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A Spectrum of Morphological Variations in the human liver lobes and its Clinical importance; a Cadaveric Study

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Abstract
Most common morphological variations of liver are irregularities in the form, shape, and presence of number of accessory lobes, accessory fissures or abnormal ligaments. Knowledge and awareness of these anomalies is useful to the clinician to rule out diseases, surgeons during segmental resection of liver and radiologist when interpreting liver radiologic findings.
The exact origin of accessory lobes of liver in man is unknown and may stimulate tumours.
Accessory fissure may mimic internal trauma at the post-mortem study. Rare abnormalities are atrophy or complete absence of one of the lobes. The developmental anomalies of liver may cause confusion to clinician during procedures like biopsy, transplantation & other important surgical or radiological procedures.
Aim of the present study *comprises a systematic analysis of the anatomical variations exhibited by 50 formalinised and glycerinated adult human livers collected from department of Anatomy, KAMSRC(Hyderabad) &KIMS (Narketpally).*
Results & Conclusion: *We found accessory liver lobes in 8 cadavers (16%), accessory fissures in 15 cases (30%), abnormal connection between left lobe and quadrate lobe in 2 cases (4%) and other morphological variations were also present.*
Detailed knowledge of anatomical variations in the human liver could be valuable in improving diagnostic procedures .in conditions associated with some liver diseases.
Hence we undertook this comprehensive study to identify important accessory lobes and fissures.
Key words: *quadrate lobe, caudate lobe, liver, accessory lobes & accessory fissures..*

Introduction

The liver is responsible for a wide range of vital functions including blood detoxification and purification, synthesis of plasma proteins, production of bile, metabolism of carbohydrates, fats & proteins. In man the Liver is essential for survival, no artificial organ or equipment has capacity to compensate for absence of liver function.

Gross anatomy of the liver divided into four lobes and eight segments. The Falciform ligament on the anterior surface divides the organ into the right

&left anatomical lobes. Two additional lobes are seen on visceral surface, superiorly Caudate lobe & inferiorly Quadrate lobe divided by ligamentum Venosum & ligamentum teres. The accessory lobes are found in infra hepatic position. Riedel's lobe is the best known example of a sessile accessory lobe.[1,2]

Abnormalities of liver are rare inspite of its complex development. Common abnormalities are irregularities in form, one or more accessory lobes or fissures. The variations have been observed in human liver and have classified as congenital or acquired.

A sound knowledge of normal & variant liver is a prerequisite for safe surgical approaches& diagnostic imaging. A presence of abnormal liver has to be kept in mind when an unexplained abdominal mass is encountered.

The study was undertaken to investigate the type & frequency of morphological variations in cadaveric Livers available from the department of anatomy, KAMSRC and KIMS. The result of liver, morphological variations have been identified, described and photographed in detail.

Materials& methods

The formalin fixed adult 50 liver specimens available in the Anatomy department of KAMSRC&KIMS constituted the study material. The livers were dissected during human cadaveric dissection classes for IMBBS medical students over period of 5 years.

The embalmed liver lobes that is right lobe, left lobe, caudate lobe & quadrate lobe were studied in detail for presence of accessory lobes and accessory fissures.

Specimens were photographed, the findings were appropriately documented

Exclusion criteria: age below 20years, specimens with cirrhotic liver..

Inclusion criteria: age between 20-70 years, weight between 1.2- 2kg. Intact liver specimens with normal anatomical features.

Observation & Results: Total number of livers studied was 50

Table 1: Showing the incidence of liver morphology types and variations from organ collection at KAMSRC & KIMS

S.NO	Characteristic features	No .of examples	Percentage
1.	Normal liver	33/50	66%
2.	Hypotrophy of left lobe with deep impressions on costal surface	2	4%
3.	Transverse liver with large left lobe	2	4%
4.	Liver with lingual process of left lobe	2	4%
5.	Liver with lingular process of right lobe(Rediel's lobe)	1	2%
6.	Liver with deep renal impressions& corset constriction	3	6%
7.	Liver with diaphragmatic impressions	2	4%
8.	Liver with accessory lobes	8	16%
9.	Liver with Accessory fissures	15	30%
10.	Pons Hepatis- Left lobe connected to quadrate lobe	2	4%
11.	Narrow (ill-defined) quadrate lobe	1	2%
12	Total Number of Variation in livers	17/50	34%

