THE ROLE OF COMPUTED TOMOGRAPHY IN THE EVALUATION OF RETINOBLASTOMA

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ABSTRACT

To assess the importance of Computed Tomography(CT) in the evaluation of retinoblastoma, we reviewed thirteen cases of retinoblastoma which presented at Hospital University Sains Malaysia, Kelantan, Malaysia, from August 1986 to June 1991. High resolution computed tomography of the orbits was performed in all patients prior to therapy. Nine patients (69%) had unilateral and four (31%) had bilateral retinoblastoma. The interesting features were the remarkably high incidence in the right eye (89%) as compared to the left eye (11%) in unilateral retinoblastoma, and overall predominance of the male population (male to female ratio was 2:1). Computed tomography detected intraocular calcification in 82% of the tumourous eyes. All patients presented at late stages when tumours were of large size. The presence of calcification was not related to the size of the tumour. CT detected calcification in a suspected retinoblastoma with a high degree of accuracy. Computed tomographic evidence of intraocular calcification in children under 3 years of age is highly suggestive of retinoblastoma.

Keywords: Retinoblastoma, Computed Tomography, Intraocular calcification

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INTRODUCTION

Retinoblastoma is the most common intraocular malignancy of childhood[1]. The incidence in Kelantan, Malaysia is found to be approximately 1 in 12,000 live births. The tumour is congenital in origin but usually is not recognized at birth[2]. When the disease extends beyond the eye mortality approaches 100%. Ocular involvement and metastasis may be present at birth[3].

Early diagnosis followed by appropriate therapy can be life saving and can often prevent loss of vision in the majority of the survivors[4]. Because of its tendency to spread locally and undergo distant metastasis, accurate diagnosis and prompt therapy are important. Computed tomography is a useful adjunctive diagnostic test in the evaluation of patients with suspected retinoblastoma[5,6]. Improvement in our ability to detect intraocular calcification with high-resolution, thin section computed tomographic scanning may increase accuracy to differentiate retinoblastoma from other simulating lesions. In addition, orbital and brain CT scanning can determine optic nerve involvement, retrobulbar spread, extraocular extension or intracranial metastasis.

The role of computed tomography has been evaluated in 13 patients with retinoblastoma to assess the incidence of intraocular calcification detected by computed tomography and the accuracy of CT in diagnosing optic nerve involvement, intra-ocular extension, extra-ocular or intracranial involvement.

SUBJECTS AND METHODS

A 5-year retrospective study was carried out to highlight the prevalence and CT features of retinoblastoma in the state of Kelantan on the East coast of Peninsular Malaysia. We reviewed the demographic data, CT scans and biopsy results of 13 patients who presented at Hospital University Sains Malaysia (HUSM), Kelantan, Malaysia between August 1986 and June 1991. All patients were examined by the ophthalmologist at HUSM. High resolution CT scanning was performed prior to therapy in all cases.

Eleven scans were performed with Phillips Tomoscan 350 whole body scanner and two scans with Toshiba TCT-60A whole body scanner.The slice thickness varied from 1.5mm to 6.0mm in different cases (3mm in 8 cases) for orbital scanning and 6.0mm to 9.0mm for brain scanning. All scans were performed in axial plane. Nine patients had unilateral and four had bilateral retinoblastoma. The patients' ages ranged from 8 months to 5 years with a median age of 24 months. Nine patients presented with leukocoria (56%), five with proptosis (31%), one presented with strabismus and blindness and another with a bleeding growth. Table I summarises the clinical and CT features in each patient. All patients presented at an advanced stage and enucleation was performed in all, including bilateral enucleation in one patient.

Tumours were staged according to Reese-Ellsworth classification[7]. Only one unilateral tumour was in stage III, all others were found to be in stage IV or V. All enucleated eyes were examined histologically and confirmed as retinoblastoma Five patients were given radiotherapy and four patients were given chemotherapy following enucleation.

RESULTS

Thirteen patients were examined by CT scanning of the orbits. Ten patients (77%) demonstrated calcification on CT. In total, 17 eyes were examined, out of which 14 (82%) demonstrated calcification on CT. All of the four bilateral retinoblastomas showed bilateral calcification on CT (Fig 1). The largest tumour was 40mm X 30mm and the smallest was 12mm X 7mm in dimension. There were 9 (69%) unilateral and 4 (31%) bilateral tumours. Only one unilateral retinoblastoma involved the left eye (11%) while all the rest of the unilateral retinoblastomas involved the right eye (89%). The incidence was found to be significantly higher in the right eye ($z=2.34$, $p=0.02$, two tailed). There were nine males (69%) and four females (31%), giving a male to female ratio of 2:1. These findings differ from the Western reports where no particular predilection for either eye is shown and the incidence is also observed to be similar for the two sexes [8].

