Intraosseous Schwannoma of the Upper Extremity A Single Institutional Experience and Review of Literature

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Swiss Journal of Radiology and Nuclear Medicine - www.sjoranm.com - SJORANM GmbH - Rosenweg 3 - CH-6340 Baar - Switzerland

Abstract

Introduction

Schwannomas are benign soft tissue tumors of neural origin, predominantly occurring in the head and neck regions due to their rich innervation. Intraosseous Schwannoma (IOS) is an exceedingly rare form of Schwannoma. This study

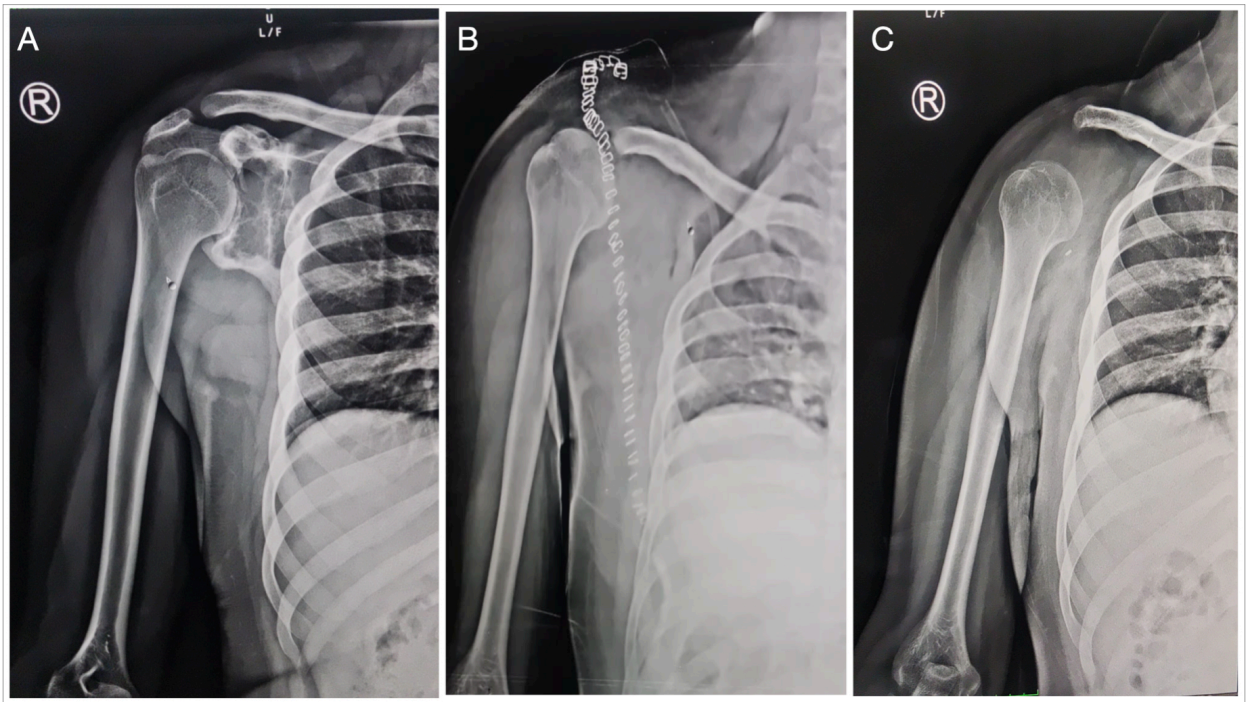


Fig.1: (A) Anteroposterior views of the shoulder showing a well defined osteolytic lesion with sclerotic borders. (B) Immediate post operative radiograph following total scapulectomy surgery. (C) At 4 years follow-up following total scapulectomy surgery

aims to enhance the understanding of intraosseous Schwannoma by reviewing cases affecting the upper extremity bones and providing a detailed analysis of their radiographic and magnetic resonance imaging (MRI) characteristics along with a review of the literature on these rare tumors.

Material and Methods

A total of three patients with IOS in upper extremity bones were identified and analyzed. Radiographs and MRI scans were available for all patients. A comprehensive literature review was conducted, including case reports, retrospective studies, and reviews of published data. The epidemiology, anatomical distribution, radiographic characteristics, histological findings, and therapeutic outcomes of intraosseous schwannoma were all investigated, identifying 31 documented cases of IOS involving extremity bones.