Table 2: Showing the incidence of accessory lobes & accessory fissures in various lobes of Liver

S.NO	Type of variations	Accessory lobes & %	Accessory fissures & %
1.	Right lobe	1 specimen (2%)	8specimen (16%)
2.	Left lobes	-	1specimen (2%)
3.	Caudate lobe	2 specimens (4%)	3specimen (6%)
4.	Quadrate lobe	5specimens (10%)	5specimens (10%)
5.	Superior And Inferior Quadrate Lobe	1specimens (2%)	

Table 3: Classification of liver according to Netter's[17]

Netter type	No of specimens
Type 1 –very small left lobe, deep costal impressions.	1 (2%)
Type 2-complete atrophy of left lobe	Nil
Type 3-transverse saddle like liver with relatively large left lobe	2(4%)
Type 4- tongue like process of right lobe(Reidel's lobe)	1(2%)
Type 5- very deep renal impression & corset constriction	3(6%)
Type 6-diaphragmatic grooves	2(4%)

Observation & Results continued

It was noteworthy that 17 cadaveric livers out of 50 were exhibited a range of morphological variations &, while 33 livers. considered to be anatomically normal.

Normal surfaces, fissures and borders were observed in 33 livers (66%) and were without accessory lobes & fissures.

17 Liver specimens showed the following morphological variations

1.Accessory fissures in different lobes in 15 livers (30%)-Table 1&2; fig-6,8,9,10,14,16,17,18,19,20, 21 & 24

2. Accessory lobes were seen in 8 livers specimens (16%).Table 1& 2,
fig– 8,16,19,20,24&26)

3. Pons hepatis joining left lobe with quadrate lobe was seen in 2 specimens 4%, table- 1, fig-11 & 15

4. A complete transverse fissure dividing quadrate lobe into superior& inferior lobes(fig–20;table-2) was seen in 1specimen(2%), while mini accessory quadrate lobe was seen in 1specimen 2%.(fig--20)

5. Elongation of left lobe(lingular process)was observed in 2 cases.(table-1; fig-12 &13.

6. One specimen showed the presence of Reidel's lobe, where right lobe extended downward to right of cystic notch.(table-1 &3; fig-3 ;

7.Abnormal leftlobe L-shapeseen in one specimen with shift of quadrate lobe& fissure for ligamentum teres to the right (fig-27) such a case was not reported in the literature.

Two livers presented deep renal impression with corset constriction (table1 &3; fig—6&7,

8.Two liver specimens(4%) had deep costal impressions on anterior surface of right lobe(table1&3; fig—1&2.

The liver specimens were classified according to 6 types of liver variations as described by Netter [17]Table 3

These data suggest that there is high incidence of anatomical variation in human liver

Discussion

In this world of the modern imaging period, it becomes very important to , surgeon ,radiologist and clinician to have a thorough knowledge of anatomy and commonly occurring variations in liver. The liver is known to show lobe and fissure anomalies

The congenital abnormalities of human liver are rareinspite of its complex development and they are rarer than any other organ of the body. The anomalies may be high in society but we do not notice them, because they are usually asymptomatic.[3]

They may present in any age group as an accidental findings.

Congenital malformations of liver are irregularities in form or occurrence of one or more lobes. Other includes agenesis of lobes and atrophy of lobes.[4]

The variations in human liver have been classified as congenital or acquired

The Congenital anomalies of liver can be categorized into two; due to defective development or due to excessive development. The anomalies are sometimes associated with malformations of other organs like diaphragm.[5]

The embryological basis of anomalies of liver morphology occurs in the course of organogenesis. The defective development of left lobe of liver can lead to gastric volvulus whereas defective development of right lobe may progress to portal hypertension.

