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### Organometric parameters of hepatoduodenal ligament in the perinatal period

*Yuzko R.V., Slobodian O.M.*

Higher State Educational Establishment of Ukraine "Bukovinian State Medical University", Chernivtsi, Ukraine

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#### CORRESPONDING AUTHOR

e-mail: [slobodianaleksandr@ukr.net](mailto:slobodianaleksandr@ukr.net)  
Slobodian O.M.

*During any surgery, in addition to pathology-related factors, it is necessary to evaluate the individual features of the anatomy of a particular area or complex of organs. The relevance of such data is confirmed by the results of numerous studies that show that half of patients are characterized by certain anatomical variants, including the location of the arteries and biliary tract. The purpose of the work is to establish the peculiarities of the morphometric parameters of the components of the hepatic-duodenal ligament. The study was based on 50 preparations of fetus corpses (4 to 10 months) and 10 newborns without external signs of anatomical abnormalities or congenital malformations. Adequate anatomical methods were used during the study: macropreparation, injection of blood vessels, making topographic anatomical sections, morphometry. Statistical analysis of the obtained data was performed using the licensed program RStudio. During the perinatal period, the length of the hepatic-duodenal ligament was found to increase from  $5.224 \pm 0.572$  mm in fetuses for 4 months to  $32.12 \pm 1.77$  mm in newborns. The chart of change of the average values of its length by months of prenatal development indicates uneven increase of organometric parameters. From 4 to 5 months observed a significant increase in the length of the hepatic-duodenal ligament, while from 5 to 7 months of development observed a period of relative slowdown of its length, and from 5 to 6 months of development even a relative decrease in length. The period from 7 to 10 months determines the period of accelerated growth of ligament. The indices of the width of the hepatic-duodenal ligament in the perinatal period increased from  $3.292 \pm 0.227$  mm in fetus of 4 months to  $21.25 \pm 0.938$  mm in newborns. The width increases are not uniform. The periods of accelerated development (4-5 months and 9 months - newborns) and the period of slow development (5-8 months) were observed. It was proved that there are periods of accelerated and slow development, in which during periods of intensive development, organometric indicators always differed significantly, were smaller than the previous ones and outweighed the following ones respectively (4-5 months and 7-9 months,  $p < 0.05$ ). Regarding the periods of slow development, the organometric indicators in these periods did not differ significantly ( $p > 0.05$ ). Therefore, analyzing the dynamics of changes in the morphometric parameters of the components of the hepatic-duodenal ligament, revealed periods of their accelerated and slow growth.*

**Keywords:** hepatoduodenal ligament, fetus, anatomy, human.

#### Introduction

Hepatic-duodenal ligament, portal hepatic vein and gallbladder are target structures during laparoscopic cholecystectomy - one of the most common surgical interventions. This manipulation is for the purpose of treating gallstone disease, which, although a benign disease, is potentially dangerous to the patient. As with any surgical manipulation, cholecystectomy is at risk for complications and errors for the surgeon. Considering the importance of

the communication structures: biliary tract, portal hepatic vein, hepatic arteries, etc., any damage to them is dangerous to the life of the patient [21-23]. That is why, along with surgical skills, knowledge of variants and features of the topography of structures of the hepatic-duodenal ligament is equally important for the favorable course of surgery. The ductal system of the liver, gallbladder and pancreas develop from the endodermal diverticula of the duodenum, which are

immersed in the transverse septum, which promotes the formation of a ligamentous apparatus - the small omentum and hepatic-duodenal ligament [24, 25]. Further growth and rotation of the duodenum lead to displacement of the rudiments of the pancreas and extrahepatic bile ducts more dorsally than the duodenum [1-6].

The gallbladder and bladder duct develop from the vesical diverticulum. Certain features of its development lead to the formation of certain variants of the structure. By this term we can mean the doubling of the gallbladder, the septum of the bladder, the bladder deeply immersed in the parenchyma of the liver, the gallbladder with mesentery and the left-sided position of the gallbladder. It should be noted that most of these anatomical features (except for the deep position of the bladder) do not present complications for the surgeon during cholecystectomy [7-12].

The purpose of the study was to determine the peculiarities of the morphometric parameters of the components of the hepatic-duodenal ligament of fetuses and newborns.