Results

Intraosseous Schwannomas primarily affect the mandible, followed by the sacrum and vertebrae. Patients frequently present with non-specific symptoms such as localized pain, swelling, or neurological impairments, which can lead to delayed diagnosis. Radiographic evaluation of IOS typically reveals lytic lesions with well-defined, expansile features and thin sclerotic rims. MRI findings showed that IOS lesions appeared low to iso-intense on T1-weighted images

*Corresponding author: Abhijeet Ashok Salunke - received: 30.05.2024 - peer reviewed, accepted and published: 09.06.2024

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and hyper-intense on T2-weighted images. These imaging characteristics are crucial for differentiating IOS from other lytic bone lesions. Histologically, the presence of Antoni A and Antoni B patterns, as well as S-100 protein positivity, confirms the diagnosis. Surgical management, consisting of curettage, provides a favorable prognosis and low recurrence rates.

Conclusion

Despite its rarity, intraosseous Schwannoma should be considered in the differential diagnosis of well-defined, expansile lytic bone lesions, particularly those with thin sclerotic rims. This review provides the most comprehensive analysis to date of IOS affecting extremity bones, emphasizing the importance of recognizing this entity in clinical practice.

Keywords: Intra-osseous Schwannoma, IOS, Upper Extremity, Upper Limb Tumors, Schwannoma of *Bones*

Introduction

Schwannoma, also known as neurilemmoma, is a benign soft tissue tumor that arises from the Schwann cells of the neural sheath.(1) It accounts for nearly 5% of all benign soft tissue tumors. The most affected regions are the head and neck, which are rich in spinal and cranial nerve supply. (2,3)

Intraosseous Schwannoma (IOS), a rare form of schwannoma, constitutes only 0.2% of all primary bone tumors. (3) The proposed mechanism for its intraosseous origin is the proximity of nerve fibres to blood vessels within the medullary canal of the bone.

IOS can affect bones through three possible pathways:
(a) direct origin from within the bone
(b) origin from the nutrient canal
(c) from nearby soft tissue leading to bony erosion. (4,5)

The head and neck region, particularly the mandible, is most commonly involved, followed by the maxilla, petrous bone, spine, and, less frequently, long bones such as the tibia, fibula, radius, and ulna. (6,7)

IOS is often associated with conditions such as Carney syndrome or Neurofibromatosis-1 (NF-1) (8,9). Given the rarity of this entity, histopathological examination is crucial for a definitive diagnosis (9).

In this study, we present three cases involving the 5th metacarpal, proximal ulna, and scapula to demonstrate the clinical and radiological features and treatment options for Intraosseous schwannoma (IOS). To the best of our knowledge, the literature on IOS is limited to case reports and small case series. This case series aims to highlight the various bones of the extremities affected by this rare lesion, differentiate it from other bone lesions, and discuss the best available treatment options.

Case Presentation

Case 1:

A 20-year-old male presented to an outpatient clinic with pain and swelling around his right shoulder, persisting for six months. The swelling had progressively worsened over the past one and a half months. He had no family history of similar issues, no history of trauma, and no medical comorbidities.

Clinical Examination:
Clinical examination revealed swelling on the dorsum of the little finger with tenderness on pressure. There was no warmth, redness, or neurovascular deficit observed around the medial aspect of the hand.

Imaging:
- X-rays (Anteroposterior and Lateral Views) Showed a well-defined lytic lesion with a cortical breach on the medial border of the shoulder. No periosteal reaction, calcification, or abnormal soft tissue was observed. (Fig.1 A)
- Magnetic Resonance Imaging (MRI): Revealed an intraosseous lesion involving the entire scapula, extending into the soft tissue on both the dorsal and volar aspects of the shoulder. The lesion displayed similar signal intensity to surroun-ding muscle on T1-weighted images, but brighter signal intensity on T2-weighted images.

Biopsy:
A core needle biopsy was performed in the planned incision line. Histopathological examination showed spindle-shaped cells arranged in fascicles. Both Antoni-A and Antoni-B cells,

characteristic of a schwannoma, were present. There were no signs of necrosis, excessive mitosis, or abnormal nuclei.

Immuno-histochemistry (IHC):
Immunohistochemical staining for S-100 and SOX10 proteins was performed, showing positive staining throughout the sample, further supporting the diagnosis of schwannoma.

Treatment:
Surgery was planned, and a posterior skin incision was made to perform a total scapulectomy. The proximal humerus was then fixed to the clavicle using prolene mesh and non-absorbable sutures (Fig.1B). Post-surgery, the shoulder was immobilised for 3-4 weeks, followed by physical therapy to gradually restore abduction, adduction at the shoulder joint, and flexion and extension movements at the elbow joint.

Follow-up:
The patient was monitored both clinically (through physical examination) and radiologically (with X-rays or other imaging). Follow-ups were conducted monthly for the first 3 months and then every 3 months for 1 year. At 60 months post-surgery, there were no signs of recurrence (Fig.1 C).