The excessive development of liver results in formation of accessory lobe which is very rare. The accessory lobes carry risk of torsion or may remain silent in many subjects.

The accessory lobes arise most common from the right lobe & may project in any direction. Most common among them is the Riedel's lobe which descends inferiorly along the right lateral surface as tongue like projection. Riedel's lobe is the best example for excessive development of liver.[6]

It was described that the hepatic malformations are common in perinatal age group and liver undergoes reformation postnatal. Accordingly all fissures and lobes of liver should disappear during postnatal.[7.]

In the present case Riedel's lobe may be due to defective development.

Multiple hepatic lobes and fissures were common on the under surface of liver opposite to quadrate lobe or left lobeor in the region of gall bladder.[8],

The present study had 5accessory lobes in quadrate lobe (10%) & one specimen had accessory lobe near right border of fossa for gall bladder

Two accessory lobes in caudate lobe, i.e. One liver specimen had with complete deep vertical fissure dividing the caudate lobe into duplicated caudate lobes.

The accessory fissures are potential sources of diagnostic errors in sonography or CT [9]

The Multiple accessory fissures may mimic pathologic macro nodular liver on CT

The Fissure may be associated with diaphragmatic scalloping or eventration on chest film.

Fluid collection in these fissures may mistake for liver cyst, liver abscess or implantation of disseminated tumours cells. The fissures are formed by the invagination of the muscular diaphragm into the liver on the costal surface.

Hussein Muktyazet et al[10] found accessory liver lobes in 6 cadavers(14.6%), atrophy of left lobe in 2 cadavers, accessory fissures in 5 cases (12.1%) and evidence of ectopic liver tissue.

Sato et al[11]found incidence ectopic liver lobe and accessory liver lobe in 0.7%, according to him accessory lobes are most commonly found on the undersurface of liver, but also seen on gall bladder. According to him ectopic livers are seen in Hepatogastric ligament, near the umbilicus, adrenal gland, pancreas and thoracic cavity.

Intra thoracic liver lobe was reported by Hansborough & Lipin in 1975[12]

Joshi et alreported[13] notching along inferior border of caudate lobe in 18% of livers, vertical fissure in 30% and prominent papillary process in 32% of livers in their extensive study on lobes and fissures.

Our present study had notching along the inferior border of caudate lobe dividing caudate process and papillary process in 3 specimens (6%), a vertical fissure in one specimen dividing the caudate lobe into two or Duplicate caudate lobes and prominent papillary process in 3 specimens.

Pujari& Deodhare[14]reported presence of a symptomatic accessory lobe may herniated into thorax through diaphragm and cause serious problems. He also reported a case of bifid liver presenting with anomalous quadrate and caudate lobes with transverse gall bladder.

Very recently Anjamrooz and Azari reported [15]a case of coexistences of multiple anomalies of hepatobiliary system. Reports on presence of

accessory liver sulci, absence of quadrate lobe and fissure for ligamentum teres, gall bladder fossa was broad shifted to left.

Lobar atrophy of the liver due to causes other than liver tumor or liver cirrhosis is a relatively rare pathological condition, and there are only a few reports in the literature.

We report two case of hypotrophy of left lobe of liver (2%) but no case of lobar atrophy except there was one case of small narrow triangular quadrate lobe

Acquired morphology_in liver are represented as linguiform lobes, small left lobe, deep renal impression with corset type constriction.

The present study had linguiform lobe of left lobe in two specimens(4%), hypotrophy left lobe in one specimen (2%), hypertrophy of left lobe with transverse saddle shape liver in two specimens(4%)& renal impression with corset type of constriction in three specimens.(6%).

Riedel in 1888described the occasional tongue-like projection of the right lobe of the liver, extending to or below theumbilicus. It has been observed almost exclusively seen in females. Reidel's lobe may extend into the iliac fossa or may extend to below the anterior superior iliac spine. The causes to this condition may be pushing down of right lobe of liver by an enlarging gall bladder, [16]

Our study study includes accessory lobes in right lobe one on inferior surface, two in caudate lobe , 5 in quadrate lobe& one liver specimen with Rediel's lobe of right lobe of liver & there was no evidence of ectopic liver tissue. Total number of accessory lobesin our study was in 8 liver specimens.

