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Surgical Management of Posterior Cranial Fossa Astrocytoma

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Abstract

Gross total resection (GTR) is curative for cerebellar astrocytoma (CA), a rare type of central nervous system tumor. Twenty patients were diagnosed with cerebellar pilocytic astrocytoma; 9 (45%) had GTR; and there was no recurrence of the tumor during the median follow-up of 6 months. The aim of the study was to take stock of how different surgeons tackled removing astrocytomas from the posterior fossa of the brains of both young and old patients who had received timely diagnoses. During the period 2021 and 2023, researchers at Al-Azhar University conducted a prospective study on twenty individuals. Individuals of either sex and any age who have a lesion in the posterior fossa of the brain and suspect it is an astrocytoma are eligible; cases that have already been treated with radiotherapy or chemotherapy are excluded. The mean age was 14.43(3 – 37), 8 (40%) males and 12 (60%) were females. Twelve of the participants had a cystic tumor, while eight had a mixed tumor. Nine individuals had lesions in the left cerebellar hemisphere, six in the right, and five in the vermian. The greatest diameter of the tumor was among 3.0 and 6.67 cm. In 11 patients, gross-tumor-resection (GTR) was accomplished, and in 9 patients, STR was performed. Thirteen people had to have a V-P shunt put in permanently. Both the pre- and post-operative visual symptoms differed significantly from one another, and the pre- and post-operative headache symptoms differed highly statistically. Surgical approach to posterior fossa astrocytoma still represents a challenge for neurosurgeons. If successful, GTR is a cure for cerebellar pilocytic astrocytoma. If the individual requires pre-operative insertion of a V-P shunt to reduce intracranial pressure (ICP) in conjunction with GTR of the tumor, the outcome is excellent. Good and excellent surgical outcomes for patients with astrocytomas of the posterior fossa of the brain can be achieved through early diagnosis, the development of microsurgical techniques, and the careful selection of the most appropriate surgical approach.

Keywords: Cerebellar Astrocytoma, Surgery, V-P shunt, GTR.

1. Introduction

Any tumor that arises from the glial or supportive tissue of the brain is called a "glioma". Astrocytic tumors are a type of glioma. The star-shaped astrocytes from which astrocytomas originate give the tumors their name [1].

According to their rate of growth and potential for metastasis (infiltration into surrounding tissue), astrocytomas are divided into four grades by the World Health Organization (WHO) in 2007. In general, the growth rate of non-infiltrating astrocytomas is lower than that of infiltrating astrocytomas [2].

The cerebellum, the cerebrum, the central regions of the brain, the brainstem, and the spinal cord are just some of the locations where astrocytomas have been found [3].

Headache, nausea and vomiting, visual disturbances, altered mental status, cognitive impairment, motor impairment, seizures, sensory anomalies, and ataxia are all possible neurological symptoms of an astrocytoma, depending on where in the CNS the tumor has spread [4].

Astrocytomas are categorized from grade I (most benign) to grade IV (most deadly) in the 2007 World Health Organization (WHO) classification of tumors of the central nervous system [5].

Characteristics such as atypia, mitoses, endothelial proliferation, and necrosis are used in the WHO classification system. These characteristics reveal the tumor's aggressive potential in terms of invasion and growth rate. Grade I tumors lack these characteristics and are thus classified. Grade II tumors (diffuse astrocytoma) are defined by the presence of cytological atypia alone. Grade III (anaplastic) astrocytomas are characterized by anaplasia, mitotic activity, and cytological atypia; grade IV (necrotic) astrocytomas show all of these characteristics in addition to microvascular proliferation and/or necrosis [5].

The study set out to assess the efficacy, safety, and outcomes of different surgical techniques for removing astrocytomas from the posterior fossa of the brain in both pediatric and adult cases.

2. Patients and Methods

From 2021 and 2023, researchers at Al-Azhar University conducted a prospective study on 20 patients. The purpose of this research was to compare the outcomes and risks of different surgical techniques for treating astrocytomas of the posterior fossa of the brain in young children and adults.

2.1 Inclusion criteria

Every individual with posterior cranial fossa astrocytoma including both sex and all age groups.

2.2 Exclusion criteria

Recurring cases.

2.3 Preoperative preparation

History taking, Examination (complete general examination and neurological examination), Investigation (Routine laboratory investigation as well as Radiological examinations) and before inducing anesthesia, every individual was given preoperative steroids, and 1 gram of a third-generation cephalosporin was given intravenously.

2.4 Operative details

Preparing patients for urgent V-P shunt is standard procedure for patients who present with acute hydrocephalus, whether the hydrocephalus developed postoperatively or not. The patient can be in the prone, concord, sitting, or lateral position during excision of a tumor from the posterior fossa, depending on the surgeon's preference.

Preparation of Soft Tissues, Incision, and Dissection: Chlorhexidine soap, an alcoholic chlorhexidine solution, and alcohol are used in a three-step process to clean the skin. To better manage pain after surgery, a long-lasting local anesthetic is injected into the wound after draping.

2.5 Suboccipital craniotomy

Suboccipital craniotomy with replacement of the bone flap is preferred over craniectomy. The risk of headache and

pseudomeningocele after surgery is reduced.

2.6 Opening the Dura

The dura is opened in a Y-shaped. Division of the midline occipital sinus and tumor/cerebellar herniation can cause significant bleeding, making it difficult to open the dura in a small posterior fossa.
When removing a tumor, surgeons may encounter differences in the nature of the tumor's border with the brain. Cerebellar astrocytomas, in general, have a well-defined boundary between the tumor and the surrounding brain tissue.
Sutures, either continuous or interrupted, are used to create a watertight closure of the Dura. After that, the wound is stitched up gradually.

2.7 Post-Operative care

Every individual was kept in an intermediate postoperative care unit for the first 24 hours. In cases where infection or wound collection was observed, patients continued receiving the same third-generation cephalosporin intravenously for an additional three days. Steroids were also administered, with dosing reduced over time. Hormone replacement therapy given to patients before surgery continued afterward. In the first few postoperative hours, patients had their serum electrolytes, hemoglobin, and renal functions measured. We also tracked the volume of urine that passed.

