Ossified metaplastic meningiomas: A systematic review on a rare subset of “brain stones”

Federica Paolini a,1, Gianluca Scalia b,*,1, Francesca Graziano b, Giuseppe Emmanuele Umana c, Rosario Maugeri b, Domenico Gerardo Iacopino a, Giovanni Federico Nicoletti b

a Experimental Biomedicine and Clinical Neurosciences, School of Medicine, Postgraduate Residency Program in Neurological Surgery, Neurosurgical Clinic, AOUP “Paolo Giaccone”, Palermo, Italy
b Neurosurgery Unit, Highly Specialised Hospital and of National Importance “Garibaldi”, Catania, Italy
c Department of Neurosurgery, Cannizzaro Hospital, Trauma Center, Gamma Knife Center, Catania, Italy

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1. Introduction

Metaplastic meningiomas are rare entities, arising from the pluripotential arachnoid cap cells that can differentiate in different mesenchymal tissues (Johnson et al., 1989; Alafaci et al., 1999). They are classified as Grade 1 tumors according to the World Health Organization (WHO), with slow growth and prevalent spinal localization. Clinical symptoms are various, mostly depending on size and location (Tai et al., 2010). The authors report a rare case of a female patient that presented a status epilepticus after an abdominal surgery procedure with history of fronto-parietal extra-axial calcified mass. A systematic review of the relevant literature was also performed. The objective of this paper was to clarify the main characteristics of this rare meningioma subtype, focusing on aspects influencing surgical technique, to guide neurosurgeons on global approach of these patients.

2. Materials and methods

A systematic review of all the previously reported intracranial metaplastic meningiomas was performed according to the PRISMA guidelines (Preferred Reporting Items for Systematic reviews and Meta-Analysis) (Fig. 1).

Two authors (F.P. and G.S.) independently performed a search on PubMed and Scopus databases from 1989 to March 2022, using the following Mesh terms:

- “Metaplastic Meningioma AND brain” (25 results)
- “Ossified Meningioma AND brain” (12 results)
- “Ossified AND intracranial AND Meningioma” (17 results)
- “Metaplastic AND Meningioma” (84 results)
- “Osteoblastic AND Meningioma” (44 results)

According to PRISMA guidelines, the research order consisted of screening titles first, then abstracts and full papers (Fig. 1). Finally, the references of the articles included were screened. No automation software was used.

To be included, studies had to analyze a single or group of patients affected by metaplastic meningiomas, osseous subtype, with definitive histopathological analysis. No time limits were set up. Only English articles were selected. The authors aimed to investigate and highlight the
The current state of art in metaplastic meningiomas treatment, according to their rarity, focusing on indications and outcomes. A database based on the previously selected case reports or case series (11 studies) was created. (Table 1). Data extracted from each study were (1) authors, (2) year of publication, (3) study design, (4) number of patients included, (5) age, (6) sex, (7) symptoms, (8) neurological examination, (9) tumor location, (10) Simpson grade, (11) presence of calcification, (12) presence of psammoma bodies. Descriptive statistical analyses were conducted.

3. Results

A total of 182 studies were identified through the PubMed and Scopus databases, 140 articles after duplicates removal. First, articles were selected by the presence in their title of the words “Osteoblastic” or “metaplastic” or “ossified” (41 articles). Then, the authors rejected studies dealing with spinal meningiomas, or different histopathological subtypes (21 articles). After screening by title, 20 abstracts were screened, according to the selection criteria. Thus, 14 studies by full-text analysis were identified. 1 record was identified through references section screening. Finally, the authors included in the systematic review 11 articles, summarized in Table 1 (Johnson et al., 1989; Alafaci et al., 1999; Tai et al., 2010; Huang and Petersson, 2011; Barresi et al., 2011; Tang et al., 2013; Caffo et al., 2016; Indiran, 2017; Choi et al., 2018; Priyadharshini et al., 2020; Kim et al., 2020).

All the selected records were used to structure a unique database to evaluate surgical outcomes and histopathological features. Patients included were 26, 11 males, 14 females (1 not reported). The mean age was 47.81 ± 14.78 years (range 26–83). Symptoms and location were heterogeneous, not different from common meningiomas subtypes. 15 patients achieved a Simpson grade I after surgery (57.69%). 20 tumors had calcifications (76.92%), and 10 lesions (38.46%) formed psammoma bodies.

3.1. Case description

A 71-year-old female patient was admitted to our emergency department because she presented a status epilepticus with right hemisome motor seizures. The patient performed an anterior pelvectomy for a bladder cancer few days prior to symptoms presentation. She had a history of a calcified left fronto-parietal extra-cerebral lesion, unmodified during previous follow-ups.

Neurologic examination showed right brachio-cranial weakness (BMRC 3/5), right hemisome brisk reflexes, right hemisome hypolgesia.

She performed a brain MRI that documented a left fronto-parietal extra-cerebral lesion with 40 × 35 mm in axial diameters, with ring peripheral enhancement on Gd-T1WI (Fig. 2) and focal left frontal anterior hypointensity on FLAIR sequences. A brain CT scan was also performed, showing a completely calcified lesion (Fig. 2).

She was planned for operative management. Under general anesthesia, in supine position with head fixed in Mayfield holder. The patient underwent left fronto-parietal craniotomy. Dura mater appeared thickened, calcified, and was removed with a circumferential durotomy. Intraoperatively, she had a hard calcified nodule of 3.5 × 3 × 2 cm extra-axially over the left fronto-parietal region, compressing motor area. The lesion was firmly attached to the dura mater; a gently arachnoid dissection with cottonoids was performed, and the lesion was removed en-bloc (Fig. 3).