Case 2:

A 27-year-old woman presented to an outpatient clinic with a complaint of pain and swelling around her right elbow for six months. The symptoms had gradually worsened over the past month. She had no family history of similar issues, no history of trauma, and no medical comorbidities.

Clinical Examination:
The clinical examination revealed swelling on the posterior aspect of the elbow, with tenderness on pressure. There was no warmth, redness, or neurovascular deficit observed around the elbow joint.

Imaging Studies:
- X-ray (Anteroposterior and Lateral View):
Showed a soap bubble-appearing lytic lesion with ill-defined margins in the proximal epimetaphysis of the ulna. (Fig.2A) There was no associated cortical breakdown or soft tissue involvement. Based on this finding, a giant cell tumor was a differential diagnosis.
- Magnetic Resonance Imaging (MRI):
Showed a well-defined lesion with iso- to hypointense signal on T1-weighted images and hyperintense signal on T2-weighted/STIR images. No cortical breakdown or soft tissue involvement was noted (Fig. 2B,C,D).
- Radionuclide Sestamibi Scan:
Performed to rule out brown's tumor due to an elevated parathyroid hormone (PTH) level of 84.1 pg/ml. The scan was negative, and no parathyroid adenoma was found.

Histopathological Examination:
A core needle biopsy was performed along the line of a future incision. The histopathological examination revealed spindle cells arranged in bundles and fascicles, with the presence of both Antoni-A and Antoni-B cells. There was no necrosis, mitosis, or nuclear atypia. Immunohistochemistry for S-100 and SOX10 showed diffuse positivity.

Surgical Intervention:
Surgery was planned using a posterior approach to the olecranon for extended curettage. The defect was filled with calcium hydroxyapatite crystals. The elbow was immobilised in a slab for four weeks. Physiotherapy was initiated to regain movement in the elbow joint, starting with flexion and extension, followed by pronation and supination.

Follow-Up:
Follow-up was conducted both clinically and radiologically. The patient was reviewed monthly for the first three months, followed by every three months for one year. At 15 months post-surgery, there were no signs of recurrence based on clinical examination and radiograph (Fig. 3 A,B).

Case 3:

A 24-year-old male presented to an outpatient clinic with complaints of pain and swelling around his right little finger for four months. The swelling had gradually worsened over the past two months. There was no family history of similar issues, no history of trauma, and no medical comorbidities.

Clinical Examination:
Clinical examination revealed swelling on the dorsum of the little finger, with tenderness on pressure. There was no warmth, redness, or neurovascular deficit observed around the medial aspect of the hand.

Imaging Studies:
- X-rays (Anteroposterior and Oblique Views):
Showed a well-defined lytic lesion with a cortical break involving the head of the fifth metacarpal bone. (Fig.4A) Additionally, there was a dislo-

cation of the joint between the metacarpal and the first phalanx. There was no periosteal reaction, calcification, or abnormal soft tissue observed on the X-ray.
- Magnetic Resonance Imaging (MRI): Revealed an intraosseous lesion involving the head of the fifth metacarpal. The lesion extended into the soft tissue on both the dorsal and volar aspects of the metacarpal. The lesion exhibited similar intensity to surrounding muscle on T1-weighted images and a brighter intensity on T2-weighted images (Fig.4B,C,D).

Histopathological Examination:
A core needle biopsy was performed along the planned incision line. Microscopic examination of the tissue showed spindle-shaped cells arranged in fascicles. Both Antoni-A and Antoni-B cells, characteristic of a specific type of tumor, were present. There were no signs of necrosis, mitosis, or abnormal nuclei. Immunohistochemical Staining (IHC) for S-100 and SOX10 proteins was performed, revealing positive staining throughout the sample, which supported the diagnosis.

Treatment:
Surgery was planned using a dorsal approach to access the metacarpal bone for extended curettage. Postoperatively, a cock-up splint was applied to the hand for four weeks to immobilise it. Physical therapy was then initiated to gradually restore flexion and extension movement of the metacarpo-phalangeal joint of the little finger.

Follow-Up:
The patient was monitored both clinically through physical examination and radiologically with imaging to track progress. Follow-up visits were conducted monthly for the first three months, followed by every three months for a year. At 13 months post-surgery, there were no signs of recurrence (Fig.5).

Results
In this study, three patients were diagnosed with intraosseous Schwannoma (2 males and 1 female). The study showed a male predilection, with the mean age of the group being 23,66 years (range 20-27 years). The presenting symptoms were pain and swelling in all cases. The mean follow-up was 17 months. Extended curetage was performed in 2 out of 3 cases (66.6%), and total scapulectomy was performed in 1 out of 3 cases (33.3%). There were no complications, and none of the patients had recurrence at the last follow-up.

