·Clinical Research·

Removal of the eye in a tertiary care center of China: a retrospective study on 573 cases in 20 years

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Abstract

• AIM: To investigate the original protopathy, direct indications, clinical characteristics, complications of orbit plants and visual conditions of eye enucleation/ evisceration.

• METHODS: A retrospective study of 573 eyes removed (573 inpatients) at Ophthalmology Department in a tertiary care center of China from January 1993 to December 2012 was completed.

• RESULTS: Cases underwent removal of the eye accounted for 2.15% of total ophthalmology inpatients, whose annual frequency declined from 3.80% to 0.52%. There were 167 eyes (29.14%) being enucleated and 406 (70.86%) eviscerated. Annual proportion of evisceration rose from 16.67% in 1993 to 90.48% in later years. Trauma was the top one (65.62%) in original protopathies followed by neoplasm (13.44%) and ocular infections (5.76%). Phthisis bulbi (45.20%) was the most common direct indication, succeeded by malignant tumor (12.57%), loss/unreconstructed of intraocular tissues due to trauma (11.00%), untreatable inflammation (9.60%), intractable glaucoma (8.55%) and sclerocorneal staphyloma (5.24%). Exenteration was underwent in 20 (25.97%) cases (40% for recurrent carcinoma). Following evisceration, secondary prosthesis implantation was more and earlier, implant exposure occurred in less but earlier and infection and extraction/exchange of implants were more than those following enucleation. Male, phthisis bulbi, evisceration and secondary implantation meant lower risk of implant exposure; eyes removed within 24h following trauma was an independent risk factor. There were 14.37% of eyes with vision of light perception at least as been removed. In the residual contralateral eyes, low vision accounted 5.58% and blindness 3.14%.

• CONCLUSION: Ocular trauma, tumor and infections were great threats to eyeball preservation. Early and effective controlling of any original protopathies was vital. Generally evisceration presented more superior and safe outcomes than enucleation did. Visual conditions of the sufferers should be focused on.

• **KEYWORDS:** enucleation; evisceration; protopathy; indication; complication; implantation; affecting factors

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INTRODUCTION

Removal of the eye, including enucleation and evisceration, sometimes with surrounding orbital tissue exenterated, is a devastating experience for sufferers, which means the loss of visual function, depth perception, normal appearance and much more. However it is necessary on some conditions to relieve ocular pain, protect vision in the fellow eye, or even preserve life. On the other times it is needed to rehabilitate cosmetic appearance. The decision of eyeball removal should be made prudently and the strict indication should be grasped which nevertheless is restricted by medical level in the status quo. Some reports [1-7] have summarized cases about enucleation and evisceration of eye balls. However, few studies have differentiated the original protopathy from the final direct indications of removed eyes. And visual function of the residual contra-lateral eye defines the sufferer's survival condition which was not paid attention to enough. This study made a comprehensive analysis on 20-year cases of eye enucleated/eviscerated in Ophthalmology Department.

SUBJECTS AND METHODS

We performed a retrospective study of 573 patients whose eyeballs were enucleated or eviscerated for eye diseases admitted in Ophthalmology Department of a tertiary care center of China over 20y period (1st January 1993 to 31st December 2012). And this study had acquired the approval of the Institutional Review Board in the PLA Geneal Hospital and kept accordence with the Declaration of Helsinki. All related medical records were detailed consulted through hospital computed medical data system. Information such as patient age, gender, reasons for medical advice, bilateral vision, clinical presentation, original protopathy,

