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Research Article

Retinoblastoma (RB) in Saudi Arabia- Retrospective Comparative Review of a Registry

Abstract

Purpose: Published data regarding retinoblastoma in Saudi Arabia (KSA) is sparse. The study will present comparison of clinical and pathologic features, and evolving patterns of the treatment during 1983-1997 (Early group=EG) to 1998-2012 (Late group=LG) periods from an RB registry representing all Rb cases in KSA.

Methods: This health record review was conducted in 2014. From the RB registry, information about gender, age, clinical features and stage at presentation; laterality, regional distribution, history, co-morbid diseases, pathologic features, surgical treatment modality and treatment outcomes were collected.

Results: The EG and LG group had 343 and 430 Rb patients respectively. The incidence of Rb in 1997 and in 2012 was 0.06 and 0.03 per 1,000 live births in Saudi Arabia respectively. The gender distribution was similar. The median age of presentation was 24 (range 11, 39) months in EG vs. 18 (8, 31) months in LG (p <0.001). Incidence of unilateral Rb was 58% [200/343] in EG vs. 56% [278/485] in LG. Positive family history of Rb was <10% in both groups. However, in EG, 120 (35%) parents were first cousins vs. 124 (27%) in the LG (p=0.12). Leukocoria was the most common presentation [71% (n=255) in EG and 66% (n=343) in LG]. Tumor confined to the eye at presentation was more common in the LG group (67% EG vs. 84% LG). Vitreous seeding was more common in LG [62% (n=302) LG vs 45% (n=156) EG; p<0.001]. In the non-surgical group, photocoagulation rate increased in the LG [23.19% (106) LG vs 3.8 %(n=13) EG; p<0.001]. The rate of chemotherapy increased from 4.1% (n= 14) in EG to 14.2% (n=65) in LG (p <0.001). The rate of external beam radiation decreased [37% (n=125) EG vs. 23.4% (n=107) LG]. The rate of extraocular tumor extension was similar in both groups (53.7% EG vs. 51.6% LG; p<0.001). The rate of full thickness choroidal involvement decreased from 13% (n=35) EG to 7.7 % (n=30) LG, (p =0.04). Optic nerve (ON) involvement in LG decreased to 3.4% (n=22) compared to 9.8 %(n=48) in EG (p <0.001).

Conclusions: Most clinical parameters of Rb remained unchanged over 30 years except an earlier median age of presentation suggesting earlier tumor detection. However, an increasing total number of Rb cases were seen in the last fifteen years. The pathologic features in LG were less advanced. A significant increase in the non-surgical treatment approaches of Rb was noted in the last 15 years.

Introduction

Retinoblastoma (RB) is the most common primary intraocular malignancy in children [1-3]. The incidence of RB ranges from 1 in 15,000 to 1 in 30,000 live births worldwide and survival rate varies by country [4,5,10]. It is estimated that RB affects 7,000–8,000 new patients worldwide yearly [4,5]. In developed countries, the survival rate has increased from 30% in the 1930s to more than 90% in the 1990s as a result of an earlier detection and significant advances in the overall therapeutic strategy [4]. In developing countries and the underdeveloped countries, however, the mortality rate remains as high as 70% due to poor public awareness and lack of access to innovative treatments [6,7]. Around the world, majority of the estimated 8,000 newly diagnosed patients with retinoblastoma will die each year [8]. In an earlier published report on retinoblastoma in kingdom of Saudi Arabia (KSA), survival rate of 80% was noted among 74 diagnosed cases from the period of 1983-1987 [9]. In a more recent report evaluating demographic information of ocular tumors from tumor registry in KSA, the incidence of malignant ocular tumors in children was found to be 3.6 per million/year (M/Y) and that of Rb was 7.7/M/Y in <5 years olds from [10]. To assess whether implementation of various screening, diagnostic and interventional programs in the past two decades in KKESH have changed the morbidity and mortality of newly diagnosed RB cases, we undertook the current study to compare the clinical and pathologic features, and evolving patterns of the treatment from 1983-1997 (Early) to 1998-2012 (Late) from the RB registry.