3. Results

Age was distributed among the group as 14.43±9.46. Median (Min-Max) 13 (3 – 37). The sex distribution was 8 (40%) males & 12 (60%) females as shown in Table .1. The most common lesion site was the left cerebellar 9(45%), then right cerebellar 6(30%) & the least was vermin in 5(25%) as shown in Table .2. Tumor resection approach was done according to the site of the lesion, in 13 (65%) patients via transcerbellar approach and 7 (35%) cases through transvermin approach as shown in Table .3. The research started by insertion of V-P shunt preoperatively in cases with acute increase ICP as headache, vomiting & meningism in 7 (35%) patients and postoperatively in 6 (30%) patients due to presence of postoperative focal edema, increase the hydrocephalic changes & increase ICP, while 7 (35%) cases did not need CSF divertion as shown in Table .4. The hydrocephalic changes were presented in 16 (80%) & 4 (20%) cases without any hydrocephalic changes. The post-operative follows up, 8(40%) cases had hydrocephalic changes & 12 (60%) cases didn't as shown in Table .5.

Table (1): Age and Sex distribution among the studied group.

Age	**Study group (n = 20)**
Age (years) (Mean ± SD)	**14.43 ± 9.46**
Median (Min-Max)	**13 (3 – 37)**
Male	**8 (40%)**
Female	**12 (60%)**

Table (2): Site of the lesion.

Site of the lesion	**Study group (n = 20)**
Lt cerebellar	9 (45%)
Rt cerebellar	6 (30%)
Vermian	5 (25%)

Table (3): Surgical approaches.

Surgical Approaches	Study Group (n = 20)
Transcerebellar	13 (65%)
Transvermian	7 (35%)

Table (4): V-P shunt insertion in the study.

V-P shunt	Study group (n = 20)
Pre-op	7 (35%)
Post-op	6 (30%)

Table (5): Pre-operative and post-operative hydrocephalic changes.

Pre-op hydrocephalic changes	Study group (n = 20)
Yes	16 (80%)
Post-operative Hydrocephalic changes	Study group (n = 20)
Yes	8 (40%)

There was early cerebellar symptoms improvement in 13 (65%) cases in the first 3 months, late cerebellar improvement in 2 (10%) cases in 3-6 months, while two cases had no improvement in cerebellar symptoms due to subtotal excision of large vermian lesions. As can be seen in the table below, surgical resection played a crucial role in alleviating the patients' distressing symptoms, with a highly significant difference between preoperative and postoperative headache improvement and a statistically significant difference between preoperative and postoperative visual signs.

Table (6): Post-operative follow-up of cerebellar improvement.

Cerebellar improvement	Study group (n = 20)
Early (first 3 months)	13 (65%)
Late (3-6 months)	2 (10%)
Not pre- operative	3 (15%)
Non-improved	2 (10%)

Table (7): Comparisons among preoperative & postoperative symptoms & signs.

Parameter	Pre-operative Yes: No	Post-operative Yes: No	P value#
Headache	100%: 0%	5%: 95%	<0.0001****
Hydrocephalic changes	80%: 20%	40%: 60%	0.0225 *
Visual signs	80% :20%	25%: 75%	0.0012**
Ataxia	85% :15%	10%: 90%	0.4

refers to the P value of Fisher's exact test.
* and **** refer to significant differences when P < 0.5 and <0.0001, respectively.

3.1 Presentation of a case (1)

A 16-year-old male presented to the emergency room with complaints of ataxia, headache, vomiting, and blurred vision. Hydrocephalic changes with a cerebellar S.O.L cystic with enhanced mural nodule were seen on contrast CT and MRI of the brain. The patient was forced to undergo a V-P shunt immediately. The lesion was nearly completely removed one month later using a lt transcerebellar approach. Pilocytic astrocytoma, grade I, was the diagnosis reached by the pathologists.