Table 1 Patient demographics of original protopathy for removal of the eye

Original protopathy	Removal of the eye (Evisceration/enucleation; %)	Mean age (range, a)	M/F	General course (mo)
Trauma	376 (304/72; 65.62)	29.97±12.06 (4.5-89)	313/63	53.88±91.85
Neoplasm	77 (2/75; 13.44)	32.75±25.58 (1.5mo-86)	40/37	32.42±63.78
Ocular infections	33 (25/8; 5.76)	54.17±20.74 (1.5-86)	13/20	61.68±127.70
Retinal detachment	20 (20/0; 3.49)	46.84±17.17 (18-81)	13/7	91.00±106.05
Primary glaucoma	15 (10/5; 2.62)	60.92±20.37 (20-95)	6/9	124.48±147.78
Chronic uveitis	10 (9/1; 1.75)	35.34±9.23 (20-53)	5/5	108.72±114.30
Diabetic retinopathy	8 (8/0; 1.40)	53.26±13.76 (40-83)	5/3	40.79±63.28
Cataract	8 (7/1; 1.40)	44.80±27.17 (11-76)	3/5	78.16±104.66
Congenital anamorphosis	7 (6/1; 1.22)	20.99±11.34 (10-43)	5/2	207.43±122.32
Eals' disease	5 (3/2; 0.87)	24.37±5.50 (20-34)	5/0	16.36±9.03
Retinal vein occlusion	4 (3/1; 0.69)	46.11±21.06 (27-66)	2/2	47.00±30.22
Coats disease	3 (3/0; 0.52)	17.13±6.14 (13-24)	3/0	190.00±121.84
Others	7 (6/1; 1.22)	39.47±20.74 (12-68)	2/5	123.46±185.46

direct indication for eyeball removal, medical and ophthalmic history, timing of eyeball removal and prosthesis implantation, exposure of the implants, with or without exenteration and histopathology reports were collected and recorded in standardized data base.

The original protopathy and direct indications of removed eyes were respectively classified. Among these, classification and definition of ocular trauma were based on the Birmingham Eye Trauma Terminology. Chronic uveitis excluded exogenous infectious factors. The categories of visual impairment were defined by the World Health Organization in 1977. Follow-up was 6mo at least.

Statistical Analysis All data were collected in an electronic database and cross-checked for errors. Statistical analysis was performed using the SPSS version 20.0 data-analysis software package. Percentage, average mean and standard deviation for descriptive analysis were included. Categorical variables were analyzed using the Chi-square test. Continuous variables were evaluated for normality, and means were compared using the t-test. The ordinal data were analyzed by Wilcoxon Signed Ranks test. Multiple logistic regression analysis was conducted to predict the independent factors affecting the occurrence of orbital implant exposure. The critical value of significance was set up at $P<0.05$ for all tests.

RESULTS

General Information A total of 573 eyes of 573 inpatients (2.15% in the same Ophthalmology Department total number) were removed during period of 1993-2012. The annual frequency of removal of the eye in contemporary inpatients declined from 3.80% in 1993 to 0.52% in 2012 (U=12.52, P<0.001) and that in contemporary eye surgeries declined from 4.50% in 1993 to 0.63% in 2012 (U=12.05, P<0.001). Among these, 167 eyes (29.14%) were enucleated and 406 (70.86%) eviscerated, whose annual constituent ratio changed significantly (U=4.78, P<0.01). The percentage of evisceration rose from 16.67% in 1993 to 90.48% in some later years. The ages of the 573 inpatients ranged from 3mo to 95y and mean was 33.84±17.91y, younger than average age of the whole inpatients in the same period (49.82±21.53y; t=-17.67, P<0.001). The juveniles under 18 years old accounted 13.96%. The gender ratio (male *vs* female) was 2.63, different from that of the whole inpatients in the same period (1.42; χ^2=19800.92, P<0.001). There were differences in constituent ratio of age between male and female (U=2.636, P<0.01). The females were far less than males in 10 to 50 years old compared with those in other age (χ^2=25.20, P<0.001). And 61.08% of removed eyes were underwent intraocular surgeries (33.43% at least twice) before removal. Their average days of hopitalizion were 13.32±7.01d.

Original Protopathies The original protopathies of the removed eyes were summarized in Table 1, in which trauma was the top one in number, followed by neoplasm. And most of enucleations were trauma- (43.11%) and neoplasm- (44.91%) related. Majority of eyes with neoplasm were enucleated which was different with eyes of other protopathies (χ^2=209.84, P<0.001). The average ages of different protopathy group were variant (F=13.52, P<0.001). The younger were in the majority of trauma and neoplasm. Males were prominently more than females in trauma (χ^2=83.28, P<0.001). The other original protopathies included one case of cysticercosis, Graves' exophthalmos, corneal dystrophy, keratoconjunctivitis sicca, Mafan's syndrome, high myopia with radial keratotomy and unknown respectively. The general disease course from onset symptom of original protopathy to removal of the eye varied from ≤24h to 50y and average were 58.81±98.02mo. And the mean courses of protopathies were different (F=3.90, P<0.001).