Methods

The RB registry at King Khaled Eye Specialists (KKESH) hospital represents all RB cases presented and diagnosed in kingdom of Saudi Arabia. KKESH is a tertiary eye center receiving and providing ocular services for the entire kingdom. It captures and maintains comprehensive population-based data on all RB patients in the kingdom. The registry list includes patient name, gender, age, date of diagnosis, laterality, geographic/regional distribution, diagnostic methods, and mode of management, complete medical/family history and co-morbid diseases. However, the registry did not capture the

end-mortality rate. The diagnostic methods were one of the following: clinical signs, laboratory data, imaging findings, indirect fundus findings, exploratory surgery findings and cyto-histopathology findings. The modes of management were surgery, radiotherapy, chemotherapy and immunotherapy, single and/or in combination. Institutional review board's approval was obtained to conduct this study and principles of declaration of Helsinki for research integrity were followed. The registry was queried to compare the trends in all these parameters for the Early vs. Late group (EG vs. LG).

To calculate the incidence of RB, we randomly considered year 1998 for EG and 2012 for LG as representative numbers. However, we cannot consider the final numbers to be an actual representation for the entire 15-year comparative period (EG vs. LG) between the two groups. The live birth data of these two years as reported by Ministry of health, Saudi Arabia were used as denominator and number of RB cases in these two years were numerators [11,12]. The data of the RB registry was transferred to spreadsheet of Statistical Package for Social Studies (SPSS 16) (IBM, Chicago, USA). Univariate analysis using parametric method was applied. For qualitative variables, we used frequencies and percentage proportion while for quantitative variables with normal distribution we used mean and standard deviations, whereas for skewed distribution, we calculated median and interquartile range. To compare outcomes of EG & LG we used two sided p value, difference of mean and its 95% confidence intervals. For this purpose, we used stat-calculator of OpenEpi software [13].

Results

A total of 343 cases with retinoblastoma were identified in the early group (EG) whereas 430 patients were identified in the late group (LG). The comparison of important demography in EG and LG group is given in Table 1. Age at which the patients presented to KKESH for evaluation and treatment shortened significantly in LG compared to EG group.

In the year 1997 there were 32 cases of RB while in 2012, they were 21. The live birth in 1997 and 2012 were nearly 409,800 and 590,000 respectively. Thus, the incidence of RB in 1997 and 2012 were 1 in 12,860 [0.07 (95% CI 0.003 – 0.3)] and 1 in 28,095 [0.03 (95% CI 0.002 – 0.2)] per 1,000 live births respectively. These are only incidence rates of RB for the years of 1997 and 2012.

The clinical presentation, extent of spread in EG and LG are compared in Table 2. Spread of RB outside the eyeball was significantly less in LG compared to EG. Leukocoria was main presentation in both EG and LG.

The mode of management in EG and LG were compared (Table 3). A significant shift towards increased use of laser photocoagulation and chemotherapeutic treatment was noted in the LG in comparison to the EG. The surgical management by enucleation has not changed in LG compared to EG.

Based on histopatholgy and genetic studies of sample from RB specimen, a comparison of EG and LG was carried out. In the EG, six patients showed to have positive 13qdeletion whereas five patients showed to have positive 13qdeletion in the LG. Two patients had trilateral RB in EG and one patient had trilateral RB in the LG. The rate of extraocular tumor extension was similar in both groups (53.7% EG vs. 51.6% LG). Solitary tumors of <6mm in size were present in 5.2% (n=18) patients in EG and 7.2% (n=31) patients in LG. The rate of orbital extension was 4.3% (n=14) in EG and 3.5% (n=15) in LG. The rate of full thickness choroidal involvement decreased from 13% (n=44) EG to 7.8 % (n=33) LG. Optic involvement in LG decreased to 3.4% (n=15) compared to 9.8 %(n=34) in EG (p <0.001). Vitreous seeding was present in 45.4% (n=156) in EG compared to 62.2% (n=267) in LG. Intracranial extension and metastasis were evident in 4.1% (n=14) in EG and 2.2% (n=10) in LG.

Discussion

Retinoblastoma is a relatively uncommon malignant, but the most common ocular, tumor of childhood that arises in the retina and accounts for about 3% of the cancers occurring in children younger than 15 years [14].

Our study with large series showed relatively similar incidence of RB in 1997 and 2012 in Saudi population although the total

Table 1: Comparison of retinoblastoma cases in Saudi Arabia in 1983 - 1997 (Early group) and 1998 -2012 (late group).

