was completed attached with noted of dragged disc or macula or both
** retina detachment in zone I

Table 2. Analysis between preoperative characteristics and anatomical success

Preoperative characteristics	Odds ratio	95%CI	p-value Fisher Exact test
Stage 4A	-*	-	0.07
GA (≤ 24 weeks)	5	0.4-59.6	0.24
BW (≤ 900 g)	1	0.1-9.6	1.0
Prior treatment (LIO or Cryo)	1.4	0.1-13.5	0.77

CI = confidence interval, GA = gestational age (≤ 24 weeks), BW = birth weight (≤ 900 g), LIO = laser indirect ophthalmoscopy, Cryo = cryotherapy
* could not calculate because one cell in the column was zero

et al[16] in stage 4A. The reattachment rate in stage 4B were 100% (3 eyes), 67% (10 of 15 eyes), and 67% (20 of 43 eyes) reported by Greven and Tasman[14], Noorily et al[15], and Trese[22] respectively. In the present study in Thai children, the anatomical success was 100% in stage 4A and 50% in stage 4B. The authors failed to reattach the retina in two eyes that had ROP in zone I. O'Keefe et al[24] reviewed the outcome of zone I ROP and showed that all 10 eyes with a buckling procedure had an unfavorable outcome. In the present study, stage 4A showed a slight favorable effect on anatomical success ($p = 0.07$, nearly significant), but other characteristics (gestational age ≤ 24 weeks, birth weight ≤ 900 g and prior treatments) could not demonstrate any significance. Although the odds ratio of two factors such as gestational age and prior treatment were higher than "1.0", the range of 95% confidence interval was too wide and p-values did not reach the significant level. A further study with a larger sample size may be needed to find these relationships.

The scleral buckle will retain its original circumference on the infant's growing eye. For this reason, Trese[22] advocates removal of the buckle if the retina has well attached by 3 months' time. The authors agree with buckle removal once the fibrovascular tissue appears inactive and the retina has reattached. Chow et al[25] reported the mean myopic reduction of 5.5 D after division of scleral buckle at a mean of 36 weeks postoperatively. Choi and Yu[26] demonstrated the effect of scleral buckle on refraction and ocular growth that the restoration of the eyeball contour after scleral buckle removal was shown from B-scan with variable degree of increment in axial length and myopic reduction. The authors observed the refractive error after scleral buckle removal with a mean of -8.68 D in spherical equivalent. One case who did not have buckle removal had a large amount of myopia (-20.00 D) at the end of the follow-up.

In the presented study, among 12 eyes with retinal reattachment, five eyes (41.66%) had visual acuity better than 20/200. Nevertheless, despite the encouraging rate of anatomical success, visual results remain disappointing similar to the other series[15,27,28]. The reason for this poor visual outcome is unclear. Possible explanations include anatomical retinal abnormalities secondary to detachment and amblyopia. Clinical observations on macular development in premature infants indicate that morphologic maturity may not be present until 42 weeks of gestation[29]. In stage 4 ROP with retinal detachment, the exposure of the retinal pigment epithelium and photoreceptor to subretinal fluid may be damaging the vision leading to form deprivation amblyopia. Retinal detachment or macular ectopia after the surgery are clearly capable of form deprivation and may thus exert an amblyogenic influence in ROP[30]. Another reason for poor visual outcomes is inadequate or difficult refractive error correction postoperatively. Although all of the presented patients were prescribed glasses after scleral buckle removal, irreversible anatomical abnormality along the geniculocortical pathway resulting in irreversible amblyopia might also develop.

In conclusion, scleral buckling surgery of selected eyes with stage 4A and 4B retinal detachments secondary to ROP may reduce the risk of progression to stage 5 ROP. The anatomical success was excellent; however, the difficulties of effectively treating the late stage of this disease and visual results will continue to challenge our knowledge and surgical techniques.

References

1. Palmer EA, Flynn JT, Hardy RJ, Phelps DL, Phillips CL, Schaffer DB, et al. Incidence and early course of retinopathy of prematurity. The Cryotherapy for Retinopathy of Prematurity Cooperative Group. Ophthalmology 1991; 98: 1628-40.