Table 2 Patient demographics of direct indication for removal of the eye

Direct indication	Removal of the eye (Evisceration/enucleation; %)	Mean age (range, a)	M/F
Phthisis bulbi	259 (222/37; 45.20)	30.30±12.24 (5-70)	217/42
Malignant tumor	72 (2/70; 12.57)	32.54±26.22 (1.5mo-86)	36/36
Loss/unreconstructed of intraocular tissues due to trauma	63 (39/24; 11.00)	29.18±15.12 (4.5-89)	54/9
Untreatable inflammation	55 (41/14; 9.60)	44.67±20.07 (1.5-84)	30/25
Intractable glaucoma	49 (42/7, 8.55)	42.79±19.39 (13-95)	32/17
Sclerocorneal staphyloma	30 (25/5, 5.24)	24.88±9.07 (13-44)	18/12
Corneal ulcer perforation	26 (22/4; 4.54)	53.16±19.12 (8-86)	13/13
Corneal bullae lesions	6 (6/0; 1.05)	38.67±18.28 (11-63)	2/4
Surgical complications	4 (4/0; 0.69)	36.80±7.80 (30-45)	4/0
Corneal graft rejection	3 (2/1; 0.52)	37.90±17.58 (23-57)	3/0
Sympathetic uveitis	3 (1/2; 0.52)	35.32±13.72 (20-45)	3/0
Erroneous judgment of benign neoplasm	3 (0/3; 0.52)	26.07±7.78 (21-35)	3/0

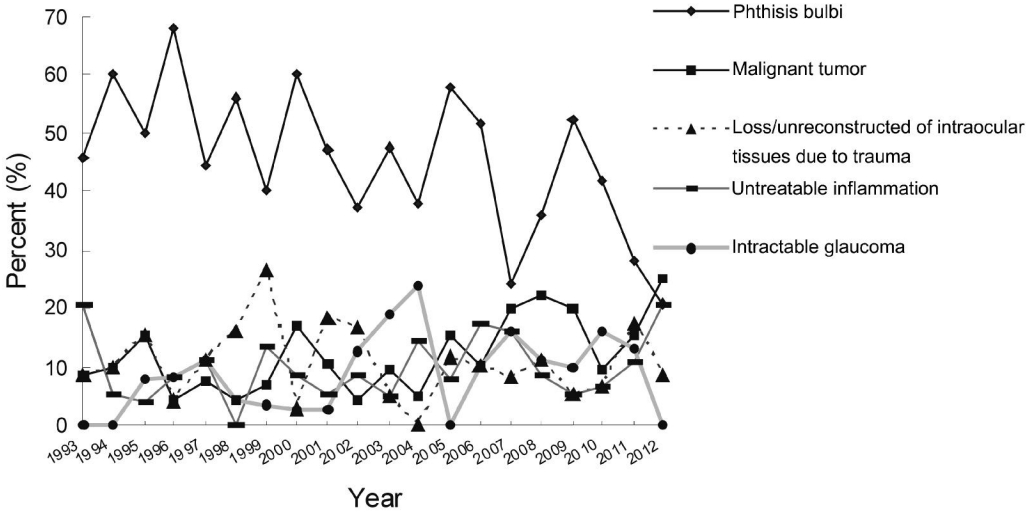

Figure 1 The tendency on frequency of major direct indications for removal of the eye from 1993 to 2012.

Direct Indications The direct indications for removal of the eye were categorized in Table 2. Phthisis bulbi was the most common direct indication succeeded by malignant tumor, loss/unreconstructed of intraocular tissues due to trauma, inflammation, intractable glaucoma and sclerocorneal staphyloma so on. Among these 86.10% (223/259) of phthisis bulbi developed from eye trauma. Most cases of malignant tumor were enucleated different from cases of other indications (χ^2=215.45, P <0.001). The mean age of sclerocorneal staphyloma group was youngest (F=9.04, P<0.001). And the gender ratio were different (χ^2=68.89, P<0.001). The surgical complications included suprachoroidal expulsive hemorrhage as lens surgery and vitrectomy individually and 2 cases of gentamycin injected into vitreous mistakenly as peribulbi injection at other hospitals. And the frequency distributions of direct indications differed in the twenty years (χ^2=264.50, P=0.0056; Figure 1). Frequency of phthisis bulbi fluctuated obviously but still much higher than that of other indications except for malignant tumor and untreatable inflammation at 2012. Annual frequency of malignant tumor went over 20.00% in some recent years, especially to 25.00% in 2012. Percentage of loss/unreconstructed of intraocular tissues due to trauma peaked at 26.67% in 1999. However double peak of 20.83% emerged in 1993 and 2012 for untreatable inflammation. And the summit (23.81%) of intractable glaucoma was in 2004.