Variables		Early group 1983 – 1997 (n= 343)		Late group 1998 – 2012 (n = 430)		Validation
		Number	%	Number	%	
Gender	Male Female	172 171	50.2 49.8	213 217	49.5 50.5	OR = 1.02 (95% CI 0.8 – 1.4) p = 0.9
Region of residence	Central East North South West Outside	100 43 19 56 87 38	20.5 8.8 3.9 11.5 17.8 7.8	130 40 50 60 115 35	30.2 9.3 11.6 14.0 26.7 8.1	Chi Square = 0.3, degree of freedom =5 p =0.6
Laterality	Unilateral Bilateral	226 117	66 33	301 129	70 30	OR = 0.8 (95% CI 0.6-1.1) p = 0.2
Family History of Rb	Present Absent	42 301	12 88	33 397	9.7 90.3	OR = 1.7 (95% CI 1.04 – 2.7) P = 0.03
Consanguinity	1st cousin Related Not related	42 175 126	12 51 37	33 109 288	7.7 25.3 67.0	Chi square = 53, df = 2, p <0.001
Age at presentation	Median 25% quartile	24 months 11 months		18 months 8 months		KW test, Chi square = 15, P value =<0.001

Table 2: Comparison of clinical features of retinoblastoma cases in Saudi Arabia in 1983 - 1997 (Early group) and 1998 -2012 (late group).

Variables		Early group 1983 – 1997 (n= 343)		Late group 1998 – 2012 (n = 430)		Validation
		Number	%	Number	%	
Leukocoria	Present Absent	255 88	74.3 25.7	333 97	77.4 12.6	OR = 0.8 (95% CI 0.6-1.2) p = 0.3
Strabismus	Present Absent	67 276	19.5 80.5	143 287	33.3 66.7	OR = 0.5 (95% CI 0.3-0.9) p <0.001
Proptosis & pain	Present Absent	32 311	9.3 90.7	26 404	6.0 94	OR = 1.6 (95% CI 0.9-2.6) p =0.08
Spread	Global In orbit ON Intracranial	230 10 48 10	77 3 17 3	387 10 25 8	90 2 6 2	Chi square = 20, df = 3 p <0.001

Table 3: Comparison of management of retinoblastoma cases in Saudi Arabia in 1983 to 1997 (Early group) and 1998 -2012 (late group).

Management mode	Early group 1983 – 1997 (n= 343)		Late group 1998 – 2012 (n = 430)		Validation Rate ratio (95% CI) p
	Number	%	Number	%	
Laser photocoagulation	13	3.8	94	21.9	0.2 (0.1 – 0.3) p <0.001
Chemotherapeutic treatment	96	28	140	32.6	0.9 (0.7 – 1.1), p = 0.25
Cryotherapy	79	23	70	16.2	1.4 (1.03 – 2.0) p = 0.03
Chemo-reduction	14	4.1	58	13.4	0.3 (0.2 – 0.5) p <0.001
External beam radiation	125	36.4	95	22.1	1.65 (1.3 – 2.2) p = 0.0002
Palliative treatment	28	8.1	11	2.5	3.2 (1.6 – 6.4) p =0.0006
Radiation Plaque	16	4.6	8	1.9	2.5 (1.1 – 5.9) p = 0.03
Unilateral enucleation	322	93.9	402	93.5	1.0 (0.9 – 1.2) p = 0.95
Bilateral enucleation	22	6.4	32	7.4	0.9 (0.5 – 1.9) p = 0.6

numbers of RB cases increased in the late group likely as a result of an overall population increase. Children with retinoblastoma present for medical care in the earlier stages now compared to the past as the mode of management has changed over the past fifteen years. Although unilateral enucleation has reduced, rate of bilateral enucleation has remained same.

In a recent study on the review of ocular malignant tumors from the tumor registry, retinoblastoma was noted to be the most common ocular malignancy (91%) in children between 1983 and 2012 in KSA [12]. Following the inauguration of KKESH, all newly diagnosed and suspected retinoblastoma cases in the nation have been promptly referred to for swift evaluation and treatment. This trend has not changed in the two-time era in spite of opening up of medical cities and universities in different regions. Thus, the RB registry at KKESH seems to represent the current diagnostic and therapeutic patterns within the country.