The average age of the patients at the time of diagnosis was 27 months (range: 8 months to 5 years). In the Western countries the average age at presentation is between 11 and 18 months [9]. The smallest lesion demonstrating calcification on

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Table I - Clinical and Computed Tomographic Features of Retinoblastoma

Case No.	Age/Sex	Presenting signs	Tumour site and stage@	Computed Tomographic Features	Metastasis	Treatment and Outcome
1	8 mo/M	leukocoria	RE Stage III	TS=16x10mm,Cal ; ND, Op N ; not involved	ND	Enucleation Alive
2	1 yr/M	leukocoria	RE Stage IV	TS=16x12mm,Cal; dense non-homogenous, Op N ; not involved	ND	Enucleation & Radiotherapy Alive
3	1.5yr/F	leukocoria, bilateral	Both Eyes Stage R V L IV	TS=R:16x10mm,L:20x12mm Cal ; Bilateral dense non-homogenous,Op Nn;involv. IO extension seen	ND	RE-enucleation Radiotherapy Chemotherapy Alive
4	2yr/F	leukocoria proptosis	RE Stage V	TS=13x8mm,Cal ; dense homogenous,Op N;not invol.	ND	Enucleation Alive
5	2yr/M	proptosis	RE Stage V	TS=40x30mm,Cal ; dense homogenous,Op N;involved, IO extension seen.	Lt. orbit Lt.maxilla Submandib.L.N Bone marrow Intracranial	Enucleation & Chemotherapy Alive
6	2yr/M	leukocoria strabismus	RE Stage V	TS=22x14mm,Cal ; multiple punctate,Op N;not involved	ND	Enucleation Alive
7	2yr/M	leukocoria, bilateral	Both Eyes Stage R:V L:IV	TS=R:14x8mm,L:18x14mm, Cal;bil.dense nonhomogenous Op Nn involved,Bilateral IO spread evident	Intracranial Rt.maxillary antrum	Enucleation-RE Radiotherapy Died Survival-2yr
8	2yr/M	leukocoria	LE Stage V	TS=20x16mm,Cal ; fine speckled,Op N ;not involved	ND	Enucleation Alive
9	2yr/M	proptosis	RE Stage IV	TS=18x14mm,Cal; ND Op N ; not involved	ND	Enucleation Alive
10	3yr/M	leukocoria	RE Stage IV	TS=12x8mm,Cal ; ND,Op N involved,Retrobulbar extension seen	Right Maxilla	Enucleation Radiotherapy Died Survival:8mo.
11	3yr/F	leukocoria;bil proptosis;bil	Both Eyes Stage R:V L:V	TS=R:30x25mm,L:20x14mm, Cal ; bil.speckled,Op Nn involved,bil. IO ext.	Intracranial Bone marrow Inguinal L.N.	Enucleation Radiotherapy Chemotherapy Died,Surv;4mo.
12	3yr/F	proptosis-RE Mass above Lt. eyebrow	RE Stage V	TS=30x26mm,Cal;dense non-homogenous,Op N involv. retrobulb.ext.seen,Lt.orbit shows extraocular mass 22x12mm, retina detached	Intracranial,Lt. orbit,Lt.maxilla bone marrow, scalp soft tissue	Enucleation EvisceralionLE Chemotherapy Died Survival:8 mo.
13	5yr/M	bleeding growth-LE, nystagmus poor vision	Both Eyes Stage R:IV L: V	TS=R:18x8mm,L:12x7mm, Cal;bil.dense homogenous, Op N involved,bil.IO extension seen	Intracranial	Enucl:LE Died Survival:4 yrs

mo=months, yr=year, M=male, F=female, bil=bilateral, Rt=right, Lt=left, RE=right eye, LE=left eye, TS=tumour size, Cal=calcification, OpN=optic nerve, IO=intra orbital, ND=not detected, L.N.=lymph nodes. @=staging according to Reese-Ellsworth calcification, LE=left eye involved only in one unilateral retinoblastoma.

CT was 12mm X 7mm and the largest tumour not showing calcification was 18mm X 14mm. The evidence of calcification on CT scan was not related to the size of the tumour. Three patients (23%) with a clinical diagnosis of retinoblastoma did not demonstrate calcification on CT (Fig 2) but were later confirmed to be having retinoblastoma by histological examination of the enucleated eyes.