Trauma and Removal of the Eye In trauma there were 362 (96.28%) cases of mechanical eye injuries and 14 (3.72%) cases of chemical or thermal burns. The open globe injuries (333 cases) including 156 (46.85%) cases of rupture, penetration 108 (32.43%), intraocular foreign body 61 (18.32%) and perforation 7 (2.10%). Among 29 close globe injuries, there were 24 cases of blunt contusion and 5 cases of lamellar lesion. The proportions of phthisis bulbi (223 cases), sclerocorneal staphyloma (26 cases) and sympathetic uveitis (2 cases) developed from trauma were significantly higher than those did from other original protopathy (59.31% *vs* 18.27%, χ^2=9.69, P=0.0019; 6.91% *vs* 2.03%, χ^2=127.83, P<0.001; 0.53% *vs* 0.51%, χ^2=188.13, P<0.001). The injured eyes (25 cases, 6.65%) were removed within 24h following trauma emergently.

Table 3 Information of neoplasms leading to removal of the eye

Neoplasm	*n*	Mean age (range, a)	Exenteration (%)	Recurrence (%)	M/F
Retinoblastoma	26	5.22±7.53 (1.5mo-32)	0 (0.00)	1 (3.85)	14/12
Choroidal melanoma	22	40.95±11.59 (21-60)	2 (9.09)	2 (9.09)	10/12
Meibomian gland carcinoma	5	58.92±13.32 (48-79)	5 (100.00)	3 (60.00)	4/1
Malignant melanoma of eyelid/conjunctiva	5	42.93±31.81 (4-86)	2 (40.00)	2 (40.00)	2/3
Adenocystic carcinoma of lacrimal gland	4	43.84±15.85 (26-65)	4 (100.00)	0 (0.00)	1/3
Choroid hemangioma	3	40.15±20.71 (23-63)	0 (0.00)	0 (0.00)	2/1
Malignant melanoma of ciliary body	2	57.02±28.26 (37-77)	0 (0.00)	0 (0.00)	1/1
Eyelid basal cell carcinoma	2	70.50 (70-71)	2 (100.00)	0 (0.00)	1/1
Malignant lymphoma	2	44.90 (40-50)	1 (50.00)	0 (0.00)	1/1
Inflammatory pseudotumor	2	50.56 (47-58)	2 (100.00)	0 (0.00)	1/1
Metastatic carcinoma	2	70 (58-82)	0 (0.00)	0 (0.00)	2/0
Rhabdosarcoma	1	72 (-)	0 (0.00)	0 (0.00)	0/1
Opitic nerve sheath meningioma	1	19 (-)	1 (100.00)	1 (100.00)	0/1
Polymorphism adenomatous of lacrimal gland with malignant transformation	1	66 (-)	1 (100.00)	0 (0.00)	1/0

Table 4 Information on orbital implants

Implants	Evisceration *n*=354 (%)	Enucleation *n*=70 (%)	Statistical analysis	Total *n*=424 (%)
Secondary implantation	13 (3.67)	31 (44.29)	χ^2=12.02, *P*=0.0005	44 (10.38)
Interval of removal of the eye-secondary implantation (range)	28.34±88.88 (1.3mo-27y)	90.17±122.00 (21d-37y)	*t*=-4.97, *P*<0.001	71.90±115.77 (21d-37y)
Implant exposure	30 (8.47)	7 (10.00)	χ^2=11.01, *P*=0.0009	37 (8.73)
Interval of implantation-exposure (range)	14.77±22.19 (10d-7y)	30.20±41.31 (12d-8y)	*t*=-4.49, *P*<0.001	17.69±26.81 (10d-8y)
Infection	9 (2.54)	1 (1.43)	χ^2=44.63, *P*<0.001	10 (2.36)
Extraction of implants	5 (1.41)	2 (2.86)	χ^2=52.66, *P*<0.001	7 (1.65)
Implant exchange	2 (0.56)	0 (0)	χ^2=62.35, *P*<0.001	2 (0.47)
Rehabilitation of saccus conjunctivae	23 (6.50)	7 (10.00)	χ^2=17.69, *P*<0.001	30 (7.08)