Review of Literature
We conducted a search of PubMed and Google Scholar using the keywords "intraosseous schwannoma", "extremity bones", and "long and short bones". Our search covered publications from 2010 to 2023 and included all types of studies (1-40).

Discussion
Schwannoma, or neurilemmoma, is a benign tumor originating from Schwann cells, typically arising in sensory nerves due to the higher number of Schwann cells surrounding the axons. In 1923, Masson coined the term ‘Schwannoma’ to distinguish these from neuromas and other peripheral nerve sheath tumors. The involvement of intraosseous regions in Schwannomas is rare. A study by Knight et al. reviewed 234 cases and found 170 cases (73%) in the upper limbs, 64 cases (27%) in the lower limbs, and only six cases (2.6%) within bone or muscle.

This case series presents the clinical and imaging findings of three cases. (Table 1) We combined our findings with those from existing literature to enhance understanding of the clinical and radiological features and to guide the management of these rare entities. The most common presenting symptoms are pain and swelling around the affected area, with a long history and slow onset. Some reports also mention sensory or motor involvement and pathological fractures as presenting complaints. The usual age of presentation is between the 2nd and 5th decade of life, with females more commonly affected. In our study, we evaluated 35 patients with a female-to-male ratio of approximately 3:1 (25:9).

We conducted a search of PubMed and Google Scholar using the keywords "intraosseous Schwannoma", "extremity bones", and "long and short bones" and our search showed 31 studies on this topic (Table 2). The most commonly affected long bones in our study were the femur, followed by the tibia, and then the humerus and scapula. Radiographically, intraosseous schwannoma appear as well-defined osteolytic lesions with a lobulated appearance, a thin rim of sclerosis, a narrow zone of transition, and cortical expansion or erosion. MRI findings show that these lesions are hypointense to isointense relative to surrounding tissues on T1-weighted images and hyperintense on T2-weighted images. A characteristic MRI feature is the "target sign", where Antoni-B cells (hypo-cellular) surround Antoni-A cells (hyper-cellular), though this is more common in soft tissue schwannoma. None of our cases exhibited the target sign.

Due to their nonspecific symptoms and rarity, diagnosing these tumors can be challenging. Histopathological examination (HPE) and immuno -histochemistry (IHC) are crucial for diagnosis. HPE typically reveals Antoni-A and Antoni-B areas with spindle cells, and IHC shows S-100 protein positivity, which is characteristic of Schwannoma.

The treatment of choice for these tumors is curettage, followed by filling the defect with bone graft, allograft, or bone cement. In cases presenting with pathological fractures, fixation is also required along with curettage and defect filling. These tumors generally have a good prognosis, with only one case of malignant transformation reported to date. Local recurrence is commonly due to incomplete removal, whereas complete removal usually prevents recurrence.

The present study has limitations due to its retrospective design and small sample size; however, it can aid researchers in developing a multicenter investigation.

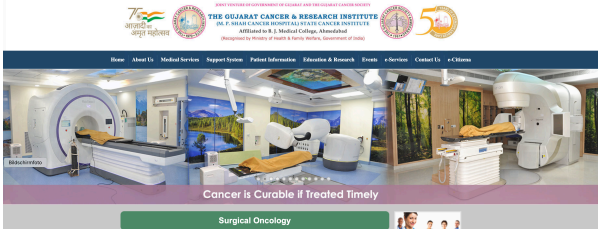
Conclusion

In this series, we evaluated three patients along with 31 cases involving upper and lower limb bones. To the best of our knowledge, this is the most comprehensive collection of isolated appendicular skeleton bones affected by IOS.

Whenever radiographs reveal a lobulated area with an osteolytic lesion surrounded by a sclerotic rim, IOS should be looked into as a potential differential diagnosis, nonetheless it is uncommon. On magnetic resonance imaging, the lesion appears isointense to hypointense on T1-weighted sequences and hyperintense on T2-weighted sequences in comparison to the surrounding tissue.

Histopathological examination (HPE) must be performed for a definitive diagnosis, which reveals typical Antoni A and B cells positive for S-100 protein. The most appropriate treatment for this rare tumour is curetage followed by filling the defect with bone graft, bone graft alternatives, allografts, or bone cement.

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Conflict of interest:

The authors declare that there were no conflicts of interest within the meaning of the recommendations of the International Committee of Medical Journal Editors when the article was written.