The current study also showed deep diaphragmatic grooves in two liver specimens and 15 accessory fissures in different parts of liver surfaces including caudate lobe & quadrate lobe .

Our study also alighted multiple anomalies in one cadaver (fig-27) which was first of its kind in literature. The liver showed 'L'shaped large left lobe, with the shift of quadrate lobe(shape of foot)& fissure for ligamentum teres to right, inferior border of quadrate lobe had small accessory lobes, with Riedel's Lobe with accessory fissure and deep renal impression with corset constriction.

I.Variation in the anterior & superior surface of liver

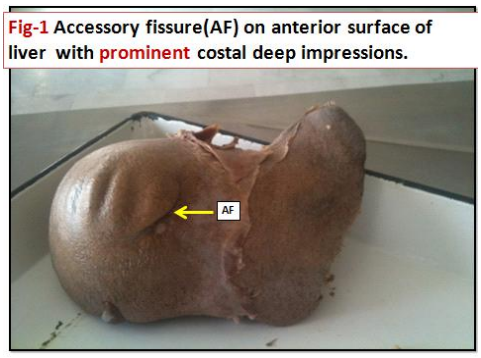


Fig-1 Accessory fissure(AF) on anterior surface of liver with prominent costal deep impressions.

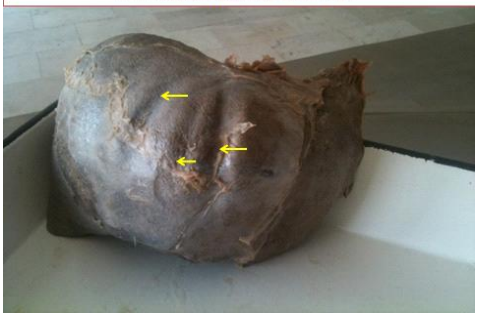


Fig -2 : Shows Deep costal impressions on anterior surface of right lobe of liver

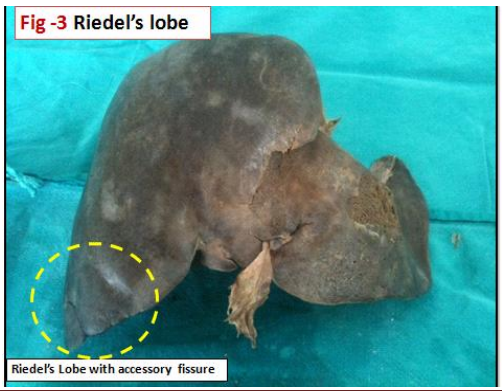


Fig -3 Riedel's lobe

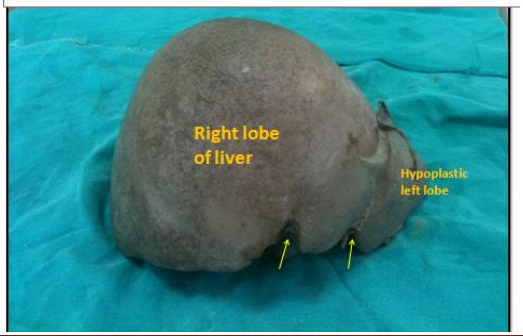
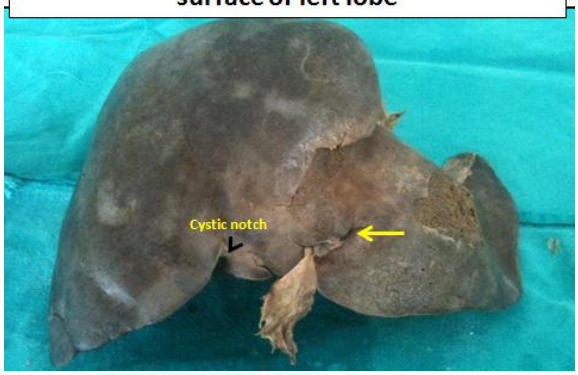


