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PICTORIAL REVIEW

Fat: friend or foe? A review of fat-containing masses within the head and neck

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ABSTRACT

Fat-containing lesions of the head and neck are commonly encountered in day-to-day practice. Our aim was to review the various imaging presentations of common and some uncommon fat-containing lesions within the head and neck with potential pitfalls and mimics. While most soft-tissue masses have a fairly similar density, the presence of fat in a mass lesion is easy to identify on both CT/MRI and can help narrow the differential. Case-based examples of lipomas, liposarcomas, lipoblastomas, dermoids, teratomas and other fatty lesions will be used to describe imaging features. While fat density can be helpful, differentiating benign from malignant fat-containing lesions can still pose a challenge. Lesions simulating pathology such as brown fat, fatty changes within organs and post-operative flaps are presented. Finally, examples of fatty lesions in atypical locations are shown to illustrate examples that should be kept in mind in any differential. The presence of fat in head and neck masses can aid radiologists in arriving at an accurate diagnosis. Knowledge of the imaging appearance of these fat-containing lesions and their mimics can help avoid unnecessary biopsy or surgery.

INTRODUCTION

Since fat can be easily identified across multiple imaging modalities, the presence of fat can be a very useful differentiating feature in the evaluation of soft-tissue lesions. Identifying fat within a lesion, along with the location of the mass, can help narrow down the differential.

CT and MRI both provide exquisite detail in the evaluation of head and neck masses. Many soft-tissue masses show no distinctive imaging features, but notable exceptions are fat-density lesions. On CT, pure macroscopic fat typically lies between -50 and -100 HU. Even outside this range, the presence of CT density below zero Hounsfield units should raise the possibility of a fat-containing neoplasm with partial volume effect. Fat has a short relaxation time on T_1 and thus appears bright on T_1 weighted (T_1w) sequences. Fat suppression techniques can be employed to suppress the high signal from fat on T_1w images, confirming the presence of fat and evaluating for underlying enhancement.

Fat-containing lesions of the head and neck are commonly encountered in daily practice. Our aim was to review the various imaging presentations of common (and some uncommon) fat-containing lesions within

the head and neck. Potential pitfalls and mimics are also presented. We show examples taken from a search of our medical records and teaching files from the past 10 years.

Lipomas

Lipomas are common benign adipocytic mesenchymal tumours in adults with reported prevalence between 13 and 25% in the neck. They may mimic other lesions in the neck. Simple lipomas contain predominantly mature adipocyte tissues. Atypical lipoma variants containing other additional tissue types (fibrous tissue, bone cartilage, vessels or myxoid stroma) are also seen.^{1,2}

On imaging, a lipoma is usually a well-encapsulated mass. However, infiltrative margins can be seen, and if large enough, a lipoma may exert mass effect on surrounding structures. On CT, lipomas show characteristic fat attenuation ranging from -50 to -140 HU. Internal septations may be present, and large vessels are sometimes encased by tumour. Lipomas on MRI show high signal on T_1 and T_2 fast-spin echo sequences which matches signal of subcutaneous fat.² Differentiation from normal fat is on the basis of encapsulation and mass effect on adjacent structures. Use of fat saturation

Figure 1. Simple lipoma: (a) axial post-contrast CT scan; (b) T_1 weighted (T1w) axial image; (c) T1w pre-contrast coronal image; and (d) T1w post-contrast coronal image. Thin (<2 mm) septa can routinely be seen (arrows). There is lack of thick septations, nodularity or enhancing soft-tissue components. It can be noted that in the fat-suppressed T1w image (d), apparent hyperintensity at the inferior extent of the lesion is related to artefactual failure of fat suppression.

sequences will show signal drop out, confirming the presence of fat. It is important to be wary of “failure of fat saturation” mimicking enhancement (Figure 1). Lipomas can occur in

unusual locations. The presence of fat should help in making the diagnosis (Figure 2). When located intramuscularly, the lipoma tends to insinuate between the muscle fibres

Figure 2. Lipomas in unusual locations: (a) axial post-contrast CT image demonstrating a fat-density midline neck mass anterior to the thyroid cartilage (arrow). The common differential for a midline benign-appearing lesion in the mid-neck near the hyoid includes a thyroglossal duct cyst and a dermoid. However, the presence of macroscopic fat may aid in the diagnosis of a lipoma in this region, as the other entities typically do not have fat attenuation. (b) Axial T_1 weighted (T1w) pre-contrast, (c) axial T1w post-contrast and (d) axial three-dimensional constructive interference in steady state images showing a small lipoma in the fundus (arrowheads), which may mimic a vestibular schwannoma. Evaluation of the T_1 pre-contrast images is essential in making the diagnosis, since this lesion will be high signal on both pre- and post-contrast T1w imaging.