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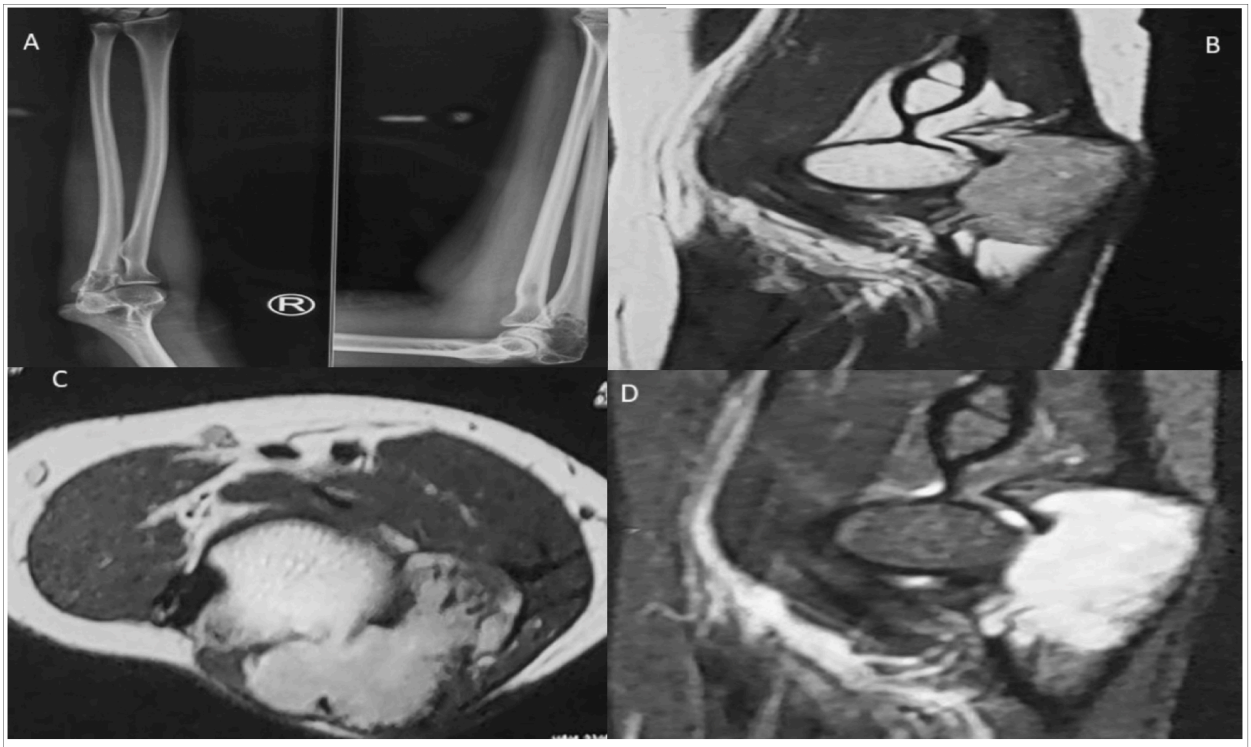


Fig.2: (A) Anteroposterior and lateral views of the elbow joint show a lytic lesion with a sclerotic margin involving the proximal part of the ulna.
(B, C, D) Sagittal and axial sections of magnetic resonance imaging of the elbow joint show an expansile lytic lesion involving the proximal part of the ulna with a medial cortical breach



Fig.3: (A) Radiograph showing antero-posterior view at 1 year follow-up following curetage of right proximal ulna intraosseous schwannoma
(B) Radiograph showing lateral view at 1 year follow-up following curetage of right proximal ulna intraosseous schwannoma
(C) At 1 year followup functional outcome following curetage and bone graft substitute surgery for right proximal ulna intraosseous schwannoma



Fig.4: (A) Anteroposterior and oblique views of the hand with wrist show a osteolytic lesion involving the fifth metacarpal head with dislocation on the dorsal aspect. (B, C, D) Coronal and axial sections of magnetic resonance imaging of the hand show an expansile lytic lesion involving the fifth metacarpal with soft tissue extension on both the ventral and dorsal aspects of the metacarpal bone.



Fig.5: Radiograph of right hand at 1 year follow-up following curetage of 5th metacarpal bone intraosseous schwannoma

No	Age & Gender	Affected Bone	Radiograph	Computed Tomography (CT-Scan)	Magnetic Resonance Imaging (MRI)	Treatment	Follow -up
1	20 yrs M	Scapula	Shows well defined lytic lesion with thin sclerotic rim involving glenoid	Shows expansile lytic lesion with cortical breach at multiple sites involving glenoid part of scapula	Shows low to isointense lesion on T1-weighted images, hyperintense lesion on T2-weighted images	Total Scapulec-tomy	60 months
2	27 yrs F	Proximal ulna	Well defined lytic lesion with thin rim of sclerosis involving proximal ulna	-	Shows low to isointense lesion on T1-weighted images, hyperintense lesion on T2-weighted images	Extended curetage + hydroxy-appatite crystals	15 months
3	24 yrs M	Fifth meta-carpal	Shows expansile lytic lesion involving metacarpal head with dislocation of 5th metacarpo-phalangeal joint	-	Shows low to isointense lesion on T1-weighted images, hyperintense lesion on T2-weighted images lesion involving 5th metacarpal with soft tissue component both on dorsal and ventral aspect	Extended curetage	13 months