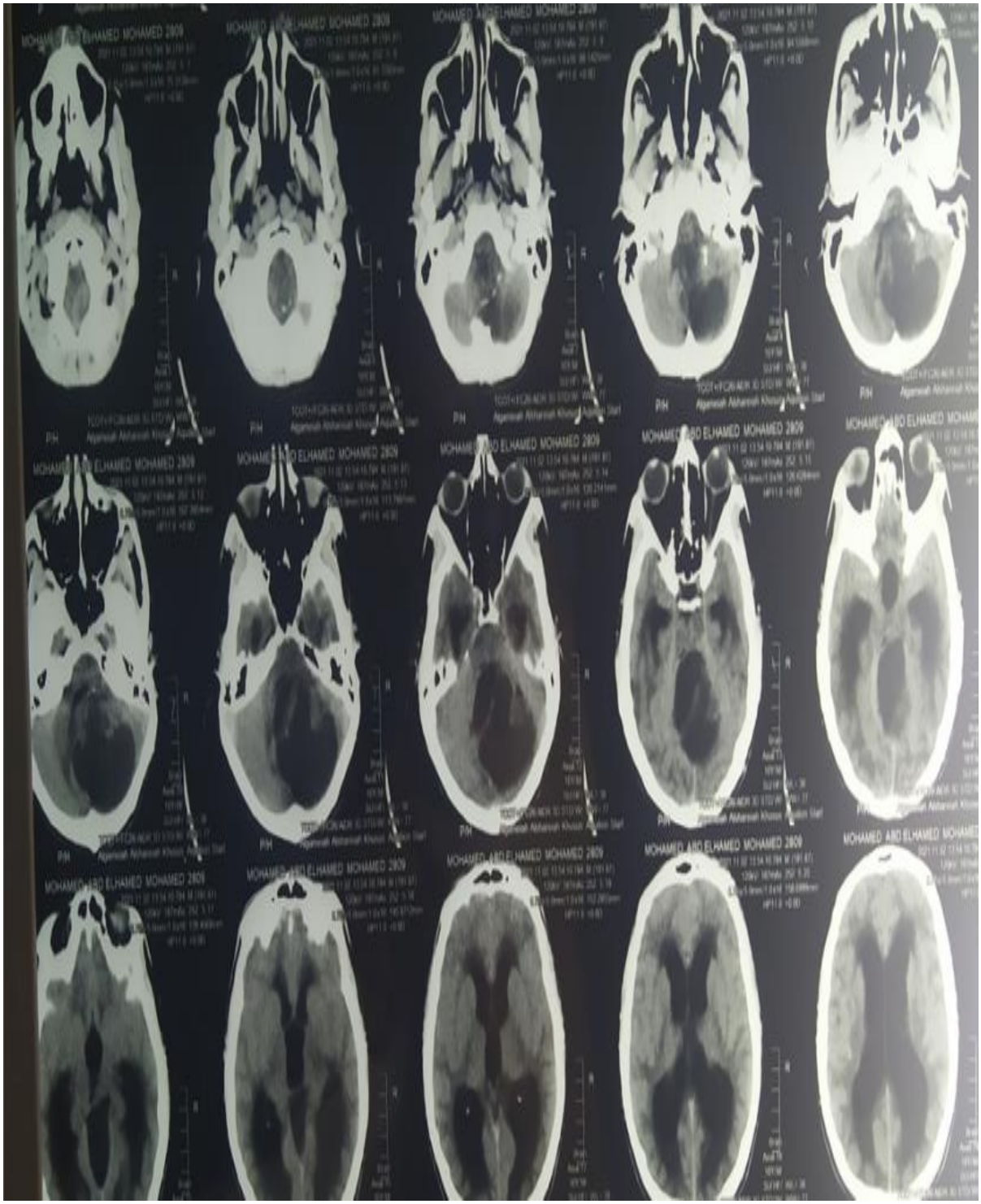

Figure (1): Preoperative CT brain without contrast, axial view.

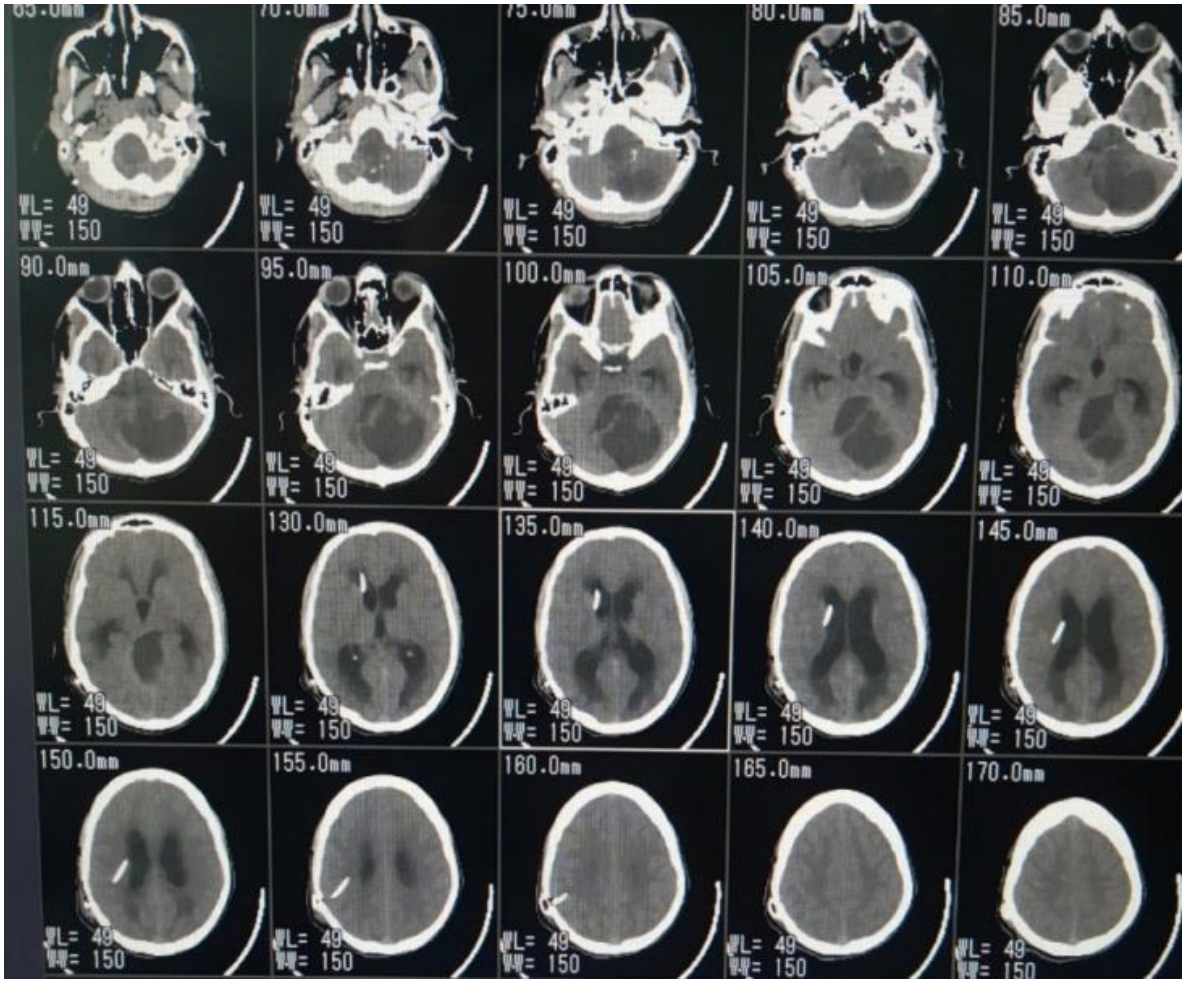

Figure (2): Post-operative CT brain after V-P shunt.