Various patterns of calcification were observed on CT scans; four patients demonstrated dense non homogenous pattern, three demonstrated homogenous calcification on CT, two patients showed fine speckled calcification and multiple punctate calcification was observed in one patient .

Three patients who did not demonstrate calcification on CT were scanned with a high resolution, thin slice (2mm to 3mm). Seven patients (54%) had CT evidence of optic nerve involvement, six patients (46%) showed retrobulbar extension of retinoblastoma on CT, four patients (31%) had extension into maxillary antra on CT and CT detected intracranial lesions in five patients (38%) (Fig 3a and 3b). Evidence of skeletal metastasis was found in three patients (23%) and lymph nodes were involved in two patients (15%).

DISCUSSION

High resolution, thin section CT scanning can detect calcification within retinoblastoma with a high degree of accuracy. Calcification may be homogenous or non-homogenous, multiple and punctate or several fine speckled foci [10,11]. Calcium usually complexed with denatured DNA is presênt in approxi-

Fig 1 - Retinoblastoma: CT scan shows bilateral dense homogenous calcification.

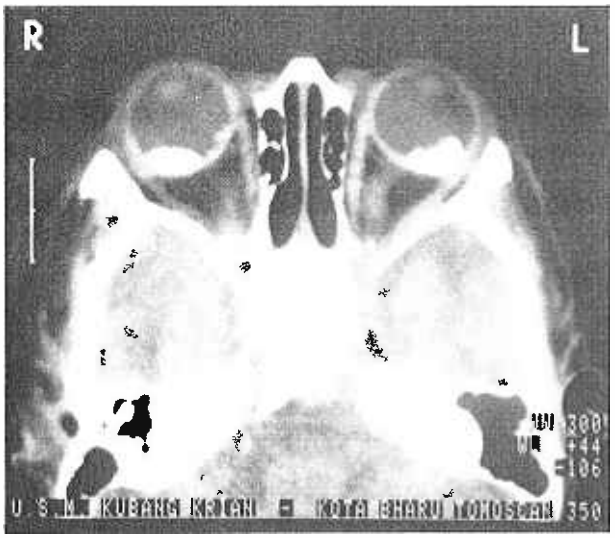
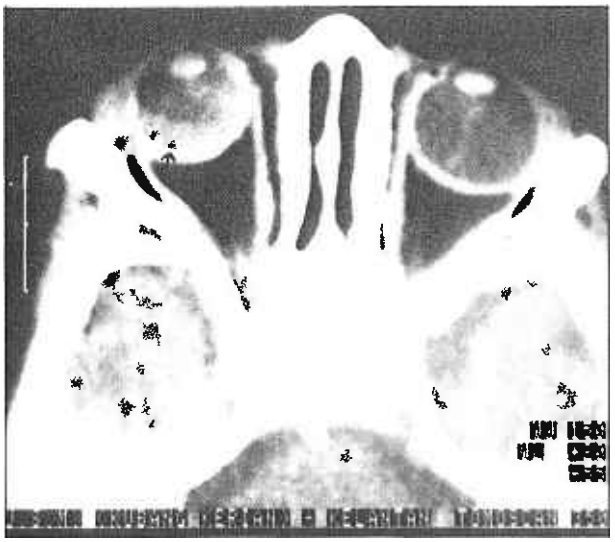


Fig 2 - Retinoblastoma: Orbital CT reveals a soft tissue mass in the right eye without calcification. It was histologically proved to be a retinoblastoma.



mately 95% of histologically examined retinoblastomas [12]. In this series tumour calcification was detected in 82% of the eyes examined by CT scanning. Patients' age at the time of diagnosis and size of the tumour did not influence the presence of calcification on CT, which is in contradistinction to the Western reports where only small tumours are observed to be devoid of calcification and large tumours have demonstrated calcification on CT scanning most of the time.

CT demonstration of calcification in retinoblastoma may be useful in the differentiation from other simulating lesions. The non calcified mass of retinoblastoma on CT scan may be very difficult to differentiate from simulating lesions. CT is of value in assessing the extraocular and intracranial spread of retinoblastoma. In children under 3 years of age, the presence of intraocular calcification on CT scanning is highly suggestive of retinoblastoma[13,14]. While in a patient under 3 years of age with leukocoria, the absence of calcification on CT makes the diagnosis of retinoblastoma less likely. In children above 3 years old simulating conditions like retinal astrocytoma, toxocariasis, persistent hyperplastic primary vitreous, Coats' disease, choroidal osteoma,and others can producc calcification and may become difficult to differentiate from retinoblastoma.

