NEW VARIANT LIVER SURFACE MORPHOLOGY ACCORDING TO PORTAL VEIN SEGMENTATION

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Abstract

Introduction- In spite of the conventional description of external liver morphology, there are new studies about different presence of some variant liver surface features. Their clinical importance in modern liver surgery and radiology as well as hepato-pancreato-biliary practice gave us the idea to perform this study.

Material and methods- This investigation consisted of two consequently performed observations of liver surface morphology. In the first 26 fresh cadaveric liver specimens and then their acrylic portobiliary casts, obtained using injection-corrosive method, were analyzed.

Results- The features of the liver shape, classified into nine types, were not in agreement with the compared results of other authors and there were some mixed types. The caudate lobe was with very different shape. We observed bicornuate shaped lobe in 29.17% of specimens, then rectangular in 25% and some different shapes like oval, heart-shaped, triangular, pear-shaped, casquet-like, iron-like and spoon-like with a cherry were found in a lower percent. In 38.46% of specimens elongated caudate process to the right lobe, directly to the segment 7 or through paracaval portion of caudate lobe (segment 9), was found. Prominent papillary process, separated by circle sulcus was observed in 3.84%. Fissure that separated caudate and papillary processes in 42.30% of specimens was analyzed. It was confirmed in only 3 portobiliary casts because this fissure in the remaining casts separated left from the right portion (4 cases), right portion from the caudate process (3 cases) and left portion from the caudate process (1 case). Gallbladder mainly as pear-shaped was observed in 25/26 specimens, but some rare anatomic variants were found. Such was the case with only Hartmann’s pouch. It was in its usual disposition except in 19.23% with short gallbladder which fundus did not project beyond the inferior border of the liver. Fissure for lig. teres was wide and profound in 11.53% and present over anterior surface of liver in 30.76%. Pons hepatis bridging the left and quadrate lobes was by mesentery in 15.38% and as parenchymatous in 23.07%. The presence of small accessory lobe connected to the tuber omentale by mesentery containing portal and biliary elements was noted. The presence of accessory sulci or fissures at the visceral and/or diaphragmatic liver surfaces i.e. on the four liver lobes was observed in 92.30%. Of these, 53.84% of specimens were on the visceral surface while 38.46% on both, visceral and diaphragmatic surfaces. They were assessed as a single fissure in 15.38% and as multiple in the remaining 76.92%. Presence of multiple vertical grooves on the liver anterosuperior surface was noted in 19.23%. They were between portal branches of segment 8 in 3.85%; portal branches of segment 8, segment 8 and 4a in 7.69%; collaterals of segment 8, portal branches of segment 4a and left portion of segment 1 in 3.85% and between portal branches of segment 8, segment 6 and 8 in 3.85% also.

Conclusion-External morphology and internal anatomy of human liver appear during life as changeable due to developmental and/or pathologic liver processes.
Keywords: liver, variant morphology, accessory sulci, accessory lobe, gallbladder
I. INTRODUCTION

In spite of the congenital conditions during life, some developmental and pathologic processes change external appearance of the liver as well as its internal structure. External superficial liver morphology, normal or variant, in the numerous anatomical [1-11], anatomical and clinical studies [12-15] was the subject of many investigations. However, we found only few studies in which this subject was correlated with internal functional liver anatomy [1, 15-17].

Having in mind the clinical significance and application of the findings in the resective liver surgery we performed this investigation of variant liver morphology related to portobiliary intrahepatic anatomy using acrylic casts.

II. MATERIAL AND METHODS

This investigation consisted of two consequently performed observations, the first on fresh cadaveric liver specimens and the second on acrylic portobiliary casts obtained from the cadaveric specimens using injection-corrosive method.

The following features were observed and photographed in 26 cadaveric specimens: the shape of the whole liver; the shape of caudate lobe and variant morphology of caudate and papillary processes; the shape and disposition of gallbladder; variations at the level of fissure for ligamentum teres; presence of accessory sulci, fissures or notch at the diaphragmatic and visceral surfaces of the four liver lobes and other features.