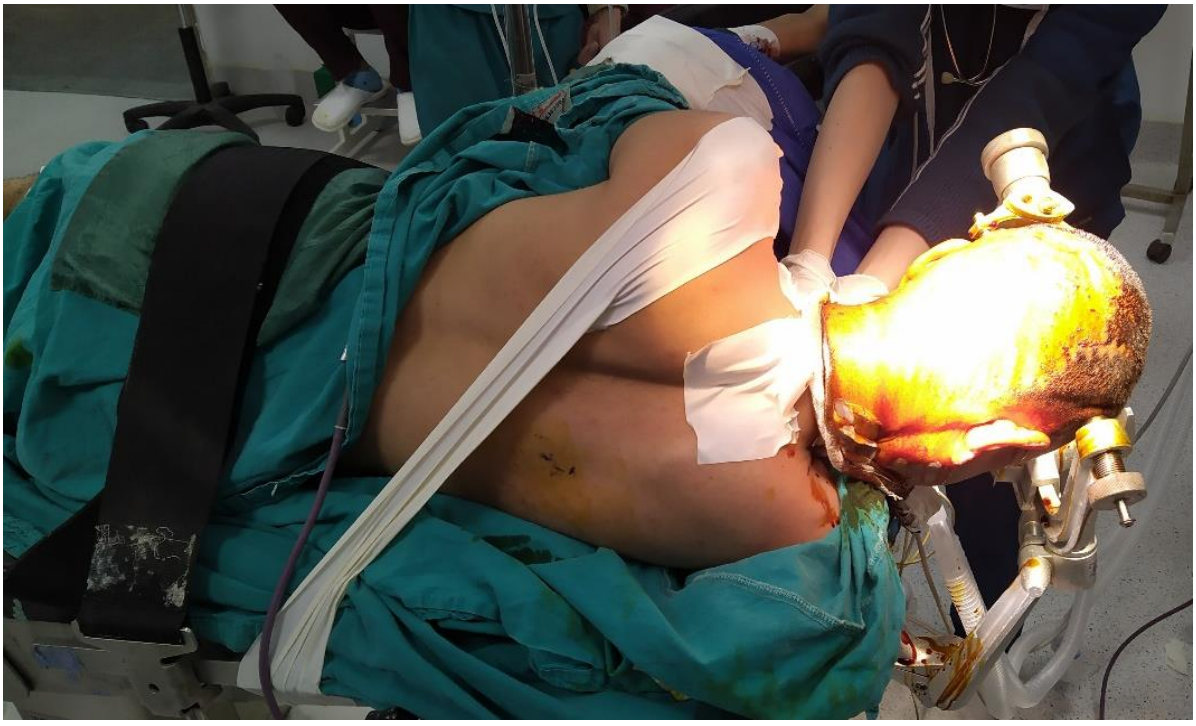

Figure (3): Park bench position during tumor excision.

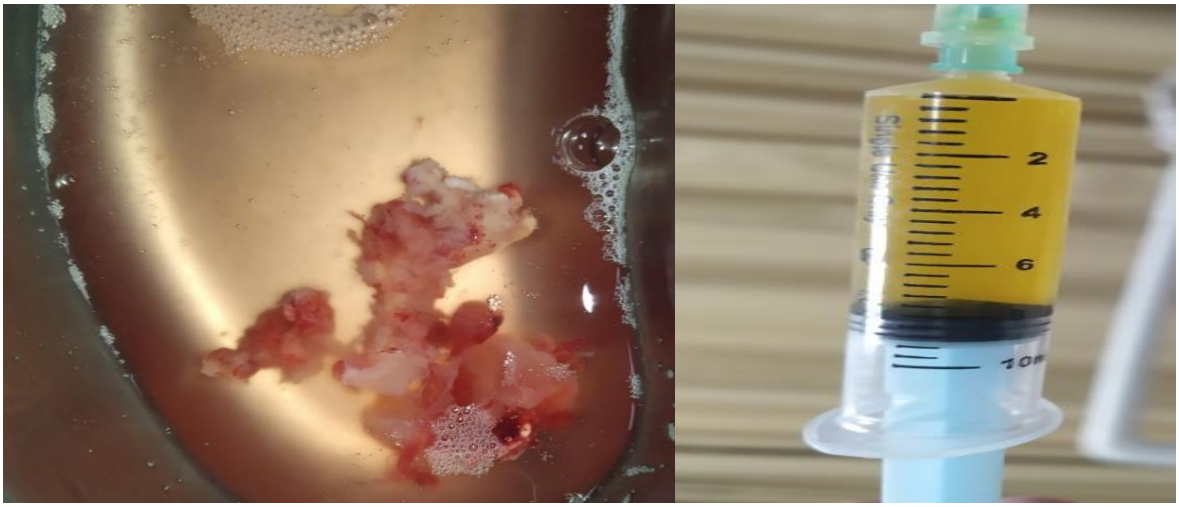

Figure (4): Gross feature of the tumor and cystic fluid.

