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Original Article

ANATOMICAL BASIS FOR THE INTRAHEPATIC GLISSONIAN APPROACH DURING HEPATECTOMIES

Bases anatômicas para o acesso intra-hepático aos pedículos glissonianos durante hepatectomias

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ABSTRACT - ***Background***: Anatomical liver resections are based on some basic technical principles such as vascular control, ischemic area delineation to be resected and maximum parenchymal preservation. These aspects are achieved by the intrahepatic glissonian approach, which consists in accessing the pedicles of hepatic segments within the hepatic parenchyma. Small incisions on well-defined anatomical landmarks are performed to approach the pedicles, making dissection of the hilar plate unnecessary. ***Aim***: Analyze parameters in liver anatomy related to intrahepatic surgical technique to glissonians pedicles, to set the normal anatomy related to the procedure and thereby facilitate the attainment of this technique. ***Methods***: Anatomical parameters related to the intrahepatic glissonian approach were studied in 37 cadavers. Measurements were performed with precision instruments. Data were expressed as mean±standard deviation. The subjects were divided into groups according to gender and liver weight and groups were compared statistically. ***Results***: Twenty-five cadavers were male and 12 female. No statistically significant difference was observed in virtually all parameters when groups were compared. This demonstrates the consistency of the anatomical parameters related to the intrahepatic glissonian approach. ***Conclusion***: The results obtained in this study made possible major technical advances in the realization of open and laparoscopic hepatectomies with intrahepatic glissonian approach, and can help surgeons to perform liver resections by this method.

HEADINGS - Liver. Anatomy. Techniques. Glissonian. Hepatectomy.

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RESUMO - ***Racional***: Ressecções hepáticas anatômicas são baseadas em alguns princípios técnicos básicos, como o controle vascular, delimitação de área isquêmica a ser ressecada e máxima preservação do parênquima. Isto pode ser obtido pelo acesso intra-hepático aos pedículos glissonianos, que consiste em controle dos pedículos dos segmentos dentro do parênquima hepático. Pequenas incisões ao redor da placa hilar, em marcos anatômicos bem definidos, são utilizadas para acesso aos pedículos, tornando desnecessária a dissecção do hilo hepático. ***Objetivo***: Analisar parâmetros da anatomia do fígado relacionada com a técnica cirúrgica da abordagem intra-hepática aos pedículos glissonianos, para definir a anatomia normal relacionada ao procedimento e, assim, facilitar a realização desta técnica. ***Métodos***: Parâmetros anatômicos relacionados à abordagem intra-hepática aos pedículos glissonianos foram estudados em 37 cadáveres. As medições foram realizadas com instrumentos de precisão. Os dados foram expressos em média±desvio-padrão. Os indivíduos foram divididos em grupos de acordo com o sexo e peso do fígado e os grupos foram comparados estatisticamente. ***Resultados***: Vinte e cinco cadáveres eram do sexo masculino e 12 do feminino. Não houve diferença estatisticamente significativa em praticamente todos os parâmetros quando os grupos foram comparados. Isto demonstra a consistência dos parâmetros anatômicos relacionadas com a técnica intra-hepática de acesso glissoniano. ***Conclusão***: Os resultados obtidos neste estudo possibilitaram grandes avanços técnicos na realização de hepatectomias abertas e laparoscópicas com abordagem intra-hepática aos pedículos glissonianos, e pode ajudar cirurgiões a realizar procedimentos seguros e eficazes por este método.

DESCRITORES - Fígado. Anatomia. Técnicas. Glissoniano. Hepatectomia

INTRODUCTION

The precise knowledge of the anatomy of the liver is the most important factor in the practice of liver surgery. Presently, hepatic surgery is a segment-oriented surgery based on knowledge of the intra-hepatic disposition of glissonian pedicles[1].

The biggest challenges while performing a hepatectomy consist of the prevention and control of bleeding, preserving as much healthy parenchyma as possible, and achieving good oncological results. Anatomical hepatectomies are those in which the resected hepatic parenchyma corresponds to the segmental division of the liver.