In the 26 acrylic portobiliary casts the previously noted findings were correlated with portobiliary intrahepatic anatomy. The obtained results were compared with other similar investigations.

III. RESULTS

The results that present liver shape are compared and tabulated as classified by Patel et al.[18] from 1 to 7 mention by Netter [19] and from 8 to 9 by Nagato et al. [20].

<table>
<thead>
<tr>
<th>No.</th>
<th>Organ type; Characteristic features</th>
<th>Patel et al. (2014)</th>
<th>Nagato et al. (2011)</th>
<th>Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal liver</td>
<td>24 (48%)</td>
<td>26 (42.62%)</td>
<td>6 (23.1%)</td>
</tr>
<tr>
<td>2</td>
<td>Costal liver with very small left lobe and deep impressions</td>
<td>3 (6%)</td>
<td>5 (8.19%)</td>
<td>2 (7.7%)</td>
</tr>
<tr>
<td>3</td>
<td>Liver with total atrophy of the left lobe</td>
<td>1 (2%)</td>
<td>1 (1.64%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>4</td>
<td>Transversal liver with a large left lobe-saddle liver</td>
<td>0 (0%)</td>
<td>4 (6.56%)</td>
<td>13 (50.0%)</td>
</tr>
<tr>
<td>5</td>
<td>Liver with lingular process</td>
<td>14 (28%)</td>
<td>13 (21.31%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>6</td>
<td>Liver with deep renal impressions and &quot;corset&quot; type constriction</td>
<td>1 (2%)</td>
<td>6 (9.84%)</td>
<td>3 (11.5%)</td>
</tr>
<tr>
<td>7</td>
<td>Liver with diaphragmatic impressions</td>
<td>6 (12%)</td>
<td>4 (6.56%)</td>
<td>2 (7.7%)</td>
</tr>
<tr>
<td>8</td>
<td>Liver with right lobe very much smaller than the left</td>
<td>1 (2%)</td>
<td>1 (1.64%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>9</td>
<td>Liver with biliary vesicle invading the diaphragmatic face</td>
<td>0 (0%)</td>
<td>1 (1.64%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>50 (100%)</td>
<td>61 (100%)</td>
<td>26 (100%)</td>
</tr>
</tbody>
</table>

Specimens with additional features: * with diaphragmatic impressions and ° with lingular process
Figure 1: A-Liver surface morphological features as seen in an anterior view: saddle liver with diaphragmatic grooves, fissure for lig. teres over anterior surface; B-Liver surface morphological features as seen in a posterior view: caudate lobe shaped casquet-like, caudate process with semianular fissure and protuberance and fissure that separates them from central part of segment 6, vertical arch-like fissure between profound and superficial parts of quadrate lobe, pear-shaped gallbladder.

Figure 2: A-Liver surface morphological features as seen in an anterior view: saddle liver with diaphragmatic grooves and lingular process (mixed type); B-Liver surface morphological features as seen in a posterior view: bicornuate caudate lobe with both horns curved to the right, vertical fissure separating left from the right portion of caudate lobe, oblique fissure between segment 7 and 6, right portal fissure cutting inferior border of liver, vertical arch-like fissure between profound and superficial parts of quadrate lobe, wide and profound fissure for lig. teres, elongated gallbladder.

Caudate lobe is a prominent liver lobe at the visceral surface of the liver; its shape was determined in the 24 cadaveric specimens as follows: bicornuate in 7 (29.17%) specimens; rectangular in 6 (25%) specimens (Fig.4); oval in 5 (20.83%) specimens and the remaining 6-25% were heart-shaped, triangular, pear-shaped, casquet-like (Fig. 1B), iron-like (Fig. 5) and spoon-like with a cherry (Fig. 3) in one specimen each. Among these specimens there were 5 specimens in which the caudate lobe sheathed the retrohepatic inferior cava vein and in one bicornuate shaped lobe both horns curved to the right (Fig. 2B).
Figure 3: Liver surface morphological features as seen in a posterior view: caudate lobe with prominent papillary process shaped spoon-like with a cherry, caudate process elongated directly to segment 7 and separated by fissure, main portal fissure cutting the inferior border of liver until the right side of gallbladder fundus, short gallbladder, its fundus did not project beyond the inferior border of the liver, vertical arch-like fissure on the quadrate lobe.