Fig 3(a) - Retinoblastoma: CT scan demonstrates homogenous calcification in the right eye and proptosis of the left eye due to metastatic deposit as well as retinal detachment in the left eye.

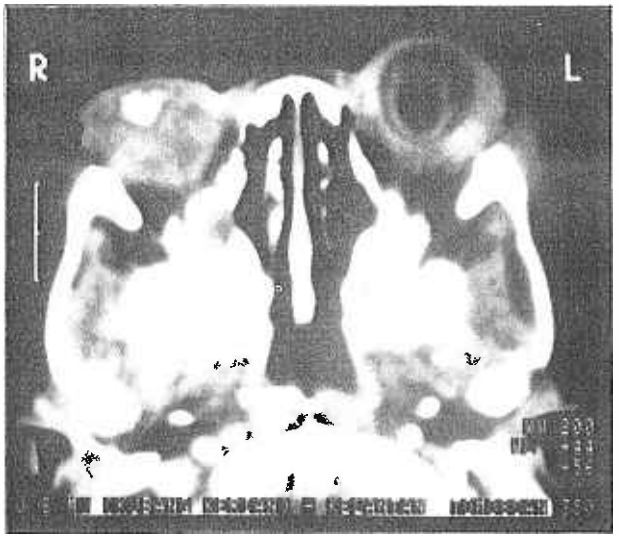
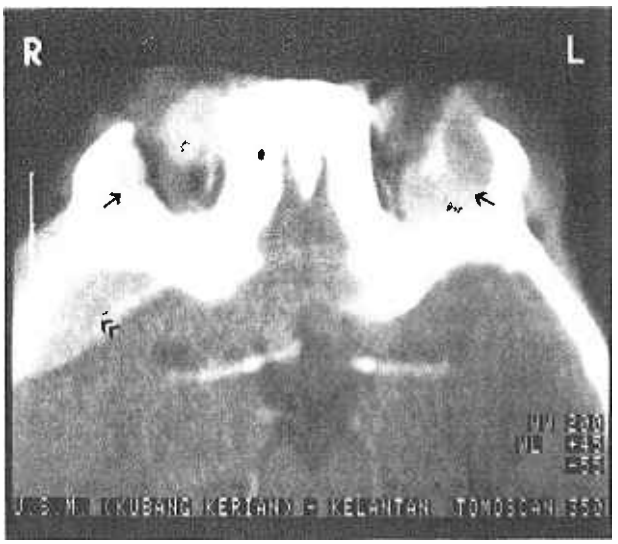


Fig 3(b)- Retinoblastoma: Enhanced CT scan of the same patient showing intra orbital metastatic deposits bilaterally (arrows) and a leptomeningeal deposit in the right anterior cranial fossa (arrowheads).



CT has the advantage over ultrasound in demonstrating gross optic nerve involvement or orbital extension of a tumour[15]. CT is also currently superior to Magnetic Resonance Imaging (MRI) in detecting intraocular calcification which is diagnostic in a suspected case of retinoblastoma[16]. Minimal retrobulbar optic nerve involvement cannot be reliably detected by CT, however CT can certainly demonstrate extraocular or intracranial spread of retinoblastoma.

Early detection of retinoblastoma is the key to increasing the survival rate. Patients diagnosed between birth and 2 years have had a 95% survival rate but those between 2 and 7 years have poor survival rate due to the tumour's metastasis[4]. In our series, 5 patients with evidence of metastasis at the time of diagnosis died with an average survival of 18.4 months. Seven patients are still alive without any evidence of metastasis so far; one patient with evidence of distant metastasis is on chemotherapy.

Only 3 children (23%) were diagnosed before 24 months of age and 10 (77%) after 2 years of age with the mean age of 27 months at the time diagnosis. This delay in diagnosis might

be due to the minimal signs and symptoms of retinoblastoma missed by parents or general practitioners [17]. Socio-cultural factors such as limited knowledge, mistrust and social pressure in emerging societies like ours may inhibit families from seeking medical advice early [18].

Although ophthalmoscopic recognition of retinoblastoma is often reliable, imaging modalities particularly CT or MRI should be used on all patients suspected of having retinoblastoma, in order to detect optic nerve involvement, retrobulbar extension, intracranial involvement, second tumours in the brain or recurrence.

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