In 1989, Galperin and Karagiulian[2] described a technique in which dissection associated with digital exposure within the hilar plate made the exposure of the glissonian pedicles easy and fast with low bleeding. One year later, Takasaki et al.[22] described a similar technique. Launois and Jamieson standardized the technique[6,7]. Finally, Machado et al.[8,9] described an innovative technique based on the studies of Galperin[2] and Launois[6], the intrahepatic glissonian approach, that precludes any dissections of the hilar plate. With small incisions on the liver capsule over well-defined anatomical landmarks it allows the approach of the pedicles of both right

and left liver[8,9]. Lately, these same anatomical landmarks were used to laparoscopic procedures[11,13].

One of the main issues that could be source of criticism to this technique is the possibility of anatomical variations and variability between gender, weight, height and hepatic volume. These could affect definitively the success and safety of the technique. Since the intra-hepatic glissonian approach does not comprise direct dissection and exposure of glissonian pedicles, precise anatomical knowledge of the intrahepatic disposition of these structures is necessary to perform it effectively and safely.

The aim of this study was to analyze parameters of the liver anatomy related to the surgical technique of the intrahepatic approach to glissonian pedicles to define the normal anatomy related to the procedure and thus facilitate the technique.

METHODS

Thirty-seven livers from adult cadavers were studied at the University of São Paulo, School of Medicine, São Paulo, SP, Brazil. All cases in which some local factor, such as previous surgical manipulation and cirrhosis, could alter the original anatomy of the upper abdomen of the corpse were excluded from this study. The dissection was carried out with proper surgical instruments for cadaveric dissection, and the measurements were performed with precise measuring instruments like a digital 200 mm caliper with a resolution of 0.01 mm (Mitutoyo 500-197 ®-20B). Glissonian pedicles from left and right liver were encircled using specific anatomical landmarks previously published[8,9,11,13] (Figures 1 and 2).

Nomenclature of hepatic anatomy and terminology of hepatic segments were used as defined by the Brisbane Convention held in 2000[20]. The results are expressed as the median (mean±standard deviation).

Cadavers were than divided in groups by gender and liver weight (more than 1300g and 1300g or less). The statistical test applied to tables was the chi-square. Continuous variables with normal distribution were compared by the unpaired Student t test.

RESULTS

Twenty-five cadavers were males and twelve females. The median weight of the liver was 1320 g, ranging between 780 g and 1800 g (1325.6±256.4 g). In 26 cases, the incisura dextra of Gans was present, there was no incisura in one and in 10 livers it was covered by hepatic parenchyma. In 21 cases, it contained the pedicle of segment 6, and in five cases, it contained the pedicles of the segments 6 and 7. In 15 cases, the bridge between segments 3 and 4 was not present, whereas it was subtle in four cases and it was present in 18 cases, uniting the cited segments around the umbilical fissure and ligament.

The length of the Arantius ligament had a median value of 35 mm (34.5±7.14 mm). The left hepatic vein presented a common trunk with the middle hepatic vein in 19 cases, while in the remaining 18 cases, these veins had separate paths between the liver and the inferior suprahepatic vena cava. Among 18 cases in which the left hepatic vein drained independently into the vena cava, in nine cases, there was an identifiable isolated path that could be encircled outside the liver parenchyma. In the remaining nine cases, this path was not identifiable.

Left pedicle

The left pedicle gives rise to the pedicles of segment 4 (with branches into segments 4a and 4b) and the pedicle to the left lateral sector, which contains the branches for segments 2 and 3. The trunk of the left pedicle shortly after his origin of the right-left bifurcation had a median diameter of 28 mm (28.2±6.4 mm). This diameter varied between 18 and 45 mm.