Fig -4 : Hypoplastic left lobe of liver with, Notches on inferior border

Fig -5 Accessory fissure on the Anterior surface of left lobe



II. Variarions In The Right Lobe Of Liver

Fig-6 Shows accessory fissures(AF) at duodenal impression & deep renal impression & corset constriction on inferior surface of right lobe of liver

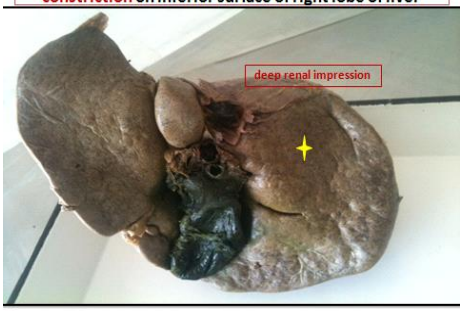


Fig -7 right lobe showing deep renal impression with corset constriction

Fig-8 : Accessory lobe(AL) & Accessory fissure(AF) to the right of the gall bladder on the inferior surface of right lobe

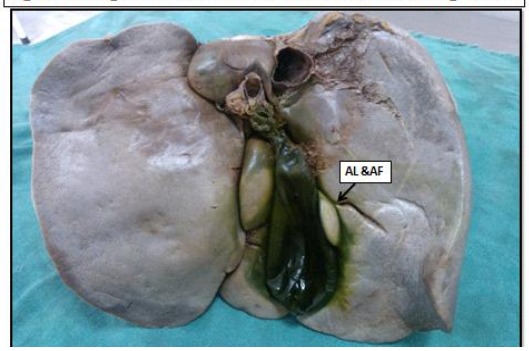


Fig-9: Deep inverted 'T' shape accessory fissure ('T'-AF) on the inferior surface of liver & vertical limb of T with portal vein

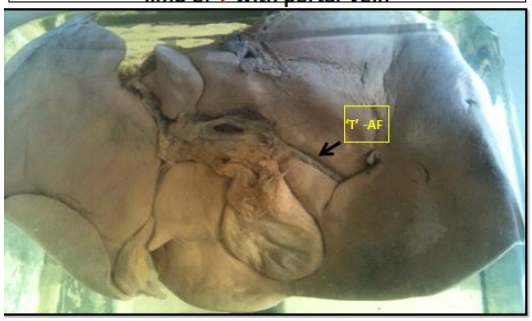
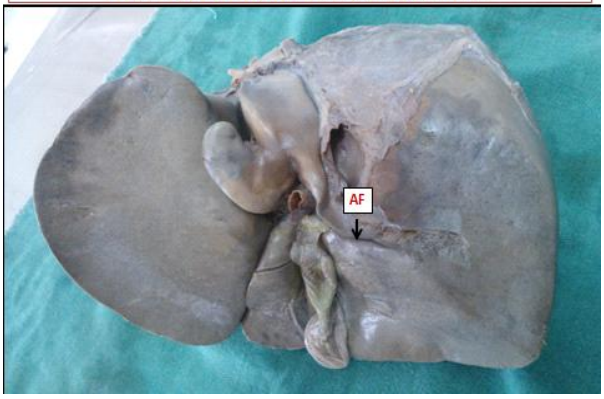


Fig -10 : Shows Accessory fissure(AF) to the right of the gall bladder b/w caudate process & duodenal impression & Accessory fissure(AF) in Quadrate lobe



III .Variations In Left Lobe Of Liver

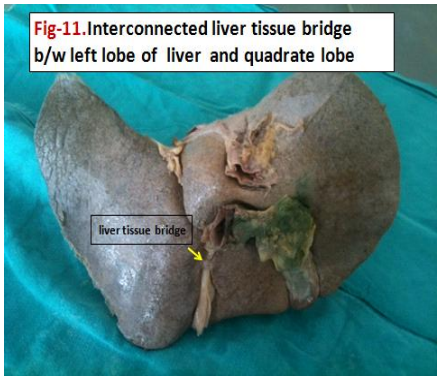


Fig-11.Interconnected liver tissue bridge b/w left lobe of liver and quadrate lobe