Figure 3. Intramuscular variant: (a) axial post-contrast CT image of the head and (b) T_1 weighted axial image of the head demonstrating a fat density and signal lesion insinuating between the left temporalis muscle fibres (arrows). (c) Axial post-contrast CT image of the neck and (d) coronal post-contrast CT image of the neck also showing a fatty lesion insinuating in the right sternocleidomastoid muscle fibres (arrows).

(Figure 3). The muscle fibres themselves may mimic thick septations and make differentiation from an atypical lipoma difficult.

Atypical lipomas in addition to adipose tissue may have varying degrees of other tissue components such as fibrous, osseous/cartilaginous, salivary and vascular tissue elements which,

based on the histopathologic appearance, are labelled as fibrolipoma, osteolipoma/chondrolipoma, chondrolipoma, angiolipoma and sialolipoma.² These components may or may not be differentiated on imaging. Atypical imaging features of lipoma include: thick septations, internal fat infiltration, nodular soft tissues, enhancement, haemorrhage and calcifications (Figure 4). Atypical lipomas may therefore be difficult

Figure 4. Atypical lipomas: (a) axial post-contrast CT image of the neck, (b) axial non-contrast CT image of the chest and (c) axial non-contrast CT image of the jaw demonstrating atypical features including the presence of fat infiltration (arrowhead), calcifications (arrow) and thickened wall (curved arrow) in an otherwise benign-appearing fat-containing lesion.

Figure 5. Spindle cell lipoma: (a) axial post-contrast CT and (b) sagittal post-contrast CT images demonstrating a fat-density posterior neck mass with areas of nodularity (arrowheads) and thick internal septations (arrow).

to distinguish from a liposarcoma on the basis of imaging appearance alone.²

A well-described atypical variant is a spindle cell lipoma. Originally described as benign lesions in which mature fat is replaced by collagen-forming spindle cells, spindle cell lipomas have a tendency to occur in the subcutaneous tissue of the posterior neck.³ They present as fat-density posterior neck masses with multiple areas of thick septations and nodularity (Figure 5). The presence of atypical features makes differentiation from well-differentiated liposarcomas impossible. However, the diagnosis should be suggested when a middle-aged male presents with a well-defined complex fatty mass localized to the posterior neck.³

Liposarcoma

Liposarcomas are a common type of sarcoma. They are, however, rare in the head and neck, making up only 1% of neck sarcomas. Head and neck liposarcomas typically have a better prognosis than elsewhere in the body.⁴

Liposarcomas arise from adipocyte tissues. Five types of liposarcoma have been described: well differentiated, dedifferentiated, myxoid, pleomorphic and mixed. They may vary widely in appearance and display both fat and soft-tissue components to varying degrees. Typically, the less differentiated liposarcomas have greater soft-tissue components and less adipose tissues.

Figure 6. Liposarcoma: (a) axial post-contrast CT, (b) sagittal post-contrast CT and (c) coronal post-contrast CT images demonstrating a heterogeneous fat-containing mass in the posterior neck (arrows) with areas of calcification and enhancing nodules (arrowheads). These features help in differentiating this lesion from lipomas.

Figure 7. Recurrent liposarcoma: (a) axial post-contrast CT and (b) coronal post-contrast CT images of the neck demonstrating a small fat-containing lesion within the left sternocleidomastoid muscle (arrows) found to represent the local recurrence of liposarcoma after resection. (c) Axial post-contrast CT and (d) coronal post-contrast CT images of the neck in a different patient showing multiple hazy fat-density lesions in the left neck (arrows), consistent with the local recurrence of liposarcoma.

Differentiation between lipomas and well-differentiated liposarcomas is difficult on imaging. Any complexity within a presumed lipoma should raise the suspicion for a liposarcoma. According to the World Health Organization classification, atypical lipomas and well-differentiated liposarcomas are essentially the same entity.¹ This corresponds with the overlap of findings found frequently on imaging.

On imaging, liposarcomas are typically seen as heterogeneous fat-containing masses in the posterior neck with areas of septations, calcification and enhancing nodules (Figure 6).^{1,2}

The more aggressive liposarcomas can infiltrate adjacent structures. Infiltrative forms tend to locally recur (Figure 7).