Figure 4: Liver surface morphological features as seen in a posterior view: rectangular caudate lobe sheathed retrohepatic inferior vena cava, elongated gallbladder with calculus in its neck, presence of a pons hepatis bridging by mesentery the left and quadrate lobes at the middle part of fissure for lig. teres.

Figure 5: Liver surface morphological features as seen in a posterior view: caudate lobe iron-like shaped, caudate process elongated through paracaval portion to segment 7, oblique fissure between central part of segment 7 and 6, parenchymatous pons hepatis bridging the left and quadrate lobes.

Caudate process was usually a short prolongation to the right from the right portion of caudate lobe, except in 2 specimens with only left portion of caudate lobe. In some shapes of caudate lobe a different level of origin was observed: from the middle of right border of caudate lobe in specimens with rectangular shape and from the anterior part of right border of caudate lobe in specimens with oval shape.

In the 10 examined cadaveric specimens (38.46%) caudate process was elongated to the right lobe. According to the analyzed portobiliary casts this prolongation was to the segment 7 directly in four cases or it was through paracaval portion of caudate lobe (segment 9-Couinaud’s Right Dorsal Sector with subsegments b, c and d) more precisely through 9c subsegment in 3 cases, then through 9b and 9c in 1 case, 9c and 9d also in 1 case and through all subsegments 9b, 9c and 9d in 1 case.
Papillary process was not clearly demarcated from the rest of the caudate lobe except in 1 case with prominent papillary process and separated by circle sulcus-Fig. 3. The observed fissure that on the visceral liver surface separated caudate and papillary processes was analyzed in 11 portobiliary casts (42.30%). It was noted that only in 3 cases the fissure separated papillary from the caudate process and that this fissure separated left from the right portion in 4 cases, right portion of caudate lobe from the caudate process in other 3 cases and left portion of caudate lobe from the caudate process in 1 case with no right portion.

Gallbladder was observed in 25/26 specimens, and it was mainly pear-shaped in 11 cases, with elongated shape in 5 cases and in 1 case it was dilated with no marked parts. In the remaining specimens some rare anatomic variants were observed: shape of Phrygian cap-1 case; elongated with fundus like hourglass-2 cases; with enlarged and tortuous neck and dilated Hartmann’s pouch-1 case; elongated oval (Fig. 2B)-1 case; elongated pendulum like-1 case; kinking dumb-bell-1 case and as congenital anomaly was the case with only Hartmann’s pouch (Fig. 6).

Also, the gallbladder was in its usual disposition except in 5 cases (19.23%) with short gallbladder embedded with margins adherent to liver mass and its fundus did not project beyond the inferior border of the liver (Fig. 3).

Regarding the fissure for ligamentum teres it was wide and profound in 3 cases (11.53%) and observed over anterior surface i.e. absent, left and quadrate lobes separated by ligamentum teres on both surfaces of liver (Fig. 1A) in 8 cases (30.76%). As more important feature was the presence of a pons hepati bridging the left and quadrate lobes. The bridging was by mesentery in 4 cases (15.38%) and it was parenchymatous (Fig. 5) in 6 cases (23.07%). On the portobiliary casts from these specimens only in 1 case with parenchymatous pons the portal branch destined to the tuber omentale transverse the umbilical portion of left portal vein branch (Fig. 7A, 7B). Among the cases where the bridging was by mesentery the presence of small accessory lobe connected to the tuber omentale by mesentery containing portal and biliary elements was noted (Fig. 8A, 8B).