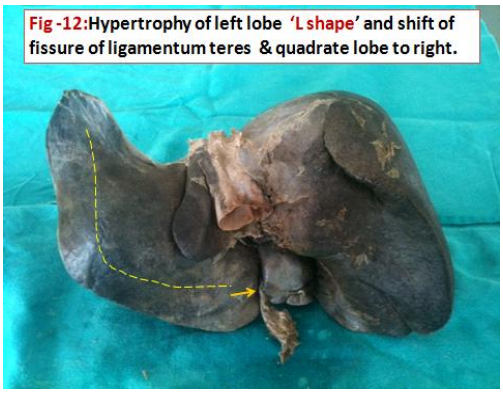


Fig -12:Hypertrophy of left lobe 'L shape' and shift of fissure of ligamentum teres & quadrate lobe to right.

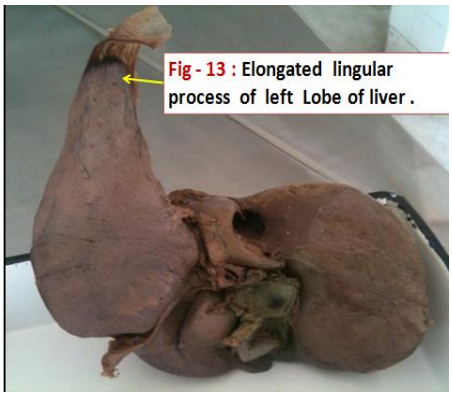


Fig - 13 : Elongated lingular process of left Lobe of liver .

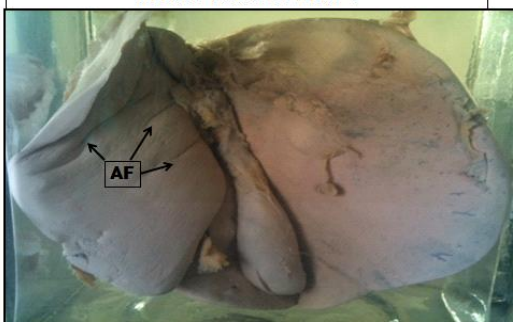


Fig - 14 : Numerous accessory fissures(AF) in left Lobe of liver .

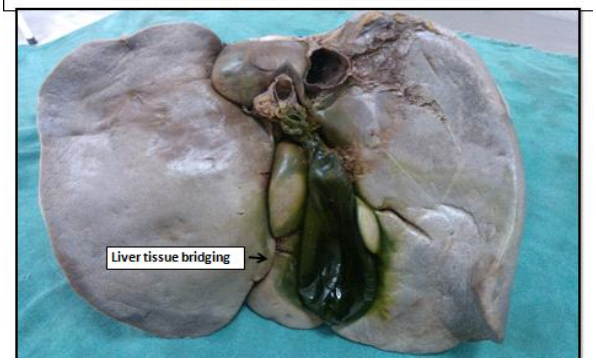


Fig -15 : Liver tissue bridging(pons hepatis) the fissure for ligamentum teres & Saddle shape liver

IV .Variation In Caudate Lobe

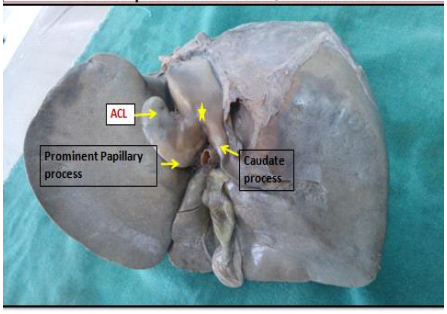


Fig -16 : Shows Accessory Caudate lobe(ACL) , Accessory fissure(AF) dividing papillary process from caudate process & AF in Quadrate lobe