Figure 8. Dedifferentiated liposarcomas: (a, b) axial non-contrast CT images of the neck demonstrating soft-tissue masses in the left lower neck (arrows) with a paucity of fat found to represent dedifferentiated liposarcomas.

Dedifferentiated liposarcoma

These occur most commonly in the seventh decade. Dedifferentiated liposarcomas may show a paucity of fat on imaging and a predominant soft-tissue component (Figure 8). They may also mimic other sarcomas such as osteosarcomas or chondrosarcomas.⁵

Lipoblastoma

Lipoblastomas are benign lesions usually occurring in children under 3 years of age. Lipoblastomas occur rarely in the neck. Other locations include the parotid gland, cheek, skin and orbit.⁶ They typically present as well-circumscribed fatty

Figure 9. Lipoblastoma: (a) T₁ weighted (T₁w) axial image, (b) T₂w fat-saturated axial image, (c) T₁w pre-contrast coronal image and (d) T₁w post-contrast coronal image in the left mid-neck demonstrating the typical appearance of a lipoblastoma as a well-circumscribed fatty septated lesion (arrows).

Figure 10. Dermoid: (a) T_1 weighted (T1w) sagittal and (b) T1w fat-saturated sagittal images demonstrating a T_1 hyperintense lesion in the suprasellar cistern (arrows) that has lost signal on fat-saturated images, consistent with a dermoid. In another patient, (c) T1w axial image of the suprasellar region and (d) T1w axial and (e) T1w fat-saturated axial images of the frontal lobes showing a large fat-containing mass in the suprasellar region (arrow), with intrinsic T_1 hyperintensity. There are fat globules in the subarachnoid space (arrowheads) confirming a ruptured dermoid. The suppression of these fat globules on the fat-saturated sequence can be noted.

lesions with septations (Figure 9). Histologically, they are composed of fat and myxoid tissues in variable proportions. Although benign, they may recur after resection. Signal intensity can vary according to the maturity of the adipose tissue.²

Dermoids

Dermoids are epithelium-lined inclusion cysts containing dermal appendages derived from the ectoderm without the true adipose tissue.⁷ The dermal appendages are thought to produce sebum-like material, giving them low density on CT. However, dermoid density may be variable.

Differentiation from other cystic lesions like epidermoid tumours and ranulas is based on the fat-like density and midline location of dermoids. On MRI, signal characteristics vary depending on lipid content. In general, dermoid cysts show high signal intensity on T1w sequences and a heterogeneous signal on the T_2 weighted sequences, reflecting dermal appendages such as hair follicles and sweat glands. As with other fat-containing lesions, fat saturation sequences can help identify the presence of fat.

Intracranial dermoid

Intracranial dermoids are seen on imaging as well-circumscribed fat-containing masses (Figure 10a,b).

Figure 11. Cervical dermoid: (a) sagittal post-contrast CT and (b) axial post-contrast CT images showing typically low-density superficial midline masses in the neck (arrows). It can be noted that significant motion artefact is obscuring portions of the upper neck.

Figure 12. Orbital dermoid: (a, b) axial non-contrast CT and (c) T_1 weighted sagittal images in different patients demonstrating fat attenuation, well-circumscribed masses surrounding the orbit (arrows), typical for orbital dermoids.

Ruptured dermoid

When intracranial dermoids rupture, they can cause chemical meningitis with meningeal enhancement (Figure 10c–e). They may obstruct the ventricular system producing obstructive hydrocephalus. Lipomas can also occur intracranially, typically in the basal cisterns.

Cervical dermoid

In the midline neck, dermoids may mimic thyroglossal duct cysts (Figure 11). The presence of low attenuation values may help in the diagnosis, although frequently the CT attenuation and MRI signal in dermoids are variable. The key to diagnosis is that dermoids are more superficial while thyroglossal remnants are embedded in the strap muscles.

Orbital dermoid

The most common location of orbital dermoids (Figure 12) is in the upper outer quadrant of the eye. They may show fat density or may have intermediate density, but their location and morphological characteristics are usually sufficient for making the diagnosis. Orbital dermoids may also produce mass effect on adjacent structures. Although orbital dermoids may sometimes resemble lipomas radiologically, they are readily

differentiated clinically because dermoids are hard whereas lipomas are soft.

Teratoma

Teratomas are considered to be true neoplasms that arise from embryonic germ cells in an aberrant location. They are typically heterogeneous on imaging and may be categorized as mature or immature. They may also have variable contents: cystic, solid or fat.^{7,8}

Mature teratoma

Mature teratomas are most commonly found in the anterior midline. They are composed of fully differentiated tissues; along with fat-density masses, they may contain cystic and solid areas with calcifications (Figure 13).