Figure 6: Liver surface morphological features as seen in a posterior view: congenital anomaly of gallbladder with only Hartmann’s pouch, vertical fissure at the quadrate lobe and at the left lobe that partly separated tuber omentale

Figure 7: A-Liver surface morphological features as seen in a posterior view: in the posterior part of fissure for lig. teres presence of parenchymatous pons hepati; B-Posterior view of portobiliary cast: portal branch destined to the tuber omentale transverses the umbilical portion of left portal vein branch
Figure 8: A-Liver surface morphological features as seen in a posterior view: small accessory lobe connected to the tuber omentale by mesentery; B-Left-posterior view of portobiliary cast: portal and biliary elements of accessory lobe seen on the umbilical portion of left portal vein branch

Presence of accessory sulci, fissures or notches at the visceral and/or diaphragmatic liver surfaces i.e. on the four liver lobes with very high incidence was observed.

At the level of caudate lobe according to the liver external morphology there was a vertical fissure between papillary and caudate processes and it is above documented by portobiliary casts findings. Also, at the level of caudate process the fissure was observed that separated according to the liver casts segments 9c and 7 from the 6-1 case, then caudate process and 9b from the 9c and the last case showed semiannular protuberance and fissure at the caudate process and additional fissure that separated this process from segment 6 (Fig. 1B).

At the level of quadrate lobe, on the liver visceral surface, an arch-like vertical fissure along left border of the lobe (Fig. 2B, 6) in 15 specimens (57.69%) and transverse and then arch-like fissure in 4 specimens (15.38%) were observed. The comparison with their portobiliary casts showed that this fissure separated superficial from the profound part of the lobe, partly along the left border of quadrate lobe.

The most rare accessory sulci and fissures were observed at the left lobe visceral surface. Vertical fissure that partly separated tuber omentale along the right border of the left lobe in 2 cases was noted and only in 1 case a sinusoidal sulcus separated segments 2 and 3.

The most frequent accessory sulci and fissures were observed at the right lobe visceral surface. The main fissure of division was present over both liver surfaces, cutting the inferior border of liver until the right side of gallbladder fundus in 1 case (Fig. 3) and only initially over both surfaces also in 1 case.

As to the presence of right fissure of division, separating segments 5 and 6 on the liver visceral surface, profound fissure was observed corresponding to the central-1 case or middle part-1 case of right fissure of division. Also, its presence was observed mainly as anterior part of this fissure like oblique or vertical fissure or sulcus which in 3 cases did not come up with inferior border of the liver, whereas in other 3 cases cutting inferior border of the liver was present over the liver visceral surface (Fig. 2B). Only in 1 case cutting inferior border of the liver the right fissure was present over both liver surfaces.

Separating segments 6 and 7, the most frequent feature was an oblique fissure between the central part of these segments (Fig. 2B) in 7 specimens, then between the central and middle parts of segments in 1 case and only once it was a transverse fissure separating the central parts of mentioned segments.

As a rare feature was the transverse fissure separating 9c subsegment from segment 7 on its central part. Also, a visceral surface gyration and fissure between superficial and profound parts of segment 8 was observed in a specimen with rough-like right lobe surface-segments 6 and 7.
Vertical grooves on the anterosuperior i.e. diaphragmatic liver surface were observed in 5 cases (19.23%) and on the acrylic casts it was determined that they were between segment 8 portal branches-1 case, then between segment 8, segment 8 and 4a portal branches in 2 cases, between collateral branches of segment 8, segment 4a and left portion of segment 1- caudate lobe in 1 case (Fig.1A) and in the last case between segment 8, segment 6 and 8 portal branches. Similar to this were the sulci separating segments 8 and 4a at the diaphragmatic surface of the liver in 3 cases, of which one on the left side of segment 8 had flat vertical surface. In spite of the right lobe only in 1 case a transverse fissure between segments 2 and 3 was found. The presence of main and right fissure of division at the diaphragmatic surface was previously noted.