Neoplasm and Removal of the Eye All types of neoplasm leaded to 78 cases of removal of the eye were listed in Table 3. Retinoblastoma (26/33.77%) and choroidal melanoma (22/28.57%) were still the significant leading reasons of removal of the eye for children (5.22±7.53 years old) and adults (40.95±11.59 years old) respectively. Totally exenterated cases accounted for 25.97% (20 eyes), 40% of which proceeded following recurrence of carcinoma. Excluding benign neoplasm (choroid hemangioma and inflammatory pseudotumor), the recurrent proportion of malignant tumor was 12.50% (9/72). The constituent ratios of exenteration (χ^2=59.55, *P*<0.001) and recurrence (χ^2=27.25, *P*=0.0115) in each type of neoplasm were significantly different. There was no difference in gender ratio (χ^2=8.62, *P*=0.8008). Leukocoria (18/26, 69.23%) was the most common manifestation for retinoblastoma followed by painful eyeball (4/26, 15.38%). However complaining of patients with choroidal melanoma about vision blurring/decline (16/22, 72.73%), sheltering feel (8/22, 36.36%) and painful eye (5/22, 22.73%) were common and there was one case of dysmorphopsia and flash of light respectively. Generally vision blurring/decline (26/77, 33.77%) were the main presenting signs for medical advice.

Other Related Conditions Untreatable inflammation resulted in quite a few of eyeball removed. Among these, 47.27% (26/55) were related with trauma (24 open globe injuries, 1 lamellar lesion and 1 alkali burn); 16.36% (9/55) originated from keratohelcosis (including 1 Mooren's ulcer); 16.36% (9/55) occurred following intraocular surgeries (3 phaco, 4 vitrectomy, 1 penetrating keratoplasty and 1 trabeculectomy) and 14.55% (8/55) were endogenous infection (3 following fever for cold, 3 for immunosuppressive drugs taking, 1 transferred from brain and hepatophyma liver abscess and 1 for diabetes mellitus). In addition inflammatory pseudotumor (2/55, 3.64%) and cysticercosis (1/55, 1.82%) were included.

Obital Implants There were 424 cases (74.00%) with spherical orbital implants, most of which were high-density porous polyethylene (MEDPOR). The proportion of orbital prosthesis implanted in eyes eviscerated was 87.19% (354/406), much higher than that in ones enucleated (41.92% , 70/167; χ^2=145.31, *P* <0.001). As Table 4 showed, frequencies of secondary implantation, implant exposure, extraction of implants and rehabilitation of saccus conjunctivae in evisceration were lower than those in enucleation. However frequencies of infection complication

Table 5 Multivariate analysis on independent risk factors of orbital implant exposure

Factor	*P*	Odds ratio	95% confidence interval
Age	0.9196	1.00	0.975-1.029
Gender (male)	0.0437	0.45	0.203-0.978
Phthisis bulbi	0.0175	0.26	0.085-0.790
Untreatable inflammation	0.4401	2.12	0.316-14.175
Evisceration	0.0016	0.09	0.019-0.397
Removal of the eye within 24h following trauma	0.0024	18.86	2.837-125.369
Secondary implantation	0.0357	0.13	0.08-0.871
Interval of removal of the eye- implantation	0.7889	1.00	0.977-1.08

and implant exchange in evisceration were higher. And intervals of removal of the eye-secondary implantation and implantation-exposure were shorter in evisceration.

Table 5 presented multivariate analysis on independent risk factors of orbital implant exposure. Male, phthisis bulbi in direct indications, evisceration in ways of removal of the eye and secondary implantation meant lower rate of implant exposure. However eyes removed within 24h following trauma was a significant risk factor.

Visions There were 14.37% of eyes with vision of light perception at least as been removed apart from 17 eyes (2.97%) of infants whose visions were unknown (Table 6). All the 22 eyes (3.84%) with vision above 0.1 were removed for diagnosis of malignant tumor. In the residual contralateral eyes, low vision accounted 5.58% and blindness accounted 3.14%.