The pedicle of segment 4 had a median diameter of 28 mm and range between 11 and 49 mm (26.8±8.2 mm). The distance between its origin and the main portal bifurcation had a median of 22 mm (21±5.3 mm) while ranging between 7 mm

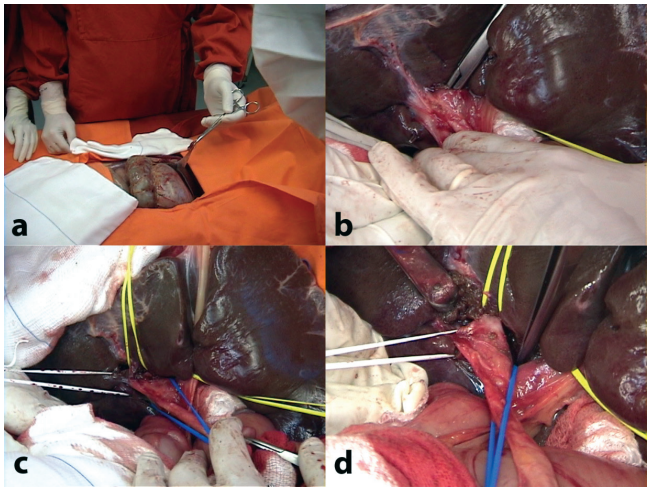

FIGURE 1 - Cadaveric dissection and retrieval of right-sided glissonian pedicles: a) anatomical parameters were studied with the liver in situ, preserving the findings and parameters encountered during an actual surgery; b) intrahepatic approach for right pedicle, using published technique[9,11]; c) final view after retrieval of right-sided glissonian pedicles: blue tape is encircling the right main pedicle (containing portal triad from segments 5 to 8); yellow tape (superior) is encircling the right anterior pedicle (segments 5 and 8); white tape is encircling the right posterior pedicle (segments 6 and 7); d) after removal of liver tissue, intrahepatic pedicles are exposed.

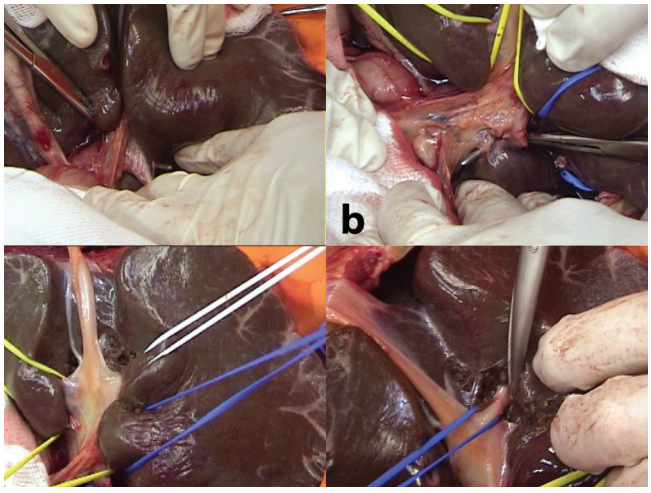

FIGURE 2 - Cadaveric dissection and retrieval of left-sided glissonian pedicles: a) intrahepatic approach for left pedicle, using published technique[8,13]; b) intrahepatic approach for pedicle from segment 1; c) final view after retrieval of left-sided glissonian pedicles: blue tape (inferior) is encircling the segment 1 pedicle (containing portal triad from segment 1); yellow (inferior) tape is encircling left main pedicle (segments 2 to 4); white tape is encircling the segment 3 pedicle; yellow (superior) tape is encircling segment 4 pedicle; blue tape (superior) is encircling the segment 2 pedicle; d) after removal of liver tissue, intrahepatic pedicles are exposed.

and 30 mm. The median diameter of the pedicle of segment 4a was 11 mm, ranging from 5 to 18 mm (11.4±3 mm). The pedicle of segment 4b had a median diameter of 10 mm and it varied between 4 and 20 mm (10.5±3.2 mm).

The pedicle of the left lateral section (segments 2 and 3) showed a median diameter of 38 mm (35.9±7.1 mm), ranging between 21 and 48 mm. The distance between its origin near the hilar plate and its bifurcation between segments 2 and 3 ranged from 1 to 5 mm, with a median of 3 mm (2.6±0.8 mm). The pedicle of segment 2 had a median diameter of 18 mm (19.5±5.4 mm), ranging between 10 and 35 mm. The pedicle of segment 3 ranged between 10 and 32 mm with a median of 17 mm (17.7±5.3 mm).

When cadavers were divided in groups by gender, there was no statically significant difference in the pedicles from the left liver (Table 1). When livers with 1300 g or less where compared to those with more than 1300 g, only the segment 4 pedicle presented statically significant difference (Table 2).