IV. DISCUSSION

The liver shape, examined on cadaveric specimens by morphological and quantitative analyses done by Patel et al. [18] and Nagato et al. [20], was classified into nine morphological types. The present study results are not in agreement with their type distribution and some specimens appeared additional features, which can be seen in Table 1. So, such specimens present a mixed type and it is not always possible to clearly classify them.

Despite this point of view, other investigators reported only anomalous or aberrant liver morphology. Liver with extremely long left lobe and another liver which was flat like a pancake, both with unknown cause, were observed by Nayak [5]. Also, the lingular (spatula-like) prolongation of the left lobe extended across and below the left dome of the diaphragm capping spleen entirely was reported by Shivarame and Kumar [21]. On the contrary, atrophy of left lobe and elongation of right lobe [8], hypoplasia of left lobe [22] and hypertrophy or hypoplasia of left lobe [7] were found. Agenesis of right lobe of the liver and enlargement of left lobe discovered as an incidental finding during ultrasonography and computed tomography was reported by Nikam and Kitture [10].

Lingual process of left lobe present in 2 (4%) specimens was noted by Mamatha et al. [9]. But, they commented that anomalies of liver can be divided into two categories, the first due to defective development and the second due to excessive development. Acquired changes in the liver morphology were presented as linguiform lobes, costal organ with very small left lobe, deep renal impressions and ”corset” type constriction and local inflammation of the organ or gallbladder. The anomalies related to excessive development of the liver lead to the formation of accessory lobes of liver which may carry the risk of torsion.

Anjamrooz and Azari [23] reported coexistence of visceral and vascular anomalies in a cadaver of an adult Iranian man. The right lobe was elongated downward and created a very deep right hepatorenal pouch. Hypoplasia was observed in the right, quadrate and caudate lobes of liver; in particular, the posterior region of the right lobe was abnormally small. Hepatic artery and bile duct variations were found along with liver lobe anomalies. Lobular hypoplasia or aplasia was not always of congenital origin.

Gupta et al. [12] study presented the liver size by physical measurements of liver diameters and its volume and correlated them with body parameters. Also, the external surface of liver was studied for presence of fissures, which may demarcate the vascular segments and the blood vessels beneath them and may help the surgeon in resection of the liver segment.

Caudate lobe is one the most investigated liver lobe due to its very complex outflow and inflow and, on the other hand, its hilar connection with left and/or right vasculobiliary systems.

Morphological studies, in which macroscopically the caudate lobe has been investigated, have shown that this lobe may be very differently shaped. The comparison of our results with those of other investigators revealed that rectangular shaped caudate lobe was the most frequent shape with incidence of 58% in Joshi et al. [3], Abraham et al. [24], Sarala et al. [25] and of 91.66% in Arora et al. [26]
classification on contrary to the incidence of 25% in the present study. We observed bicornuate-shaped lobe in the highest percent of 29.17% that was on the second place in Joshi et al. [3] and Abraham et al. [24] studies and was not observed by Sarala et al.[25] and Arora et al. [26]. In the mentioned studies some different shapes of caudate lobe like pear or inverted pear, heart, quadrate, triangular, columnar in lower percent were found.

An abnormal, dumbbell-like caudate lobe was found in one liver (1.81%) by Nayak [5]. The case reported by Singh et al. [22] was a congenital abnormality of duplicate caudate lobe with oblique fissure and hypoplastic left lobe of liver. Their opinion was that such case is important not only for clinical practice but for morphologists for new variants along with new morphology and for new developmental defect to embryologists. Also, in 2014 Mamatha et al. [9] reported an abnormal caudate lobe in 4 livers (8%) and Phad et al. [7] streak-shaped caudate lobe.

According to Joshi et al. [3] the classification of the liver, depending on the internal architecture, differs from its gross anatomical appearance. The major fissures are important landmarks for interpreting the lobar anatomy and locating the liver lesions. They reported presence of a notch or vertical fissure separating the caudate process and the papillary process.