Intraoperative neurophysiological monitoring showed mild MEPs improvements at the end of surgical procedure. Histologic samples documented a metaplastic ossified meningioma, with psammoma bodies. (WHO grade 1). Post-operatively, the patient showed a complete subsidence of seizures, and a partial regression of the motor deficits (BMRC 4/
4. Discussion

Metaplastic meningiomas are slow-growing tumors, classified as Grade 1 according to WHO classification. The originating arachnoid cell passes through a mesenchymal differentiation into osseous, cartilaginous, smooth muscle, xantomatous of lipomatous tissues, alone or in combination (Alafaci et al., 1999; Tai et al., 2010). These represent 4 different entities of the same subtype. As we know, 26 cases of intracranial ossified metaplastic meningiomas have been previously reported in literature (Table 1).

The diagnosis is not different from the other meningiomas subtypes (Johnson et al., 1989; Barresi et al., 2011; Caffo et al., 2016; Indiran, 2017; Choi et al., 2018; Priyadharshini et al., 2020; Kim et al., 2020). In fact, the most common presenting symptoms are headache (12/26) and seizures (6/26). Neurological examination of patients affected is strictly related to the tumor location. The most frequent locations were convexity (9/26) and skull base (7/26). Brain CT scan examination is mandatory, because the features of ossified meningiomas in MRI is not typical (Huang and Petersson, 2011). In case of a hard rock appearance of this meningioma subtype, a Simpson Grade I is often challenging, especially in skull base lesions (Alafaci et al., 1999). As regard superficial lesions in non-eloquent areas, the attempt to gain GTR is

Table 1

| No | Authors/Year          | N of patients | Age (years), Sex | Symptoms                                      | Neurological Examination | Location                | Simpson Grade | Calcification | Psammoma Bodies |
|----|-----------------------|---------------|------------------|-----------------------------------------------|--------------------------|-------------------------|---------------|---------------|-----------------|
| 1  | Johnson et al., 1989  | 1             | 53, M            | Dizziness, Blurred vision, Headache           | Negative                 | 4th ventricle           | I             | Yes           | Yes             |
| 2  | Alafaci et al., 1999  | 1             | 28, F            | Headache, headache, diplopia                  | Left lateral emianopia   | Right lateral ventricle | I             | Yes           | Yes             |
| 3  | Tai et al., 2010      | 1             | 60, M            | N.R.                                          | Headache, left limbs     | Right frontal lobe      | I             | Yes           | No              |
| 4  | Barresi et al., 2011  | 5             | 37, F            | Headache, seizures, subjective vertigo        | Negative                 | Left temporo-basal      | I             | Yes           | Yes             |
| 5  | Huang and Peterson, 2011 | 1            | 55, F            | Headache, Generalized tonic-clonic seizures   | Negative                 | Clinoitd                | I             | Yes           | Yes             |
| 6  | Tang et al., 2013     | 6             | 41, M            | Headache                                      | N.R.                     | Right Lateral ventricle | I             | Yes           | N.R.            |
| 7  | Caffo et al., 2016    | 4             | 83, F            | Headache, neurologic delay                    | Right hemiparesis, right| Left frontobasal        | III            | Yes           | Yes             |
| 8  | Indiran et al., 2017  | 1             | 33, M            | Headache                                      | N.R.                     | Left frontobasal        | I             | No            | Yes             |
| 9  | Choi et al., 2018     | 1             | 26, M            | Intermittent right upper extremity weakness   | right Babinski sign      | Left parietal           | II            | Yes           | N.R.            |
| 10 | Priyadharshini et al., 2020 | 1          | 28, M            | Headache                                      | Negative                 | Left parieto-occipital  | N.R.          | Yes           | Yes             |
| 11 | Kim et al., 2020      | 4             | 60, F            | Blurred vision                                | N.R.                     | Anterior falx           | I             | Yes           | N.R.            |
|    |                       |               | 62, M            | Headache                                      | N.R.                     | Midline frontobasal     | I             | Yes           | N.R.            |
|    |                       |               | 37, F            | Seizures                                      | N.R.                     | Right frontal           | IV            | Yes           | N.R.            |
|    |                       |               | 55, F            | Headache                                      | N.R.                     | Midline falx            | IV            | Yes           | N.R.            |
often performed by using en bloc resection, after gentle arachnoid dissection. In cases of location in eloquent regions, or involvement of nerves or great vessels, a piecemeal resection using high-speed drill, Kerrison rongeurs and pounches is the best surgical approach (Alafaci et al., 1999). Often, leaving a residual fragment is the only chance, as seen in 7 patients of the present review. Considering the case series by Tang et al., during a 2-year follow-up, a low rate of recurrence was documented (only 2 cases) (Tang et al., 2013).

The presence of calcification is often matched by the presence of psammoma bodies. Nonetheless, Huang et al. reported a rare case of ossified metaplastic meningioma with several calcified areas and wire-like streaks of calcification, forming patterns reminiscent of chicken...
wires (Huang and Petersson, 2011). Considering their rarity, differential diagnosis is mandatory, including osteoma, osteoblastoma, fibroma, even calcified giant aneurysms (Alafaci et al., 1999).

5. Study limitations

The present review has several limitations. First, papers included in systematic review are case reports or case series, and the level of evidence is scant. Moreover, general approach to the patient, surgical techniques, complications rate, long term outcome, are features not globally highlighted in the previous literature.

6. Conclusion

Metaplastic meningiomas are rare entities, classified as Grade I according to WHO. Their existence must be considered because of their unicity in a multimodal approach and tailored surgical technique.

Ethics approval

There is no ethical issue in this paper.

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Patient consent

Patient gave her consent for images or other clinical information reported in the paper.

Declaration of competing interest

There are no conflicts of interest.

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Fig. 4. Post-operative brain MR scan demonstrating the complete removal of the calcified mass.