Our study showed that the incidence of RB in Saudi Arabia in 1997 and 2012 were 1 in 12,860 and 1 in 28,095 per 1,000 live births respectively. In a previous population based study of RB in the KSA for the period of 1982-1986, the incidence of retinoblastoma in Riyadh, Saudi Arabia was reported to be 1 in 11,580 live births per year [15]. The RB (7.7/M/Y in <5 years old Saudi children) is less frequent than that reported in some Gulf countries, but higher than that reported from the West [14,16]. It should be noted that incidence of RB across the globe varies by race, sex, ethnicity and geography because of multiple factors [1-8,17,20,22]. As examples of geography and ethnicity, the incidence of RB in US stands at approximately 10 to 14 cases per 1 million in children aged 0 to 4 years and varies by race, sex and ethnicity [5,22]. The annual incidence rate of RB in UK and various European countries stands at 4 per million children below age 15 years [1,4,8,19]. In a study of Omani children between 1990-2002, the age-adjusted incidence of RB was determined to be 4.04/million/year in children <15 years and 8.33/million/year in children <5 years [16]. The mean age at diagnosis was 32.2 months (33.8 months for unilateral RB and 13.2 months for bilateral RB). 75% had unilateral tumors and 25% had bilateral tumors thus our study suggests early presentation similar clinical presentation but high incidence compared to Oman. In a comprehensive epidemiological study published by Wong et al., it was shown that the retinoblastoma diagnosed at younger than 1 year increased significantly during 1975-1984 in SEER 9 (APC, 6.2%) and then decreased significantly during 1992-2009 in SEER 13 (APC, −3.1%) and non-significantly in SEER 18 (APC, −1.4%) [21]. The incidence of RB varied during the study period amongst Blacks, Whites and Hispanics in the population [21]. The use of highly sensitive allele-specific polymerase chain reaction, as a molecular genetic testing for *RB1* mutations, results in rates of detection of *RB1* mutations of 95% and 93% in bilateral and unilateral familial retinoblastoma patients, respectively [31]. In another study of epidemiology of retinoblastoma in Jordan, the median age for RB diagnosis was shown to be at 12 months. The globe survival rate was about 68.0% at 1 year, 63.3% at 2 years, and 62.1% at 5 years. The mean survival time was 101.6 months. The overall ocular survival rate for eyes with retinoblastoma was close to regional and international

figures [32]. In a recent 12-year study of 192 patients by Gunduz et al., the overall risk of enucleation following retinoblastoma diagnosis in Turkey to stand at 75% in eyes with unilateral retinoblastoma and 24% in eyes with bilateral retinoblastoma with a mean follow-up of 28.0 months. The study showed extraocular retinoblastoma carried a 75% risk of systemic metastasis and 67% risk of death [33]. In an epidemiological study assessing for survival rates of retinoblastoma patients in Iran, authors determined survival were 100% at 1 year, 94.8% at 3 years and 83.1% at 5 years through Kaplan-Meier estimation. The study showed the mean age at diagnosis was 28.5 months. Fifty-two per cent of the cases were unilateral, and 48% were bilateral. The most common presenting sign was leucokoria (64.8%) followed by strabismus (28.2%). The authors concluded that the progress in methods of treatment, early detection of the disease and prompt referral to specialized centers has led to improved outcomes for patients with retinoblastoma in terms of globe and patients' survival [34]. Bugghari et al., showed annual crude incidence of retinoblastomas in Karachi to be at 4.0/100,000 and 2.4/100,000 in children under the age of 5 and 10 years respectively and the corresponding age standardized rates being 5.3/100,000 and 4.8/100,000 for the period 0f 1998-2002 [35]. In a recent retinoblastoma study in Egypt, Zomor and colleagues determined that the mean age at presentation of RB patients to be at 20.6±17months in 262 patients and the most common clinical presentation to be leukocoria in 73.8% patients followed by strabismus in 13.1% patients [36].