TABLE 1 – Left liver pedicles: groups divided by gender

	Female (n=12	Male (n=25)	p
Left pedicle(mm)	27,3 ± 5,4	28,6 ± 6,9	NS
Pedicle Sg 2,3 (mm)	36,4 ± 7,7	35,6 ± 7,0	NS
Pedicle Sg 2 (mm)	19,2 ± 6,8	19,6 ± 4,9	NS
Pedicle Sg 3 (mm)	19,6 ± 5,4	16,8 ± 5,2	NS
Pedicle Sg 4 (mm)	24,9 ± 10,6	27,7 ± 6,8	NS
Pedicle Sg 4a (mm)	11,9 ± 1,6	11,2 ± 3,5	NS
Pedicle Sg 4b (mm)	10,1 ± 3,3	10,7 ± 3,2	NS
Pedicle Sg 1 (mm)	10,3 ± 1,7	11,3 ± 3,8	NS

Sg=segment

TABLE 2 – Left liver pedicles: groups divided by liver weight

	≤ 1300g (n=15)	> 1300g (n=22)	p
Left pedicle(mm)	28,7 ± 6,5	27,8 ± 6,5	NS
Pedicle Sg 2,3 (mm)	36,1 ± 6,9	35,7 ± 7,4	NS
Pedicle Sg 2 (mm)	19,1 ± 5,4	19,7 ± 5,6	NS
Pedicle Sg 3 (mm)	18,1 ± 5,8	17,4 ± 5,1	NS
Pedicle Sg 4 (mm)	26,9 ± 8,6	26,7 ± 8,1	NS
Pedicle Sg 4a (mm)	12,0 ± 2,3	11,0 ± 3,4	NS
Pedicle Sg 4b (mm)	12,0 ± 3,7	9,5 ± 2,4	< 0,01
Pedicle Sg 1 (mm)	10,6 ± 3,2	11,3 ± 3,4	NS

Sg=segment

Right pedicle

The right pedicle had a median diameter of 26 mm (26.8±4.7 mm), ranging between 18 and 37 mm. The distance from its origin soon after the main portal bifurcation to its bifurcation into the anterior and posterior right pedicles ranged between 12 and 41 mm with a median distance of 27 mm (26.2±6.8 mm). The pedicle of the right anterior section (comprising segmental pedicles of segments 5 and 8) had a median diameter of 16 mm, ranging from 10 to 31 mm (17.1 mm±4.9 mm). The pedicle of the right posterior section (containing segmental pedicles of segments 6 and 7) also varied between 10 and 31 mm with a median of 18 mm (18.4±5.6 mm).

When cadavers were divided in groups by gender, there was no statically significant difference in the pedicles from the right liver (Table 3). When livers with 1300 g or less were compared, there was only statically significant difference in the pedicle of segments 6 and 7 (Table 4).

TABLE 3 – Right liver pedicles: groups divided by gender

	Female (n=12)	Male (n=25)	p
Rt ped. – Rt bif. (mm)	26,5 ± 7,6	26,0 ± 6,5	NS
Right pedicle (mm)	27,0 ± 4,6	26,7 ± 4,9	NS
Pedicle Sg 5,8 (mm)	16,5 ± 6,2	17,4 ± 4,3	NS
Pedicle Sg 6,7 (mm)	19,5 ± 6,4	17,9 ± 5,2	NS

Rt=righ; ped=pedicle; bif=bifurcation; Sg=segment

TABLE 4 – Right liver pedicles: groups divided by liver weight

	≤ 1300g (n=15)	> 1300g (n=22)	p
Rt ped. – Rt bif. (mm)	26,5 ± 5,2	26,0 ± 7,8	NS
Right pedicle (mm)	26,9 ± 5,2	26,7 ± 4,5	NS
Pedicle Sg 5,8 (mm)	17,3 ± 5,6	17,0 ± 4,6	NS
Pedicle Sg 6,7 (mm)	20,7 ± 6,0	16,8 ± 4,8	< 0,05