2. Cryotherapy for Retinopathy of Prematurity Cooperative Group. Multicenter trial of cryotherapy for retinopathy of prematurity: preliminary results. Arch Ophthalmol 1988; 106: 471-9.
3. Cryotherapy for Retinopathy of Prematurity Cooperative Group. Multicenter trial of cryotherapy for retinopathy of prematurity: one-year outcome - structure and function. Arch Ophthalmol 1990; 108: 1408-16.
4. Cryotherapy for Retinopathy of Prematurity Cooperative Group. Multicenter trial of cryotherapy for retinopathy of prematurity: 3 -year outcome - structure and function. Arch Ophthalmol 1993; 111: 339-44.
5. Cryotherapy for Retinopathy of Prematurity Cooperative Group. Multicenter trial of cryotherapy for retinopathy of prematurity: Snellen visual acuity and structural outcome at 5 years after randomization. Arch Ophthalmol 1996; 114: 417-24.
6. Tasman W. The natural history of active retinopathy of prematurity. Ophthalmology 1984; 91: 1499-503.
7. Flynn JT, Bancalari E, Bachynski BN, Buckley EB, Bawol R, Goldberg R, et al. Retinopathy of prematurity. Diagnosis, severity, and natural history. Ophthalmology 1987; 94: 620-9.
8. Gilbert WS, Quinn GE, Dobson V, Reynold J, Hardy RJ, Palmer EA. Partial retinal detachment at 3 months after threshold retinopathy of prematurity. Long-term structural and functional outcome. Arch Ophthalmol 1996; 114: 1085-91.
9. McPherson A, Hittner HM. Scleral buckling in 2 - to 11-month old premature infants with retinal detachment associated with acute retrolental fibroplasias. Ophthalmology 1979; 86: 819-36.
10. Grunwald E, Yessur Y, Ben-Sira I. Buckling procedures for retinal detachment caused by retrolental fibroplasias in premature babies. Br J Ophthalmol 1980; 64: 98-101.
11. McPherson AR, Hittner HM, Lemos R. Retinal detachment in young premature infants with acute retrolental fibroplasias: thirty-two new cases. Ophthalmology 1982; 89: 1160-9.
12. Topilow HW, Ackerman AL, Wang FM. The treatment of advanced retinopathy of prematurity by cryotherapy and scleral buckling surgery. Ophthalmology 1985; 92: 379-87.
13. Tasman W, Brown GC, Schaffer DB, Quinn G, Naidoff M, Benson WE, et al. Cryotherapy for active retinopathy of prematurity. Ophthalmology 1986; 93: 580-5.
14. Greven C, Tasman W. Scleral buckling in stage 4B and 5 retinopathy of prematurity. Ophthalmology 1990; 97: 817-20.
15. Noorily SW, Small K, de Juan E Jr, Machemer R. Scleral buckling surgery for stage 4B retinopathy of prematurity. Ophthalmology 1992; 99: 263-8.
16. Hinz BJ, de Juan E Jr, Repta MX. Scleral buckling surgery for active stage 4A retinopathy of prematurity. Ophthalmology 1998; 105: 1827-30.
17. Chuang YC, Yang CM. Scleral buckling for stage 4 retinopathy of prematurity. Ophthalmic Surg Lasers 2000; 31: 374-9.
18. The Committee for the Classification of Retinopathy of Prematurity. An international classification of retinopathy of prematurity. Arch Ophthalmol 1984; 102: 1130-4.
19. McDonald MA, Dobson V, Series SL, Baitch L, Varner D, Teller DY. The acuity card procedure: a rapid test of infant acuity. Invest Ophthalmol Vis Sci 1985; 26: 1158-62.
20. Teller DY, McDonald MA, Preston K, Sebris SL, Dobson V. Assessment of visual acuity in infants and children: the acuity card procedure. Dev Med Child Neurol 1986; 28: 779-89.
21. Palmer EA, Hardy RJ, Dobson V, PHelps DL, Quinn EG, Summers CG, et al. 15-year outcome following threshold retinopathy of prematurity: final results from the multicenter trial of cryotherapy for retinopathy of prematurity. Arch Ophthalmol 2005; 123: 311-8.
22. Treses MT. Scleral buckling for retinopathy of prematurity. Ophthalmology 1994; 101: 23-6.
23. Machemer R. Description and pathogenesis of late stages of retinopathy of prematurity. Ophthalmology 1985; 92: 1000-4.
24. O'Keefe M, Lanigan B, Long VW. Outcome of zone I retinopathy of prematurity. Acta Ophthalmol Scand 2003; 81: 614-6.
25. Chow DR, Ferrone PJ, Trese MT. Refractive changes associated with scleral buckling and division in retinopathy of prematurity. Arch Ophthalmol 1998; 116: 1446-8.
26. Choi MY, Yu YS. Efficacy of removal of buckle after scleral buckling surgery for retinopathy of prematurity. J AAPOS 2000; 4: 362-5.
27. Kalina RE. Treatment of retinal detachment due to retinopathy of prematurity: documented disappointment [editorial]. Ophthalmology 1991; 98: 3-4.
28. Quinn GE, Dobson V, Barr CC, Davis BR, Flynn JT, Palmer EA, et al. Visual acuity in infants after