Table 1: Study characteristics of patients with upper extremity intraosseous Schwannoma (IOS)

S.No	Study	Age,Sex	Side	Affected Bone	Cheif Complaint	Radiograph	CT-scan	MRI	Treatment	Follow-up
1	Sun et al [10] (2023)	29yrs,M	R	Radius	Painless mass around lateralaspect of forearm since 4months.	shows lesion involving distal end of radius extending upto ulnar aspect.	showing relation of bone with tumor	showing invasion by tumor and it nearly measures around 4.8x3.7x3.6cm	Wide local excision+ iliac bone flap(via 3D-image reconstruction)	12 months
2	Salunkhe R et al [11] (2012)	42yrs,M	L	Calcaneum	Pain,swelling around heel and ankle since 1 month.	shows expansile lytic lesion with cortical thinning at anterior aspect of calcaneum	-	-	Curettage+ composite bone graft(bone marrow and synthetic hydroxyapatite crystals)	12 months
3	Hansra SS et al [12] (2022)	17yrs,F	R	Distal humerus	Painless mass around anteromedial aspect of elbow since 1week.	shows well defined lytic lesion with sclerotic rim with soft tissue component.	-	showing intraosseous lesion(2.5cm) with dumbbell shape mass with large extraosseous component on anteromedial aspect(5cm). Lesion is isointense on T1 and hyperintense on T2 images.	Curettage+ allograft and synthetic bone putty to fill the void	-
4	M.Wahyudi et al [13] (2022)	19yrs,F	L	Thigh	Pain around thigh since 4years with increased pain intensity from past 3 months.	shows well defined osteolytic lesion with sclerotic rim involving the anterior cortex of distal femur	-	shows eccentric lesion with irregular outline. Lesion is isotense on T1 and hyperintensity on T2 weighted images.	Curettage+ synthetic bone graft	6months
5	P Reyniers et al [14] (2021)	49yrs,F	L	Shoulder(Glenoid)	pain around shoulder since 3 months.	shows well defined lesion in glenoid with sclerotic margin.	-	shows expansile, and lobulated bony lesion in inferior part of glenoid(2.6x2.4x1.7cm). Lesion is isointense on on T1 and hyperintense on T2 weighted images.	Extended curettage+ lyophilized allograft used for bone grafting.	12months
6	Kamath J et al [15] (2021)	45yrs,F	L	Elbow	Pain, diffuse swelling around elbow from past 1year.	shows a well defined lytic lesion with sclerotic border in meta-diaphyseal region of distal humerus with pathological fracture.	-	shows lesion involving distal humerus region with cortical and septations. Lesion is hypointense on T1 and hyperintense onT2 weighted images	Resection+ reconstruction with ipsilateral fibula strut graft and fixation with plates,screws.	6months
7	Huajun et al [7] (2021)	55yrs,F	R	Shoulder(Proximal humerus)	Pain and restricted motion around shoulder from past 1 year.	shows involvement of proximal humerus by well defined osteolytic lesion with some endosteal scalloping.	shows well defined lesion with lytic component, cortical thinning and ballooning with fracture in proximal region.	shows invasion of cortex and surrondng soft tissue by tumor. Lesion is isointense on T1 and hyperintense on T2 weighted images.	Extended curettage+ allograft+ fracture fixation with plate	6months
8	Lim et al [16] (2021)	77yrs,F	R	Elbow(Ulna)	Pain around elbow	shows well defined with radiolucent area involving the proximal part of ulan with pathological fracture is seen.	-	shows intraosseous lesion with expansile nature involving near by muscles and subcutaneous tissue measuring around(7.8x4.4x3.6cm)	Curettage+ void filled by bone cement and beta-tricalcium phosphate+ hydroxyapatite crystals along with plate fixation	36 months
9	Mardi et al [17] (2021)	46yrs,F	R	Tibia	Swelling and tenderness around medial side of knee	shows well defined lytic lesion involving proximal part of tibia with sclerotic rim.	-	shows well lobulated lesion measuring around 3.2x1.35cm on anteromedial aspect of proximal tibia.	Excision	8months
10	McAleese et al [18] (2020)	55yrs,F	R	Femur	Pain around mid thigh since 2years	-	shows well defined osteolytic lesion at mid-shaft level with cortical erosion.	shows eccentrically located lesion with well defined margin.Lesion low intensity on T1 and high intensity onT2 weighted images.	Excision+ Prophylactic intramedullar nailing	3months
11	Ali SM et al [19] (2022)	18yrs,F	R	Fibula	Pain around leg since 2yrs	shows lytic lesion with septations affecting distal shaft of fibula	-	shows expansile lytic lesion involving distal shaft of fibula with multiple septa measuring(2.2x2x1.4cm).Lesion is isointense on T1 and hyperintense on T2 weighted images.	wide excision	-