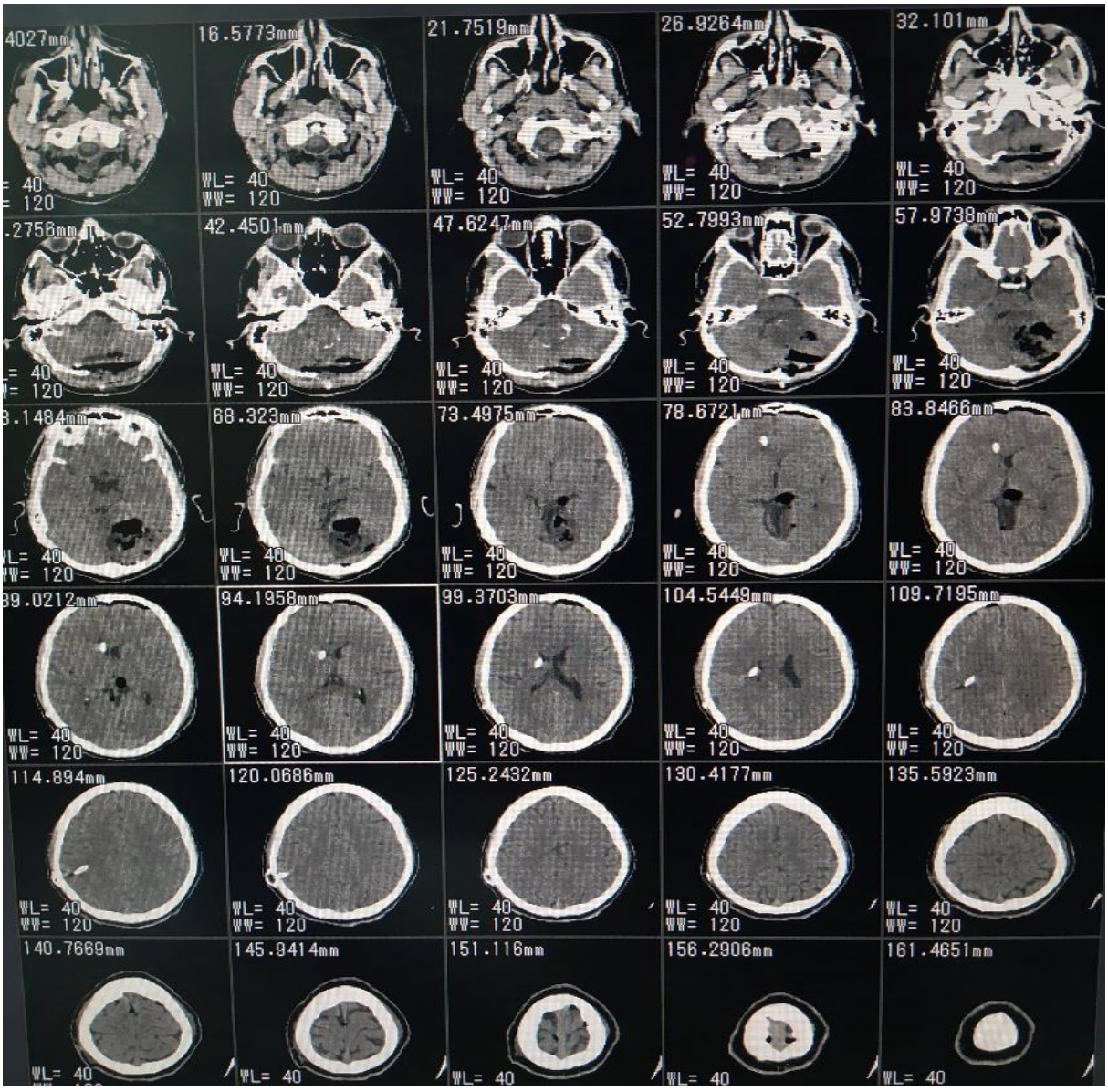

Figure (5): CT scan immediate post-operative tumor resection, axial view.

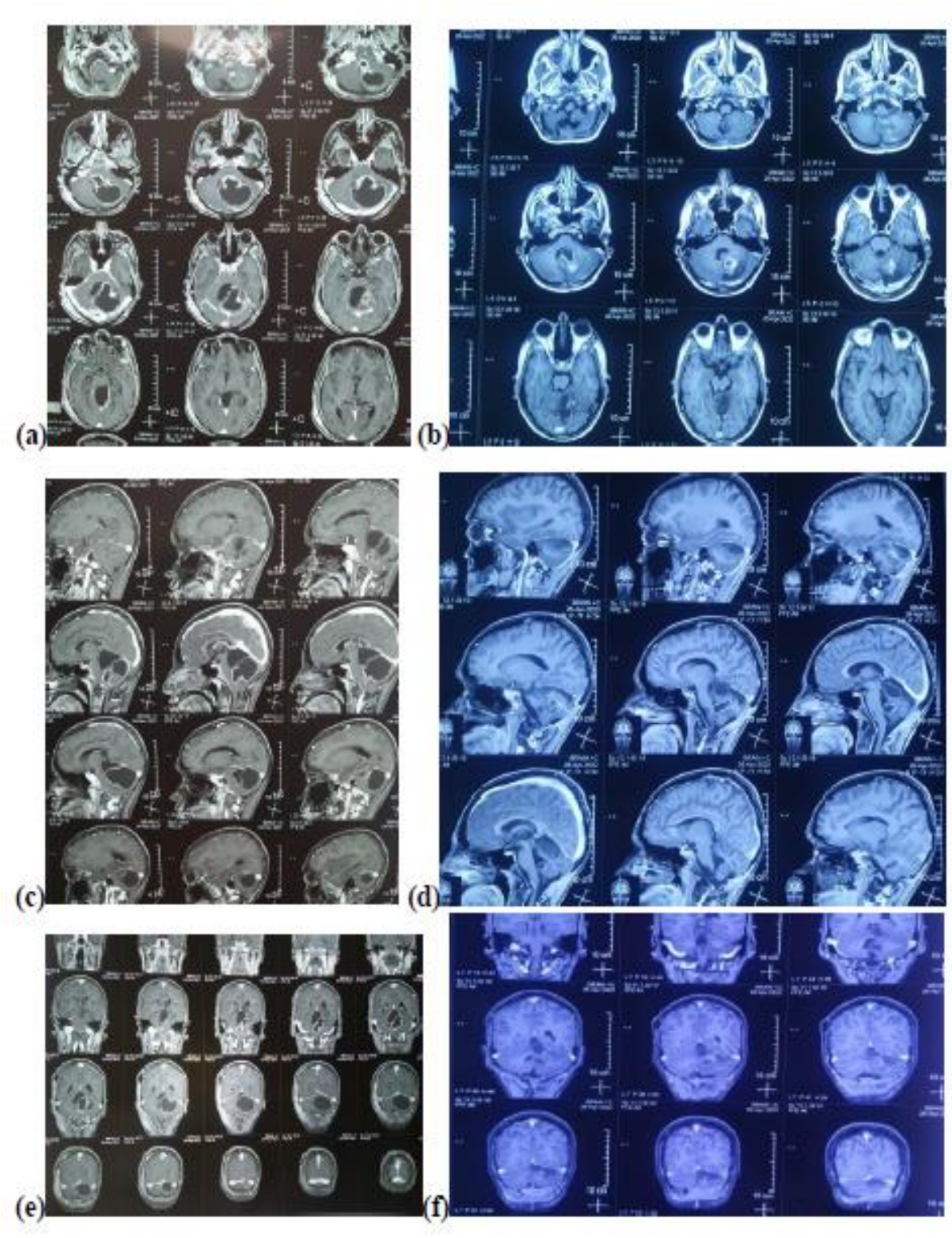

Figure (6): MRI brain with contrast preoperative and 6 months postoperative: (a) preoperative axial view, (b) postoperative axial view, (c) preoperative sagittal view (d) postoperative sagittal view (e) preoperative coronal view (f) postoperative coronal view.