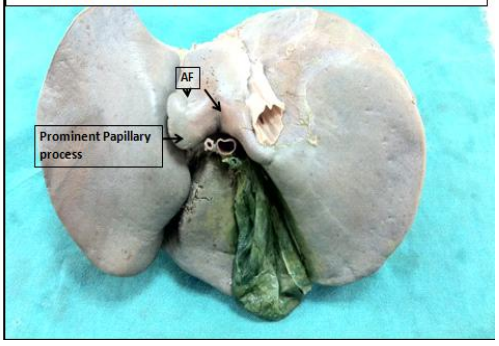


Fig-17:Show Prominent papillary process with accessory fissure(AF) of caudate lobe

Fig-18 Shows Accessory fissure between caudate process and Prominent papillary process of caudate lobe

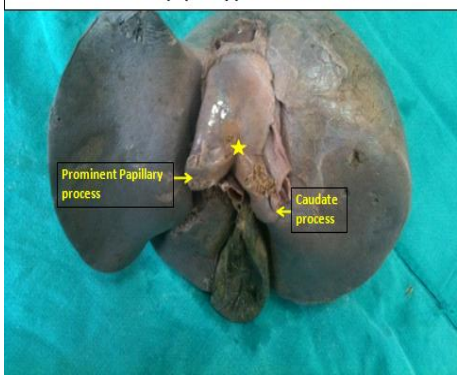
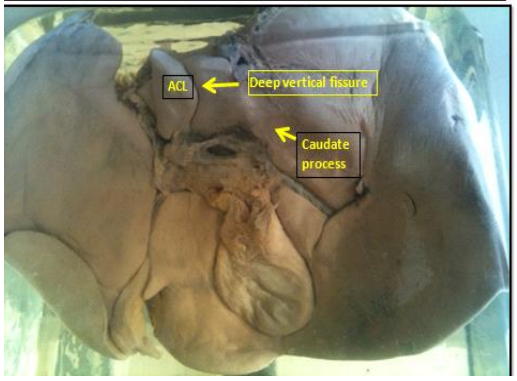


Fig-19: Accessory caudate lobe(ACL) separated completely by deep vertical fissure



V. Variation In Quadrate Lobe

Fig -20 Shows transverse fissure dividing quadrate lobe into superior (SL)& inferior lobe(IL) & presence of small accessory quadrate lobe in the Transverse fissure

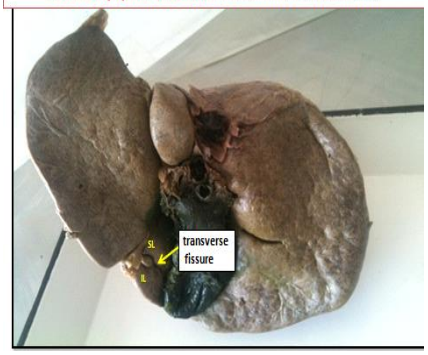


Fig-21: Deep vertical Accessory fissure dividing the Quadrate lobe into right triangular part & left quadrangular parts

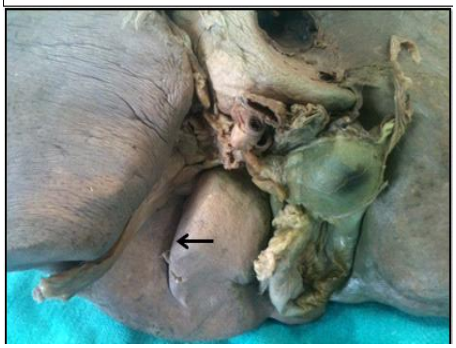


Fig -23: Narrow and triangular Quadrate lobe

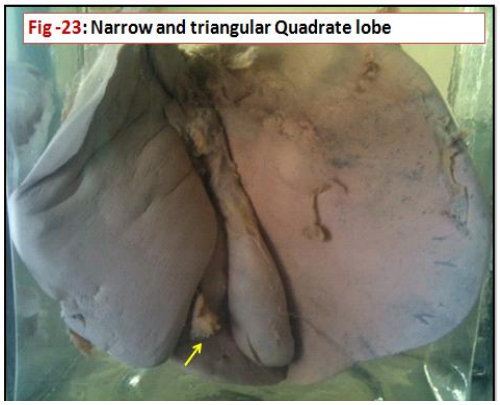


Fig - 24: Accessory lobe(AL) in the abnormal shift of quadrate lobe to right(quadrate lobe resemble like foot)