12	Drumond et al [3] (2020)	49yrs,M	R	Calcaneum	Pain,swelling around hindfoot since 1month	shows well defined lesion in calcaneum involving anterior process,body with cortical breech	-	shows lesion involving calcaneum measuring around 5cm ,both medial,lateral wall breech wih medial soft tissue component. Lesion is hypointense on T1 and hyperintense on T2 weighted images.	Excision + void filled by bone cement+ 2 cortico-cancellous screws.	12 months
13	Haberal et al [6] (2018)	35yrs,F	R	Calcaneum	Pain around heel since 8months with gradual increase from past 2months	shows well defined cystic lesion in the long axis of calcaneum.	-	shows lesion involving posterior aspect of calcaneum measuring 2.2x2cm. Lesiom is hypointense onT1 and hyperintense on T2 weighted images.	Excision+ bone grafting	2 months
14	Nguyen et al [20] (2017)	48yrs,M	R	Scapula	Incidental finding on imaging	shows expansile lytic lesion involving inferior part of glenoid	shows lesion surronded by thin cortical border with no internal calcification	shows lobulated lesion involving inferior part of glenoid with no soft tissue component.	Surgery	-
15	Gurkan et al [21] (2017)	34yrs,F	R	Hamate	Pain,swelling around wrist since 2 years	shows well defined multiloculated lesion with sclerotic rim, with cortical destruction on dorsum.	shows expansile ,well defined lesion with cortical breech on dorsal aspect	shows expansile lesion with soft tissue component on dorsum of wrist.Lesion is isointense onT1 and hyperintense on T2, PD-fat suppressed images.	Curettage+ Bone grafting(iliac crest)	7months
16	Al-Lhedan et al [2] (2017)	18yrs,F	R	Femur	Swelling on posterior aspect of thigh	shows lesion involving posterior surface of shaft femur without cortical breech but with definitive soft tissue component.	-	shows exophytic type of soft tissue mass on posterior aspect of shaft femur.Lesion is hypointense on T1 and hyperintense onT2 weighted images.	Excision+ Bone grafting	-
17	Hyun young kim et al [22] (2017)	38yrs,M	L	Hip	Pain around hip and groin since 2 months	shows well defined lobulated lesion in intertrochanteric region	shows lytic lesion with sclerotic rim around intertrochanteric region with subchondral fracture in femur head	shows well contoured lesion measuring 3.5x2.7x2cm.Lesion is isointense on T1 and hyperintense on T2 weighted images	Intralesional curettage+ Bone grafting	-
18	Perera et al [23] (2017)	56yrs, F	L	Knee	Pain, difficulty while walking since 6weeks.	shows well defined lytic lesion involving the supracondylar region with extension upto diaphysis of femur.	-	shows well defined lesion involving anterolateral aspect of distal femur extending upto diaphyseal region.	Excision+ bone grafting from iliac crest and bank bone+ prophylactic plating	24months
19	Suzuki et al [24] (2016)	87yrs,F	L	Elbow(Proximal ulna)	Swelling, tenderness around medial aspect of elbow since 1 month	shows a well defined lytic lesion involving proximal ulna with pathological fracture, with cortical thinning.	shows expansile lesion with cortical thinning of proximal ulna	shows intraosseous lesion with soft tissue component. Lesion is isointense on T1 and hyperintense on T2 weighted images.	Marginal resection and curettage+ hydroxyapatite granules+ plating	12months
20	Wang et al [25] (2016)	50yrs,F	R	Foot(Tarsal bones)	Dull aching pain and swelling from 30years with increase in size of swelling from past 6years.	shows well defined, expansile lytic lesiom with sclerotic rim affecting base of 2nd,3rd metatarsal, all cuneiforms,cuboid and navicular	shows expansile lesion extending in both inferior and superior direction with some soft tissue extension on plantar aspect.	shows lesion involving midfoor region with lesion being isointense onT1 and hyperintense onT2 weighted images.	Excision+ allograft to fill the void+ fixation with two kirschner wire	18months
21	Tian et al [26] (2014)	42yrs,F	L	Shoulder(Scapula)	Pain around shoulder since 4years.	shows well defined oval lesion surronded by thin rim.	shows large mass in scapula with destruction of glenoid with extension in nearby muscles.	shows lesion causing destruction of scapula with extension in surronding rotator cuff muscles measuring approximately 8.8x8x4 cm. Lesion is isointense on T1 and hyperintense on T2 weighted images.	Resection	10 months