3.2 Presentation of a case (2)

Male case, 4.5 years old Complained of ataxia & headache of 3 months duration. MRI brain with contrast show cerebellar SOL has cystic & solid parts. It was excised totally via transvermian approach. Histopathology was Pilocytic astrocytoma G I.

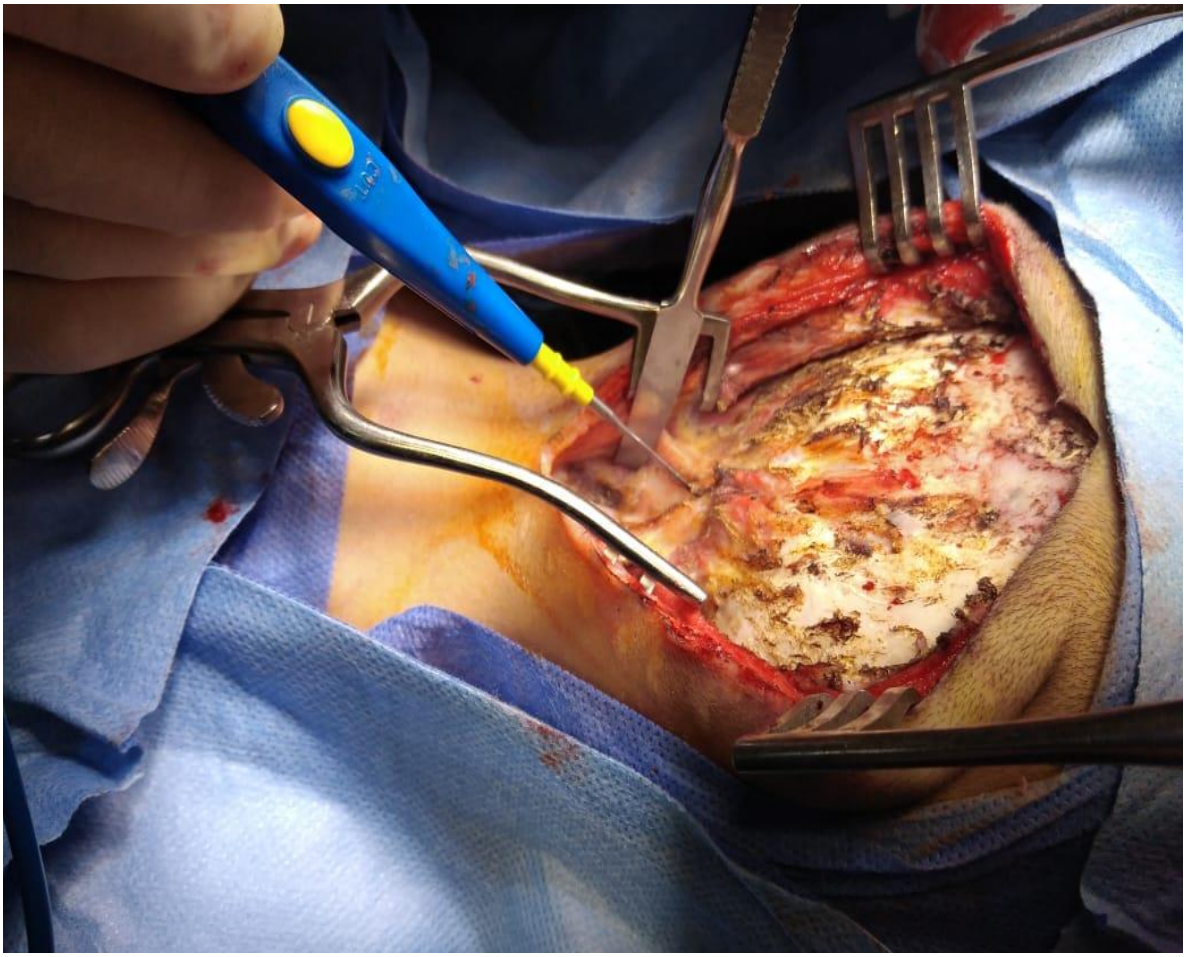

Figure (7): Prone position during tumor excision.