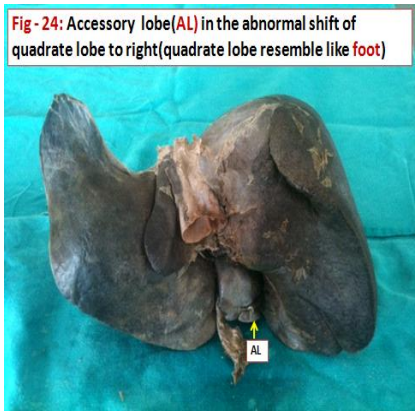


Fig -25 : Shows very narrow Quadrate lobe of liver & Pear shape Caudate lobe

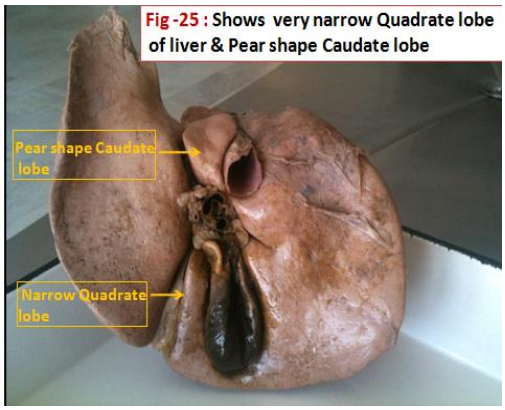


Fig -26 : Shows Accessory Quadrate lobe(AQL) and Liver tissue bridging(pons hepatis) the fissure for ligamentum teres

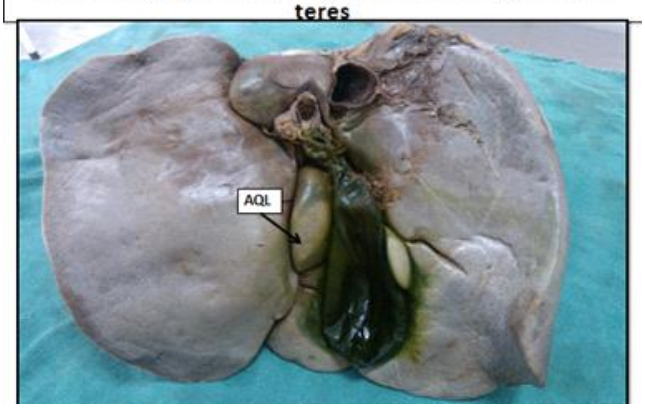
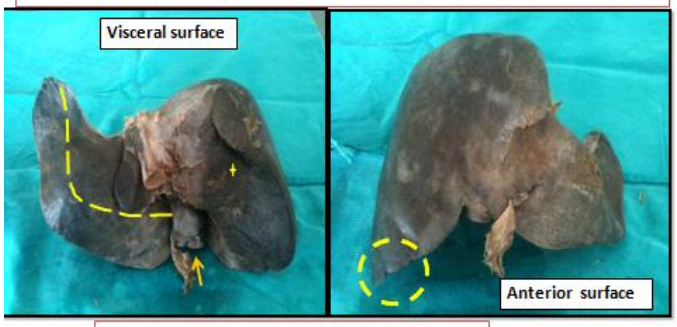


Fig -27:Hypertrophy of left lobe 'L shape' and shift of fissure of ligamentum teres & quadrate lobe(appears like foot) to right, with Riedel's lobe & deep renal impression with corset constriction



Liver with multiple anomalies

Conclusion

This work was taken up to enlighten the anatomists, morphologists, clinicians and embryologists to update the knowledge of morphological variations of liver. Knowledge of liver variations like atrophy, agenesis, and presence of accessory fissures or lobes, absence of normal fissure or lobe can cause diagnostic error in interpretation. and avoid fatal or serious complications .

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Conflict of interest: Nil

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