There is a controversy concerning interpretation of the lobar anatomy in the published studies. If the caudate lobe comprises two portions, Spieghel’s lobe or Couinaud’s Ist segment (Left Dorsal Sector) to the left of the inferior vena cava and paracaval portion or Couinaud’s IXth segment (Right Dorsal Sector with subsegments b, c and d) in front of and to the right of the inferior vena cava what is separated by the observed fissures and does the caudate process belong to the Ist or to the IXth liver segment?

In accordance with Anjamroz and Azari [23] the caudate process of the caudate lobe was posterior to the porta hepatis on one deformed liver. They thought that it was an abnormal location of the caudate process. Enlargement of caudate process and paracaval portion in 8 (10%) cases by Phad et al. [7] was seen. Arora et al. [26] noted that caudate lobe below and to the right was connected to the right lobe by a narrow caudate process, which was immediately behind the porta hepatis and above the epiploic foramen. Vertical fissure extending upwards from the inferior border of the caudate lobe was seen in 7 specimens (19.44%). From the right anterior angle of the caudate lobe, the caudate process extended anteriorly and to the right where hepatic tissue of the caudate lobe merged with the right lobe. Caudate process was present between porta hepatis anteriorly and the fossa for the inferior vena cava posteriorly.

Similar findings were found in our study. Caudate process, on the basis of portal branches origin, may originate at the level higher than anterior angle of the caudate lobe. This was confirmed with the results about fissure separating caudate and papillary processes. Also, its elongation to the segment 7 directly or through paracaval portion of caudate lobe in few specimens was demarked with additional fissure.

Kogure et al. [16] performed a study to clarify the interrelation among portal segmentation, the hepatic venous system, and the external notch of the caudate lobe. Their results showed that the proper hepatic vein was internally located by the portal fissure between the two portal areas, the Spiegel lobe and the paracaval portion. In more than half of the livers, the caudate lobe showed an external notch at the caudal edge. These notions were based on the Kumon’s division of the caudate lobe into three parts: the Spiegel lobe, the paracaval portion and the caudate process [27].

Studies about liver surface features by Joshi et al. [3], Pryakhin et al. [15] as well as about caudate lobe morphological variations by Abraham et al. [24], Sarala et al. [25], Arora et al. [26] with different incidence confirmed the presence and appearance of prominent papillary process.
In the Phad et al. [7] study enlargement of papillary process was named as feature of Spieghel’s lobe or of Counaud’s segment. Also, notch or fissure separating papillary process from the rest of the caudate lobe was seen in 2 (2.5%) specimens.

As a contribution to this, the old statement of Auh et al. [28] is worth mentioning that papillary process appeared separately from the rest of the liver in 10 (20%) of the 50 CT examinations.

Similar is the finding of one case in our study with separated papillary process on the caudate lobe surface, which was a part of the caudate lobe left portion (Fig. 3).

On the basis of the previously mentioned literature data and our own experience, we can say that caudate lobe is comprised of two portions - left and right, papillary process is the prominence of the left portion whereas caudate process is divided from the right portion except in the cases with only left portion of caudate lobe.

Shape, size and disposition of gallbladder mainly are of special interest during cholecystectomies. In spite of its variable shape, one congenital anomaly and some variant dispositions that mean different approach to the gallbladder were noted in 20% of the examined specimens. In similar percentage of 18.18% such short gallbladder was noted by Nayak [5], and in lower incidence (1 case -2%) was reported by Mamatha et al. [9]. According to Gupta et al. [12] the incidence of gallbladder fundus remaining within the inferior margin of the liver or projecting beyond was equal (50%). There was an associated anomaly like mesentery of gallbladder seen by Shetty et al. [4] among two livers on the inferior surface.

Absence of fissure for ligamentum venosum and its presence on the anterior surface was reported by Nayak [5] and a high percent of its presence over anterior surface was noted in 26% (13) of specimens in the study of Mamatha et al. [9].