The globe laterality and the rate of RB in the local sub-population of the local Saudi population remained unchanged between the two groups likely because of stable pattern of residency of the Saudi citizens. In analysis of gender bias in RB presentation, whereas in other studies and countries, the incidence of retinoblastoma shows male or female predominance, we found the gender distribution to be relatively equal and stable for the past 30 years in KSA [22,24]. In a recent study, Wong et al., showed a significant excess of total retinoblastoma among boys compared with girls during 2000-2009 in contrast to earlier reports of a female predominance in North America [21]. The authors showed that the retinoblastoma rates among white non-Hispanics decreased significantly since 1992 among those younger than 1 year and since 1998 among those with bilateral diseases similar to other childhood tumors [21]. They attributed this reduction to the availability of RB1 genetic testing to the high risk RB parents as well as improved technology and identification of RB1 carriers particularly in those 1 to 4 years old and those with unilateral disease [21]. A statistically significant reduction in the median age of presentation to KKESH from the earlier to late period was observed from 24 months to 18 months likely as a result of earlier tumor detection programs and informative public educational programs resulting in heightened public awareness in the Kingdom [25]. However, neither presenting symptoms nor the signs showed any clinically significant shifts over time. Rate of patients with positive family history of RB remained unchanged over time and between the two groups. Despite the ongoing educational progress, no clinically significant shift in the rate of consanguinity was observed between the two groups in our study. However, changing patterns in rate of consanguinity would certainly not influence the RB incidence rate as the *RB1* gene is inherited in an autosomal dominant pattern in germinal retinoblastoma. In terms of gender, laterality and region of residency for RB presentation in KSA, there was no clinically significant difference between the early vs. late groups. A statistically significant decline in the rate of consanguinity in the late group is likely attributed to the continuing and the aggressive public campaign to raise the local community awareness on the issue of a connection between retinoblastoma events and the close family marriages as first cousins. The statistically significant reduction in the age of presentation of children with retinoblastoma in the late group likely signifies the increased general public knowledge for retinoblastoma as a serious life-threating disease, an earlier detection of retinoblastoma by the local physicians and the faster referral to the specialty centers as well as an improved overall public access to the health care for the patients in the late group.

The rate of advanced cases declined significantly in the LG. Rate of tumors invading retro-bulbar section of the optic nerve regressed as well as choroidal involvement and vitreous seeding indicating earlier tumor detection. Rate of intracranial extension as well as hematogenous metastasis and *phthisis bulbi* significantly decreased in the LG because of improved treatment modalities as well as earlier clinical detection. In comparing Reese-Ellsworth classification between the two groups, groups of multiple tumors, tumor extending anterior to *ora serrata* and massive tumors involving over half of the retina all showed declining patterns as a result of an earlier detection of RB in the LG [26].

In this study, the statistically significant rise in the use of photocoagulation, chemo reduction and chemotherapeutic therapy and a clinically significant reduction in cryotherapy, radiation plaque, external beam orbital radiotherapy (EBORT), palliative treatment and bilateral enucleation in the late group provides the needed evidence that the standard and acceptable world-wide treatment program modalities in the KSA have been adopted and further insight into the adherence of the RB programs to the internationally acknowledged treatment standards.

The surgery rate of retinoblastoma in our study did not change over time and remained stable at 72-74% over the 30-year period. This number is higher in comparison to other reported studies in Taiwan standing at 61.8% from 1996 to 2003, Singapore at 47.7% and Japan at 48.5% [20,27,28]. Our study did not investigate for survival rate of RB patients. However, it must be noted that the survival rate is unique for each country and specifically related to the development of a particular nation. As an example, the 5-year survival rate of retinoblastoma is 80% in Taiwan [20], which is lower than that reported in Europe (95%) [17], in the United States (93%) [29], and in Japan (10-year survival rate was 86.7% in bilateral cases and 92.3% in unilateral cases) [27], but close to that reported in Singapore (3-year survival rate was 83%) [28], in a study of Omani children, the five-year RB survival rate was 89% [29]. With continuum of progress, adoption of the latest treatment modalities and the newly available genetic testing, increasing survival rate for RB patients in KSA will soon be realized. Statistically significant increase in number of cases presenting with strabismus in the late group compared to the early group is likely attributed to the earlier diagnosis of RB in the late group.

Limitations of our study does include lack of data on the overall survival rate as well as relevant information on the death rate in correlation to the time of diagnosis, atypical cases, treatment types and laterality history. Our registry does not include the death rates and survival rates cannot be calculated as a result. Previous reports have attributed that the atypical cases are likely the regressed retinoblastoma that had reactivated or undergone malignant changes of retinoma [20].

Future roadmap in approaching RB in KSA will include further adaptation of recommendations of American National Institute of Health or the American Society of Clinical Oncology for the genetic testing in the screening process and in the settings of genetic susceptibility as well as adherence to the latest diagnostic and treatment protocols. Such protocols have changed survival rate in other nations, which have adopted such programs [30].

In conclusion, the results of this study show that the most RB clinical parameters remained unchanged over the period of 1987-2012 in Saudi Arabia. Exceptions, however, included a statistically significant earlier median age of presentation and less advanced pathological features suggesting earlier tumor detection; and an increasing overall number of RB cases seen in the last fifteen years because of overall national population growth. Furthermore, a significant increase was noted in the non-surgical treatment approaches of RB including photocoagulation, chemotherapy and chemo-reduction because of internationally available standard treatment modalities.

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