Table 6 Visual acuity of eyes before been removed and the contralateral eyes respectively *n* (%)

Visual acuity	Removed eyes	Contralateral eyes
Best corrected visual acuity		
≥1.0	1 (0.18)	424 (74.00)
0.5-1.0	5 (0.87)	64 (11.17)
≤0.5	3 (0.52)	18 (3.14)
Low vision		
≤0.3	11 (1.92)	23 (4.01)
≤0.1	2 (0.35)	9 (1.57)
Blindness		
≤0.05	5 (0.87)	3 (0.52)
≤0.02	55 (9.60)	12 (2.10)
No light perception	474 (82.72)	3 (0.52)
Unknown	17 (2.97)	17 (2.97)

DISCUSSION

According to previous research, a downward trend after removal of the eye (especially through enucleation) has been universally reported [1-3]; this resulted from the significant increase in the number of hospital admissions for ocular diseases in this study. The percentage of removal of the eyes in ophthalmic surgeries was lower in our study (mean 1.90%) than in that reported by Ibanga *et al* (7.7%)[4] or the Chinese Tong Ren Eye Center (4.5%)[5]. Generally, the gender and age distributions are decided by the disease constitution of the population. In China, trauma as the primary pathogenesis for removal of the eye mostly affected adult and teenage males.

The causes for removal of the eye in our study were retrospectively classified according to the original protopathies and the direct indications developing from the former respectivly, through which the real distribution of eye diseases leading to removal of the eye could be clarified. Among the protopathies, trauma was the most common (65.62%), and neoplasm was the second most common (13.44%), which is similar to the results of the Tong Ren Eye Center (trauma 62.5%; tumors 28.5%)[5], which jointly reflect the characteristic conditions in China. Eye injury is a prominent threat to the visual health of the general public in China, the largest developing country and has an enormous population. Some studies [2,6,7] also reported trauma as a top cause. In particular, a report from Iceland [2] agreed with our study in terms of the top three causes. However, the infectious causes were more common in southern Nigeria[4]. Regarding enucleation, tumors were the most frequently occurring in India[8,9], which is consistent with our data. Apart from trauma and unavoidable neoplasms, other protopathies treated with delays, insufficiently or even improperly, were allowed to evolve into end-stage eye diseases that could be relieved or controlled only by removal of the eye. Thus, their general courses were relatively longer. From the point of view of clinical practice, it is fundamental and necessary for eyeball preservation to make proper, moderate and effective treatments and to perform traumatic operations with experienced judgment. Otherwise, eyes that initially had controllable diseases could deteriorate to the point of requiring removal.

The direct indications of removal of the eye demonstrate the end of medicine's wits coping with the eye diseases in status quo. Phthisis bulbi was the most frequent indication (45.20%) for removal of the eye in this study, which is not consistent with others [1,2,5,6,8,10,11] mightly for the various divisions of causes in different studies. The direct indications here, including phthisis bulbi, represent the final results of

eyes that have survived various diseases and managements. As many as 86.10% of phthisis bulbi cases arose from trauma, and the demographic traits of both were similar. The reasons for the removal of the eyes included the following: the decay of the intraocular tissue structures and their functions in phthisis bulbi, the capacity to guard against malignant cancer cells as they invade the surrounding healthy tissues and the impossibility of anatomically reconstructing the posterior segment to repair the loss of or damage to the intraocular tissues from trauma. All of these conditions left removal of the eye as the only reasonable option. Compared with the above, other indications could be avoided to the greatest extent of medical technology and could be managed until relevant progress could be made in ophthalmology and bio-engineering.

The annual frequency tendency of causes for removal of the eye was analyzed according to direct indications in this study. The intervals between the onset of the protopathies and the final removal of the eye varied and might have represented a very long time. Therefore, it is not accurate enough to study the temporal distribution of removal of the eyes by their original protopathies. In this study, the frequency of phthisis bulbi decreased to the lowest level during 2012; this observation partially reflects the reduced proportion of transformation from the protopathies to phthisis bulbi. The general increasing trend of malignant tumors leading to removal of the eye in this study was similar to those of some other studies [3,8]. The increased occurrence of untreatable inflammation in recent years was perhaps related with the strengthening of bacterial drug resistance. Neovascular glaucoma, which represents the majority of intractable glaucoma, could not be managed at one time and currently be partially prevented, controlled and even cured, especially after introduction of anti-vascular endothelial growth factor therapy and the recognition of hypoperfusion eye disease.