Also, absence of fissure for ligamentum teres and presence of a tunnel in its place was observed by Nayak et al. [29]. The presence of the pons heptis joining the quadrate and the left lobes was seen in 30% by Joshi et al. [3]. In the majority of these cases, the pons was bridging the upper third of this fissure. In 80% of the livers the fissure continued onto the anterior surface, where the fissure was vertical, oblique or T-shaped. An abnormal connection between left lobe and quadrate lobe in 14% cases was observed by Deepak and Shanta [8]. Our findings have shown this fissure over anterior surface in 8 cases (30.77%) and the presence of a parenchymatous pons heptis or bridging by mesentery in 10 cases (38.46%). In parenchymatous bridging, only macroscopically left and quadrate lobes were fusioned, while in their internal anatomy there was a plane of subdivision as a level of demarcation among these lobes-Fig. 5, 7).

The liver tissue in communicating with the liver main mass was named an accessory lobe while the liver tissue lying the vicinity of the liver was named ectopic liver - Collan et al. [30]. They classified ectopic livers into four main types:

1. Accessory liver lobe that can reach a considerable size and is attached to the liver by a stalk.
2. Small accessory liver lobe which is attached to the liver but usually small, about 10-30 g in weight.
3. Ectopic liver which is situated outside the liver without any connection with it. It is usually attached to the gallbladder or intra-abdominal ligaments.
4. Microscopic ectopic liver which is found occasionally in the wall of the gallbladder.

Small additional lobes situated in the vicinity of the porta hepatis, caudate and quadrate lobes in 5 livers (9.09%) were observed by Nayak [5].

According to Pryakhin et al. [13] accessory lobes of the liver have different size, shape, situation and connection with maternal organ.
Accessory caudate lobe being a part of caudate lobe and having no stalk or pedicle of its own was seen by Chhabra et al. [31].

A small accessory lobe of the liver situated in the posterior part of the fissure for lig. teres, triangular in shape and about one inch in width was reported by Nayak et al. [29]. This lobe was attached to the left lobe through a vascular pedicle. Similar to this case is our case illustrated in Fig. 8A.

In the study of Pujari and Deodhare [32] there is a data on six cases of pedunculated accessory lobes of the liver with symptoms described in the English literature and all of them were found in women. Their case of symptomatic accessory lobe of liver was attached by a well defined triangular mesentery to the gastro-hepatic ligament and presented the seventh reported case. New literature report on accessory liver lobes performed in Mumbai population-Maharashtra, India, was done by Deepak and Shanta [8]. They found accessory liver lobes in 3 cases i.e. 6%, but there was no evidence of ectopic liver. Later Leena [11] reported an ectopic liver tissue attached to the serosa of gallbladder, which duct drained into the gallbladder.

Multiple prominent vertical grooves on the anterosuperior surface of the liver were also examined. Their incidence in the present study was 5 specimens (19.23%), which coincides with other author’s findings: Joshi et al [3] in 6%, Mamatha et al. [9] and Gardner et al. [15] in 12%, Shetty et al. [4] in 24%, Phad et al. [7] in 25%, Macchi et al. [1] in 40% and others.

Macchi et al. [1] investigated possible predisposing factors that might represent weak zones of the hepatic parenchyma particularly susceptible to the mechanical effect of the diaphragm. The corrosion casts showed the location of the sulci at the level of the boundaries between the ramifications of the terminal branches of the portal triad where the hepatic veins were located in 73%.

Similar to our results are those to Ono et al. [17]. They found that most grooves were located within segment VIII wholly (31/79 grooves) or partially (39/79). By contrast only 11 grooves corresponded to the border between two segments (segments VIII/IV in 6 cases and segments VIII/VII in 5 cases).

Gardner et al. [15] reported hepatic surface grooves (HSG) in an Afro-Caribbean population. All the specimens had HSG on the surface of segment IVa, 5 had HSG on the surface of segment VIII and only 1 specimen had a HSG at segment III. The fact that 50% of their cadavers had co-existing visceral grooves at segment VI suggests another etiology than “diaphragmatic slip” and “rib-compression” is responsible.