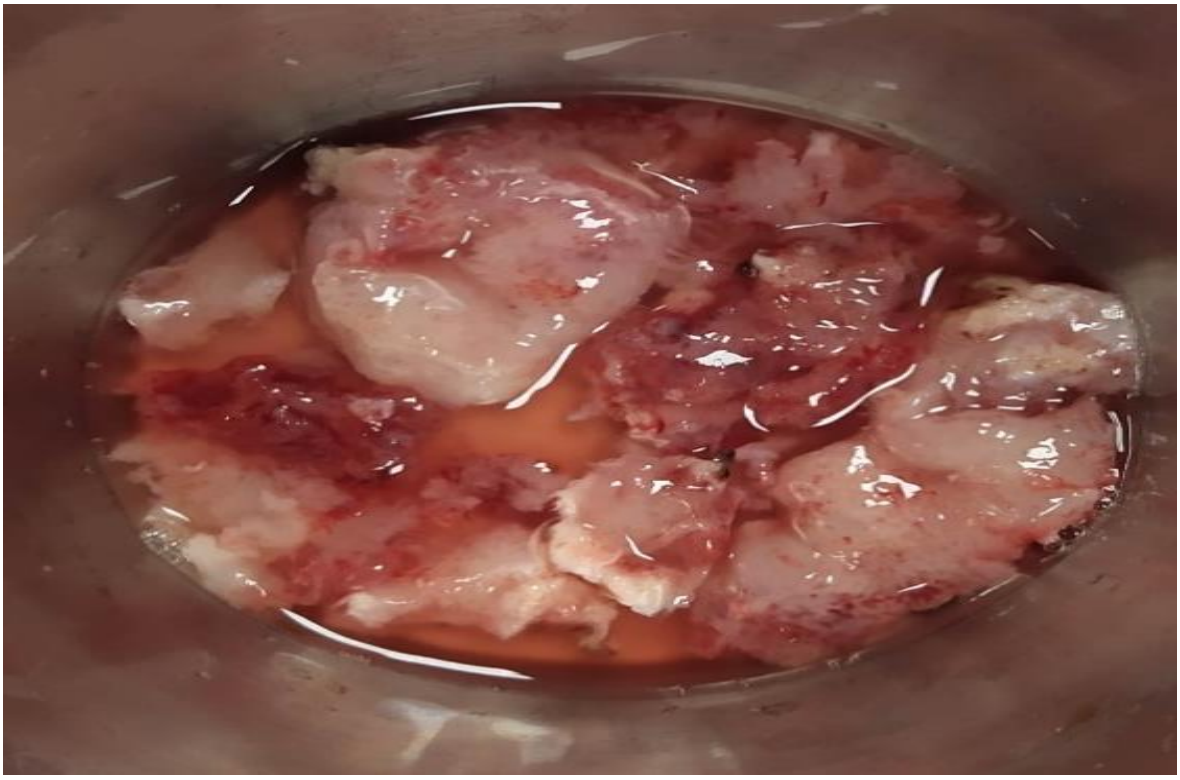

Figure (8): Gross feature of the tumor.

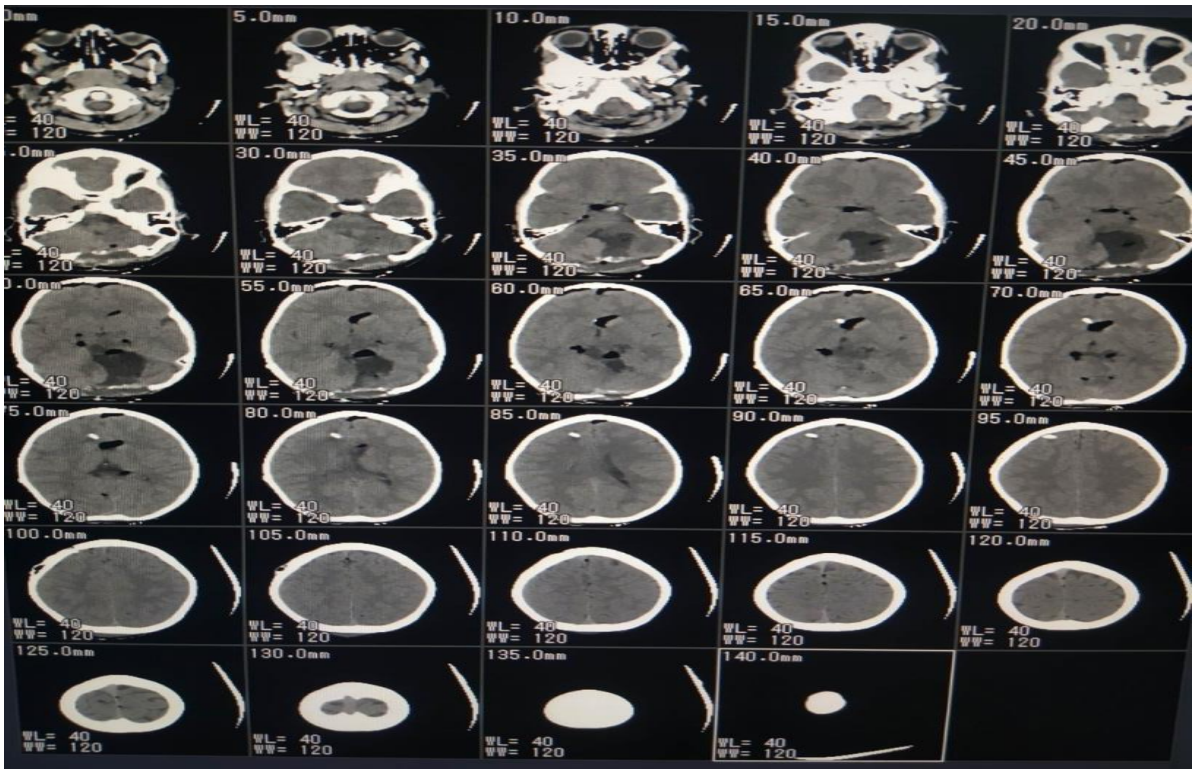

Figure (9): CT scan immediate post-operative tumor resection, axial view.