Retinoblastoma and choroidal melanoma are still the primary types of malignant neoplasms, resulting in the majority of removal of the eyes among children and adolescents, both in our studies and those of other researchers[9,12]. Chemotherapy can be used to treat early lesions for the preservation of the globe [13]; however, enucleation may still be required. Furthermore, the absolute number of enucleations secondary to neoplasms has not decreased over time, despite an increase in globe-conserving treatments, such as chemotherapy and radioactive plaques [3,8]. In particular, metastatic malignant neoplasms of the eye are almost always fatal, against which there are still no other effective therapies[3,14]. Certainly, early diagnosis and treatments for the eye diseases of infants could preserve the eyeball and vision to an extreme extent. However, the absence of trained pediatric ophthalmology specialists and pediatric eye care centers is a realistic problem in developing countries, such as China. The misconceptions of ophthalmologists and parents often delay necessary pediatric eye care interventions. Currently, regular examinations of audio acuity for infants have been established in China, but no such evaluation of ocular conditions as an essential examination for infants has been provided in China to date. The implementation of such evaluations will depend on sufficient financial support, the development of fundus examinations without dilating the pupil, anesthesia and standardized trained personnel.

The choice between enucleation and evisceration is still controversial except for the enucleation for malignant tumor and infiltrative infection tumors of eyes. Apart from individual viewpoints [2,3], evisceration is preferred for being closer to physiological anatomy [1,4,6,7,15,16]. The proportion of evisceration increased by 73.81% in our data, and no sympathetic uveitis due to evisceration was found during the 20y of our study. In our study, the proportion of orbital prosthesis implantation in eviscerated eyes was higher, implant exposure occurred less often but earlier, and secondary infection of implants occurred more often following evisceration. Nakra *et al* [17] reported fewer cases of exposure and extrusion in evisceration, which was similar to our results. However, some studies assumed that the occurrence of complications (including implant exposure, infection, lower lid laxity, fornix insufficiency, and need for subsequent surgery) was similar in the two methods [6,7]; conversely, some claimed exposure and extrusion were higher in evisceration [18,19]. These complication differences may be due to differences in operative indication, surgical technique, available implant materials and perioperative management. In some cases, structural lesions of eye, *e.g.* more severe tissue edema, inflammatory infiltration and defects, increased the probability of exposure and extrusion, which contributes to a varying degree to the risk factors of orbital implant exposure (removal of the eye within 24h following trauma in our data). However, phthisis bulbi and secondary implantation were both protective factors for plant exposure in our analysis, which might be due to the stable and silent tissue environment after eliminating inflammation and edema. The contraction and thinning of remaining soft tissues is a problem for these types of cases. Thus, the expertise of the operating physician plays pivotal role in providing personalized surgery for the patients. Evisceration may be not better than enucleation for some patients and surgeons, but in most cases with indications and with the majority of surgeons, it results in superior, more physiological motility and better long-term health of the orbit. Additionally, our multivariate analysis data showed that evisceration itself was an operative method of reducing implant exposure risk, and no sympathetic ophthalmitis was observed in evisceration cases.

Regrettably, at least 14.37% of eyes that still possessed visual function were required to be removed. This presents a challenge for us to treat more manageable eye diseases excluding malignant tumors and to preserve eyeball and the vision both. Vision of the residual eye following contralateral eye removed becomes vital for patients who must adapt to the status of monophthalmia. As a result of adaptation, one-eyed individuals are considered to be capable of maintaining perfectly normal lives and to not be limited by their lack of binocularity [20]. Unfortunately, 5.58% of these one-eyed patients experience low vision and 3.14% experience blindness in their remaining eye, thus losing their ability to adapt and worsening their living conditions. Promotion and popularization of ocular health care and a social salvage system for the blindness should become a focus in China.

This retrospective study revealed the general situation and evolution about removal of the eye in recent 20y in China and reminded us there remained a big improvement space for reducing or avoiding the results of removal of the eye as far as possible. However retrospective study often lose a lot of analysis possibility and results due to the data not regular enough which is the limit of this study. If related long-term multicenter prospective case-control study can be stalished, we can gained more data with guiding significance in the early intervention, removal of the eye operation time and methods and orbital prosthesis implantation.

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