vitrectomy for severe retinopathy of prematurity. Ophthalmology 1991; 98: 5-13.
29. Isenberg SJ. Macular development in the premature infants. Am J Ophthalmol 1986; 101: 74- 80.
30. Von Noorden GK, Crawford MLJ. Form deprivation without light deprivation produces the visual deprivation syndrome in macula mulatta. Brain Res 1977; 129: 37-44.

ผลการรักษา retinopathy of prematurity stage 4 ด้วยวิธี scleral buckling ในคนไทย

แมนสิงห์ รัตนสุคนธ์, ศิริรักษ์ วิเศษศิลปานนท์, สุภาภรณ์ เต็งไตรสรณ์, อนุชิต กิจธารทอง, จักรี หิรัญแพทย์

วัตถุประสงค์: *เพื่อศึกษาผลของการผ่าตัดรักษา retinopathy of prematurity stage 4A และ 4B ด้วยวิธี scleral buckling ในคนไทย*

วัสดุและวิธีการ: *เก็บรวบรวมข้อมูลย้อนหลังผู้ป่วยคลอดก่อนกำหนดที่มีภาวะ retinopathy of prematurity stage 4 ที่ได้รับการรักษาด้วยการผ่าตัด scleral buckling ตั้งแต่เดือนตุลาคม พ.ศ. 2543 ถึงพฤษภาคม พ.ศ. 2547 และดูผลการรักษาในแง่ของการติดของจอประสาทตา การมองเห็นและการเปลี่ยนแปลงของค่าวัดสายตา*

ผลการศึกษา: *จากการศึกษาตา 16 ตาในผู้ป่วย 10 คน พบว่ามีระยะเวลาการติดตามการรักษาเฉลี่ยเท่ากับ 17.3 เดือน (ระหว่าง 3 ถึง 44 เดือน) มีการติดของจอประสาทตาหลังผ่าตัด 100% (8 ใน 8 ตา) ในผู้ป่วย stage 4A และ 50% (4 ใน 8 ตา) ใน stage 4B เมื่อสิ้นสุดการศึกษามีการผ่าตัดเอาแผ่นซิลิโคนออก 92% (11 ใน 12 ตาที่มีการติดของจอประสาทตา) พบค่าวัดสายตาแสดงภาวะสายตาสั้นเฉลี่ย -8.68 diopter (ระหว่าง -4.75 ถึง 13.50) และระดับสายตาหลังผ่าตัดอยู่ในเกณฑ์ดีเท่ากับ 50% ใน stage 4A และ 12.5% ใน stage 4B*

สรุป: *การผ่าตัด scleral buckling สามารถลดความเสี่ยงในการเปลี่ยนจาก retinopathy of prematurity stage 4 ไปเป็น stage 5 โดยมีผลการติดของจอประสาทตาอยู่ในเกณฑ์ดี แต่ค่าระดับสายตาของผู้ป่วยยังให้ผลการรักษาที่ไม่ดีและไม่สามารถพยากรณ์ได้*