Rt=righ; ped=pedicle; bif=bifurcation; Sg=segment

Hilar plate and relationship with glissonian pedicles

The average distance between the hilar plate and the portal bifurcation into right and left branches was 3.5 mm (SD:1.0 mm), ranging from 1 to 7 mm. This bifurcation occurred at a median angle of 35°, ranging between 25° and 45° (35.1±5.2°). For the distance between the bifurcation of the main portal pedicle and the distal insertion of the Arantius ligament (the closest point between the ligament and the left portal vein referred to as the distal Arantius ligament), the median value was 33 mm, ranging between 20 and 40 mm (32.9±42.2 mm). The distance between the bifurcation of the main pedicle into the right and left pedicles and the base of the round ligament (the point where it comes in contact with the liver parenchyma) varied between 20 mm and 45 mm, with a median of 33 mm (32.6±6.2 mm). There was no statistically significant difference between groups when parameters related to the hilar plate were studied.

DISCUSSION

The knowledge of the intrahepatic arrangement of glissonian pedicles gains importance from the fact that the elements of the portal triad, upon entering the parenchyma, are still surrounded by an extension of the liver capsule and runs together within the liver. This fact was already known in 1640, according to descriptions of the Dutch Leiden Johannes Walaeus dated two years before the description of Francis Glisson about the capsule covering the liver on all its faces, except for the diaphragmatic face (bare area)[21]. This feature allows for the simultaneous and simple control of vascular inflow (arterial and portal branches) and biliary drainage for all liver segments described by Couinaud[1].

The technique of the intrahepatic approach to the glissonian pedicles is based on the surgical approach of hepatic segments through access to elements of the hepatic pedicle contained by a capsule of connective tissue that encompasses them in a single beam. Opening and extensive dissection of the hepatic parenchyma become unnecessary, since the parts of the liver with the corresponding pedicle of the segments to be resected are accessed only through small incisions on the hepatic capsule on previously determined landmarks[8,9,11,13]. The description of these specific landmarks was a direct result of the data collected in this study, as well as the completion of cadaver dissections performed for this purpose.

Another advancement of liver surgery was yet to come: the realization of anatomical hepatectomies by videolaparoscopy. Intrahepatic access to glissonian pedicles fit perfectly with laparoscopy, since it avoids unnecessary extensive dissection along the hepatic hilum during laparoscopic procedures, which are technically complex and potentially time-consuming with high morbidity. Moreover, the basic principles and benefits of open surgery were maintained, such as maximum preservation of the parenchyma, independent approach of all segments and sections of the liver, enabling surgeries in two stages, sequential surgery in cases of recurrence of the underlying disease, and preserving the safety and low mortality achieved with open surgery[10,11,12,13,14,15].

As demonstrated, all of these advances are inseparable from the developments in the knowledge of hepatic anatomy. This knowledge, the development of techniques, and surgical

training were achieved through cadaveric dissection and precise anatomical measurements. This is the first time that accurate measures related to the intrahepatic approach to glissonian pedicles during anatomical hepatectomies were performed. In this study, in contrast to studies, all anatomical parameters were studied with the liver in situ, preserving the findings and parameters encountered during an actual surgery (except for the weighing of the organ)[1,3,4,5,19]. Thus, parameters of normal or usual anatomy were determined. These data are useful to those who intend to perform such procedures, both in the preparation before the onset of clinical practice and during possible technical difficulties while performing a hepatectomy. Simple parameters such as the thickness of a pedicle or the angle between two pedicles, the thickness of a vein, or knowledge of what might be inside a hepatic fissure, can be used to avoid accidents during a procedure or make it easier to perform.

The results of this study have enabled major technical and scientific advances related to the intrahepatic approach to glissonian pedicles, either by open surgery or by laparoscopy. During the study period, the anatomical knowledge obtained by cadaveric dissections was immediately applied to actual anatomical hepatectomies, publications and workshops, where these parameters could be taught effectively with great reproducibility[16,17,18,23].

CONCLUSION

The data obtained in this paper, as well as the absence of statically significant difference in almost all parameters related to the intrahepatic glissonian approach confirm the steadiness of the anatomy of intrahepatic structures. These findings strongly corroborate to the fact that this technique is safe and highly reproducible.

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