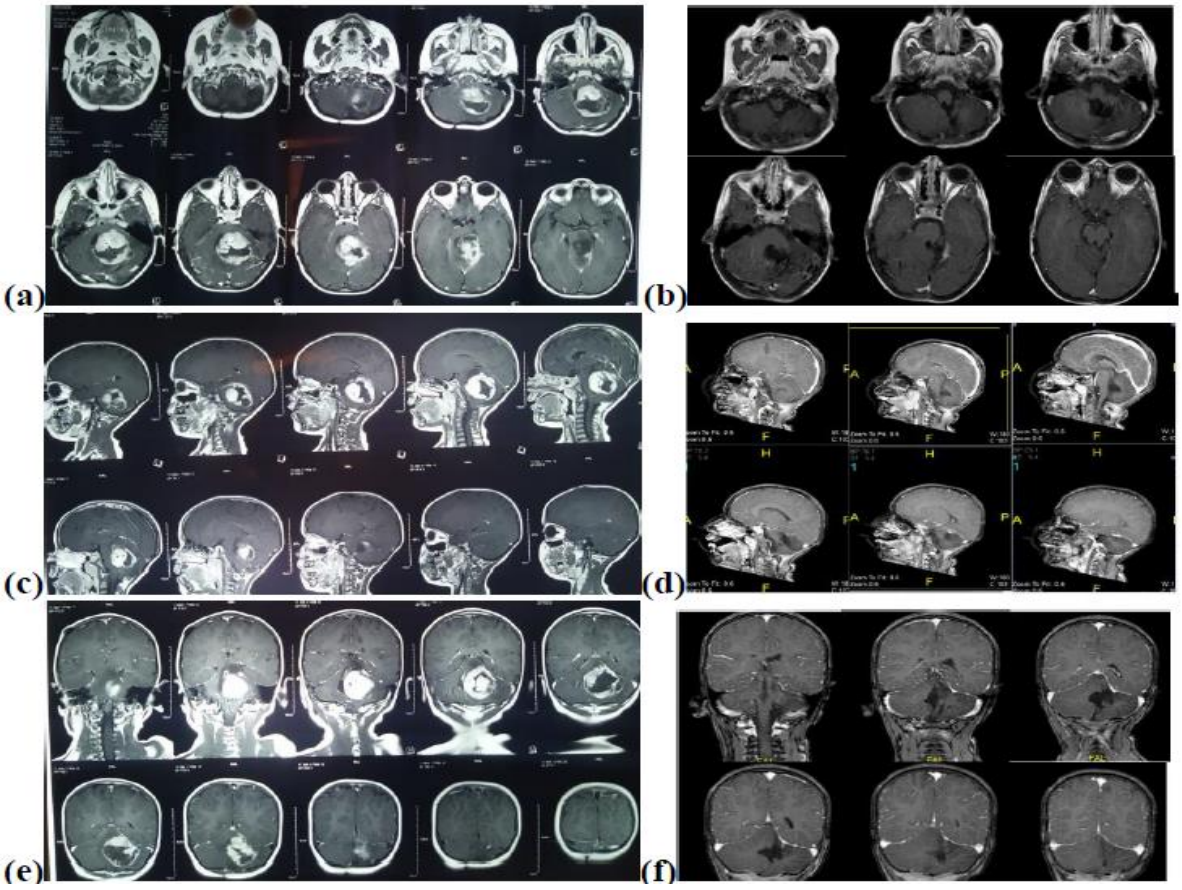

Figure (10): MRI brain with contrast preoperative and 6 months postoperative: (a) preoperative axial view, (b) postoperative axial view, (c) preoperative sagittal view (d) postoperative sagittal view (e) preoperative coronal view (f) postoperative coronal view.

4. Discussion

As regarding demographic data: In our study, we had 20 cases diagnosed with cerebellar pilocytic astrocytoma with mean age 14.43± 9.46 most of our cases were females 12(60%) with male, female ratio is two, three. One hundred percent of patients with posterior fossa astrocytoma were presented with headache, 85% presented with ataxia, and 80% presented with blurred vision, and 55% presented with nystagmus as their primary symptom.

Our findings are in line with those of **M.Emara et al.,** who studied 44 cases (with a 3:2 male to female ratio) and found that the most common initial symptoms were headache (90.9%) and vomiting (77%) [6]. However, a 2016 study by **Jiang et al.** involving 67 patients found that symptoms of increased intracranial tension, such as nausea or vomiting (69%), headache (29%), and cerebellar dysfunction, such as ataxia and diplopia (3%), were the most common clinical presentation [7]. Another 2016 study involving 45 cases found that headache (51%), nausea/vomiting (36%), visual disturbance (18%), and gait disturbance (18%) were the most frequently occurring symptoms [8]. The mean age of the 161 cases studied by **Roberti et al**. was 47 years old, and their ages ranged from 10 to 81 [9]. Our research showed that 9 (45%) of the tumors were located on the left cerebellum, followed by 6 (30%) on the right, and only 5 (25%) on the vermis. The average size of the tumors was 5.03±1.04 cm. In 12 (60%) cases, the lesion was predominantly cystic with mural nodules, while in 8 (40%) cases, the lesion was both cystic and solid. Sixteen (80%) patients exhibited hydrocephalic changes, while the other four showed no signs of condition.

Lesion was cystic in 15 patients (38.5%) and included both solid and cystic components in 16 cases (41%), which is consistent with our findings. The largest diameter of the tumor was between 2 and 7 centimeters. There was preoperative hydrocephalus in 31 patients, or 79.5% **Elwatidy S M et al.** [10] A study of 39 cases found that lesions occurred more frequently in the midline (56.4%), on the right cerebellar hemisphere (30.8%), and in the left cerebellar hemisphere (12.8%) than in the study by **Elwatidy S M et al.** [10]. Our protocol for treating cases who present with acute hydrocephalus in the form of increased intracranial pressure (ICP) symptoms like headache, vomiting and meningism includes preoperatively preparing the case for urgent V-P shunt, which was done in 7 (35%) cases, and postoperatively in 6 (30%) cases due to the presence of postoperative focal edema, hydrocephalic changes, and increased ICP. Similar to our study, **M.Emara et al**. inserted a V-P shunt pre or post tumor removal in 30 cases (68.2%) [6]. Another study found that 53 percent of cases had a V-P shunt placed [11]. **Shih et al** study found that 33% of patients required permanent CSF diversion [8]. Ten cases (50%) had an excellent outcome, and nine cases (45%) had a good outcome with no recurrence. One case in our series (5%) had a mediocre outcome because of tumor invasion into the brain stem, hydrocephalus that did not go away, and only partial removal of the tumor. Twelve cases in the M.Emara et al. report had a good surgical outcome (27.3%), twenty-two patients had a good outcome (50.0%), and ten cases had a poor surgical outcome (22.7%) [6]. Another study with a smaller sample size found that 77% of the 66 patients who underwent surgery had a good outcome, while 23% had a poor outcome (moderately disabled, unable to perform daily activities independently, or with a neurological deficit) [12]. This report had some limitations, including its short follow-up period and its low case volume .

5. Conclusion

It is still difficult for neurosurgeons to remove astrocytomas from the posterior fossa through surgery. If successful, GTR would be a cure for cerebellar pilocytic astrocytoma. If the patient requires pre-

operative insertion of a V-P shunt to reduce intracranial pressure (ICP) in conjunction with GTR of the tumor, the outcome is excellent. Cases with cerebellar pilocytic astrocytoma can expect a successful surgical outcome if the tumor is correctly diagnosed early on, microsurgical techniques are used, and the right surgical approach is chosen.

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Conflicts of interest: No competing interest

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