Immature teratoma

Immature teratomas are composed of undifferentiated or incompletely differentiated tissues with areas of fat and soft-tissue density. They may also have cystic areas and calcifications. They may manifest clinically as difficult delivery and airway obstruction in neonates. The clinical presentation and imaging findings often make the diagnosis clear (Figure 14).

Figure 13. Mature teratomas: (a, b) axial post-contrast CT images of the neck in two different patients showing heterogeneous masses in the midline of the neck, demonstrating solid and cystic areas (arrow) as well as the adipose tissue (arrowheads).

Figure 14. Immature teratoma: (a) axial post-contrast CT and (b) sagittal post-contrast CT images of a newborn demonstrating soft-tissue areas (arrowheads) as well as fat (arrows) in a large anterior neck lesion. These may cause difficult delivery and airway obstruction in neonates.

Brown fat

Brown fat is a hypermetabolic adipose tissue commonly found in the neck and supraclavicular areas (Figure 15). On imaging, it is seen as areas of bilateral symmetric fludeoxyglucose avidity in the neck.⁹ Hibernomas are benign but metabolically active tumours of brown fat origin that may show fludeoxyglucose avidity.

Lipomatosis

Madelung's disease is a rare entity commonly described as multiple symmetric lipomatosis (Figure 16) typically affecting the posterior neck and upper trunk.¹⁰ The typical distribution of fat and clinical history of alcohol abuse is useful in the diagnosis. Awareness of this entity may be useful in differentiation from a fat-containing lesion.

Figure 15. Brown fat: (a) axial non-contrast CT, (b) axial positron emission tomography (PET)/CT fused and (c) coronal PET/CT fused images showing fat within the lower neck (arrows) that are demonstrating symmetric fludeoxyglucose avidity on a PET/CT study (arrowheads) consistent with brown fat.

Figure 16. Lipomatosis: (a) axial non-contrast CT and (b) T_1 weighted axial images showing prominent symmetric fat in the posterior neck (arrows) consistent with lipomatosis in the neck.

Sialosis

Sialosis is a non-specific term sometimes used to describe a diffuse non-focal enlargement of the salivary glands, usually secondary to systemic causes. In the late stages, sialosis may be seen as a marked fatty infiltration of the salivary glands (Figure 17).¹¹

Surgical flaps

Various flaps are used for reconstructive surgery in the head and neck, including local flaps, free flaps and pedicle flaps. With the lack of operative details, surgical flaps may be mistaken for fat-containing lesions (Figure 18).¹²

Figure 17. Sialosis: (a) axial post-contrast CT and (b) coronal post-contrast CT images showing diffuse non-focal enlargement of the parotid glands with end-stage fatty infiltration (arrows).

Figure 18. Surgical flaps: (a) axial post-contrast CT and (b) coronal post-contrast CT images showing a large, fat attenuation flap (arrows) placed as part of reconstructive surgery in the neck. The enhancing area of early recurrent tumour anterior to the flap (arrowhead) can be noted.

Other neoplasms

Occasionally, some neoplasms may have a fatty component as seen here in pleomorphic adenoma and thyroid adenoma (Figure 19).

Chronic denervation

Extensive fatty replacement of the tongue or muscles of mastication can mimic tumour (Figure 20), commonly seen with hypoglossal and V3 denervation injury. Denervation injury can

produce varying imaging appearances depending on the duration of injury.¹³ The characteristic distribution of fat is key to this diagnosis.

CONCLUSION

The presence of fat in head and neck masses can aid radiologists in arriving at an accurate diagnosis. Knowledge of the imaging appearance of these fat-containing lesions and their mimics can sometimes help to avoid unnecessary biopsy or surgery.

Figure 19. Other fat-containing neoplasms: (a, b) axial post-contrast CT images of the neck demonstrating a large left thyroid lobe adenoma with internal fat attenuation (arrows). (c) Axial post-contrast CT and (d) sagittal post-contrast CT images at the skull base showing a pleomorphic adenoma within the deep lobe of the right parotid gland (arrowheads) with an internal fatty component.

Figure 20. Chronic denervation: (a) axial post-contrast CT, (b) T_1 weighted (T1w) axial and (c) T1w coronal images of the head showing fatty denervation involving the left side of the tongue (arrows), a finding that should not be confused with a neoplasm.

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