Yoshimitsu et al. [33] reported two types of pseudolesion seen at computed tomography. In the non cirrhotic liver they were distinguished due to transient extrinsic compression, typically caused by ribs or the diaphragm and due to a “third inflow” of blood from other than the usual hepatic arterial and portal venous sources: the cholecystic, parabiliary, epigastric-paraumbilical venous system, or aberrant veins. The right seventh to eleventh ribs, which are curved medially and may compress the liver, have been reported to cause pseudolesions, most typically in segments V and VI. Uneven contraction of the muscle bundles of the diaphragm can create pseudolesions around the dome of the liver, typically in segments VII and VIII. Aberrant drainage of the parabiliary venous system occasionally occurs in segments I and IV.

Accessory sulci (AS) or fissures in our study were observed in a very high incidence of 24/26 specimens (92.307%). Among these, 14 (53.84%) were on the visceral surface while 10 (38.46%) on both, visceral and diaphragmatic surfaces.

Gupta et al. [12] on normal liver specimens obtained from 50 cadavers found correlation between liver dimensions and body parameters. Also, they studied the external surface of the liver for presence of fissures and found 1-3 fissures distributed on all lobes in 70% of specimens demarcating the vascular segments. On dissection, these fissures at places corresponded to the intersegmental veins.
Incidence of fissures on various lobes on the liver surface was predominantly as single fissure except on the left lobe and ranged from 1 to 3.

On contrary, the results of the present study revealed a single fissure in 4/26 specimens (15.38%) and multiple fissures in the remaining 20/26 specimens (76.92%). A lower incidence of AS was reported by Othman et al. [2] as a rare anomaly presented in only 5% -2 specimens out of 40 embalmed cadaveric livers. The AS was located in the inferior and posterior surface of the right lobe.

According to Joshi et al. [3] accessory fissures and grooves were more common on the posterior and the inferior surface of the right lobe in 80% of 90 formalin-fixed livers, other than the diaphragmatic fissures. Also, they observed the same finding in the left (18%) and quadrate (20%) lobes. Shetty et al. [4] studied accessory fissures on 50 formalin fixed cadaveric specimens of liver. Twelve of these livers showed accessory fissures on antero-superior surface and 2 livers on their inferior surface. Furthermore, the study revealed that these fissures were more numerous on the right lobe when compared to the left lobe.

In the study done by Muktyaz et al. [6] 36 adult embalmed livers of North Indian origin were observed for the presence of AS. In different percentage AS were presented on liver surface: on inferior surface in 4 livers (11.1%), diaphragmatic surface in 2 livers (5.5%), posterior surface in one liver (2.7%) and right lateral surface in one liver (2.7%).

Mamatha et al. [9] examined 50 human cadaveric liver specimens and found accessory fissures on right and left lobes in 5 (10%), on caudate lobe in 6 (12%), on quadrate lobe in 5 (10%), fissure of lig. teres over anterior surface in 13 (26%) specimens.

Phad et al. [7] out of 80 livers, taken from embalmed cadavers, in 20 (25%) found sulci on the anterior and superior surface of the right and left lobes. These sulci were localized also on posterior and inferior surfaces and were seen in caudate and quadrate lobes.

A higher incidence of AS was present in the study by Deepak and Shanta [8]. Using formalin fixed 50 adult livers of Mumbai population-India they found accessory fissures in 21 cases (42%). The found fissures ranged from 1-5.

AS of liver in the population of Haryana-India were examined by Jain et al. [14]. They found AS in 13 (36.1%) out of 40 livers. These sulci were transverse, vertical as well as curved in shape. Out of these in nine livers a single sulcus was present (25%) while in five livers the sulci were multiple (13.88).

**V. CONCLUSION**

External morphology and internal anatomy of human liver appear during life as changeable due to developmental and/or pathologic liver processes.

**REFERENCES**