22	Kito et al [27] (2014)	21yrs,F	L	Elbow(Proximal ulna)	Pain around elbow since 1 month.	shows defined lytic lesion with sclerotic rim and few trabeculations in proximal part of ulna.	shows expansile lesion with cortical breech and soft tissue extension	shows lobulated mass involving proximal ulna with soft tissue component. Lesion is isointense on T1 and hyperintense on T2 weighted images.	Excision+ beta tricalcium phosphate crystals to fill the void	42 months
23	Wang et al [28] (2014)	42yrs,M	R	Femur	Pain around lateral aspect of knee and leg	shows well defined lesion with lobulated appearence involving posterior cortex of femur	-	shows intracortical mass with soft tissue component affecting posterior cortex of femur shaft. Lesion is isointense onT1 and increased intensity on Fat-suppressed T2 weighted images	Extended curettage+ bone cementing+ prophylactic plating	5months
24	Wang et al [29] (2014)	75yrs,F	L	Tibia	Pain, swelling around leg and ankle since 1year.	shows well defined lytic lesion involving distal tibia with no intra lesional calcification	shows lesion involving distal tibia with cortical break on lateral aspect involving tibio-fibular joint.	-	Excision+ bone cementing	-
25	Ansari et al [30] (2014)	48yrs,F	R	Foot(1st metatarsal)	Swelling around foot since 9years,Pain from past 1year	shows well defined lytic lesion with sclerotic border involving 1st metatarsal.	-	shows well defined mass involving 1 st metatarsal with cortical break on dorsum.Lesion is isointense onT1 and hyperintense onT2 weighted images.	Excision+ fibular grafting + 2 kirschner wire	24 months
26	Flores Santos et al [31] (2014)	70yrs,F	L	Foot(Cuboid)	Swelling around foot since 8years.	shows well defined lesion with thin rim involving cuboid	shows expansile lesion in cubois with cortical erosion and soft tissue extension.	shows lesion involving cuboid with extension upto plantar aspect and measuring(7x3x2.5cm)	Curettage+ bone grafting	18 months
27	Kashima et al [32] (2013)	62yrs,F	R	Tibia	Pain around leg	shows well defined lesion with sclerotic rim in mid-shaft region of tibia with pathological fracture.	-	shows dumb-bell shaped lesion in mid-shaft tibia with cortical break on postero-lateral aspect.	Excision+ Ilizarov fixator, then revision excision of remote lesion	24months
28	Kashima et al [32] (2013)	55yrs,F	L	Tibia	Pain around leg since 20years with increase pain from past 1year	shows well defined lytic lesion affecting the tibia	-	shows lesion involving the postero-lateral aspect		
29	Hoshi et al [33] (2012)	44yrs,F	R	Hip	Pain around hip since 3years.	shows well defined lytic lesion surronded by sclerotic rim in neck region and extension upto subtrochanteric region.	shows lytic lesion in femur neck with cortical ballooning and thinning.	shows dumbell shape lesion in femur neck extending upto subtrochanteric area and measuring about 9.1x5.7x3.4cm.Lesion is isointense on T1 and hyperintense on T2 weighted images.	Curettage+ bone graft(iliac crest) and tri-calcium phosphate crystals+ compression hip screw.	-
30	Afshar and Afaghi et al [34] (2010)	12yrs,M	R	1st web space	Painless swelling around 1 st web space since 18 months.	shows well defined lytic lesion involving base of 2 nd metacarpal with cortical break.	-	shows well defined lesion involving base of 2 nd metacarpal with soft tissue component on volar aspect.Lesion is isointense on T1 and hyperintense onT2 weighted images.	Curettage+ Bone grafting	6months
31	Bagci et al [35] (2010)	19yrs,F	R	Radius	Pain and swelling around proximal radius since 6months	shows well defined, expansile lesiom involving proximal part of radius extending upto diaphysis with pathological fracture.	-	shows well defined lesion with intraosseous extension in radius measuring approximately 10cm.	Curettage	45 months
32	Current Study (2024)	20 yrs,M 27 yrs,F 24 yrs.M	R	Scapula Proximal Ulna Metacarpal	Pain Swelling	well defined lytic lesion with thin sclerotic rim	expansile lytic lesion with cortical breach at multiple sites involving glenoid part of scapula	Shows low to isointense lesion on T1-weighted images, hyperintense lesion on T2-weighted images.	Resection of Scapula Curretage and Bone Graft substitute of ulna Curettage of Metacarpal	60 months 15 months 13 months

Table 2: Review of literature on intra-osseous Schwannoma (IOS) in extremity bones

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