### Materials and methods

The study was based on 50 preparations of corpses of fetus (4 to 10 months) and 10 newborns without external signs of anatomical abnormalities or congenital malformations. Adequate anatomical methods were used during the study: macropreparation, injection of blood vessels, making topographic anatomical sections, morphometry.

The work was performed in compliance with the main provisions of the Declaration of the World Medical Association on the ethical principles of conducting scientific and medical research with human participation (1964-2000) and the order of the Ministry of Health of Ukraine No. 690 of 23.09.2009 and is a fragment of a comprehensive planned initiative scientific research work of department anatomy of human named after M.G. Turkevych, anatomy, topographic anatomy and operative surgery of the Higher Medical Institute of Ukraine "Bukovinian State Medical University": "Features of morphogenesis and topography of organs and systems in prenatal and postnatal ontogeny periods" (State registration no. 0115U002769).

Statistical analysis of the obtained data was performed using the licensed program RStudio. The null hypothesis was tested that the samples were taken from one distribution or from distributions with the same median:

$H_0$ : {each group has the same distribution}

$H_1$ : {each group does not have the same distribution}.

The nature of the distributions was estimated for each of the variations obtained, the average for each trait being studied, the standard deviation, the percentile span of the indicators. Used Student's t test, nonparametric Kruskal-Wallis test (answers the question whether there are differences between group distributions, but does not specify which groups are different), Conover-Iman test for comparison of stochastic dominance and results between

different pairwise comparisons after test for stochastic dominance among groups. Statistically significant values were considered to be  $p < 0.05$ .

### Results

Analyzing the organometric parameters of the hepatic-duodenal ligament by constructing a box diagram (Fig. 1), it can be seen that the difference between the medians of the samples (horizontal line in the box) is statistically significant. The Kruskal-Wallis test performed the following results: since  $p < 0.05$ , the difference between the medians of the groups is statistically significant. Using the Conover-Iman test, when comparing the morphometric parameters of the length of the hepatic to duodenal ligament of fruits of different age groups and newborns, revealed certain features of their dynamics. The length of the hepatic-duodenal ligament of the fetus of 4 months significantly shorter than in fetus of 5 months ( $p < 0.05$ ). However, this parameter is not significantly different from such fruits for 6 months ( $p > 0.05$ ), the latter, in turn, is significantly smaller than the length of the hepatic-duodenal ligament of the fetus for 5 months. Further, from the 6th to the 9th month of development, the morphometric indices differ significantly with each other, and the index of the length of the hepatic-duodenal ligament of each subsequent month significantly exceeds that of the previous month. Median difference for couple: "10 months" - "newborns" are not statistically significant ( $p > 0.05$ ), that is, the length of the hepatic-duodenal ligament of the fetus is 10 months and newborns were not significantly different, although they were by far the highest among all study groups.

Descriptive statistics of the length of the hepatic-duodenal ligament during the perinatal ontogeny period are presented in Table 1.

The graph of the mean values of hepatic-duodenal ligament by age group (Fig. 2) of the perinatal period indicates the intensity of changes in the parameters of hepatic-duodenal ligament during the perinatal ontogeny period.

Column diagram for the group of medium hepatic-duodenal ligament widths looks like (Fig. 3).

Analyzing the morphometric parameters of the width of the hepatic-duodenal ligament by constructing a box

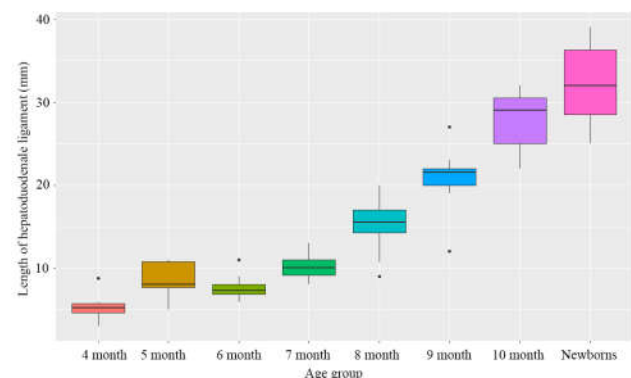
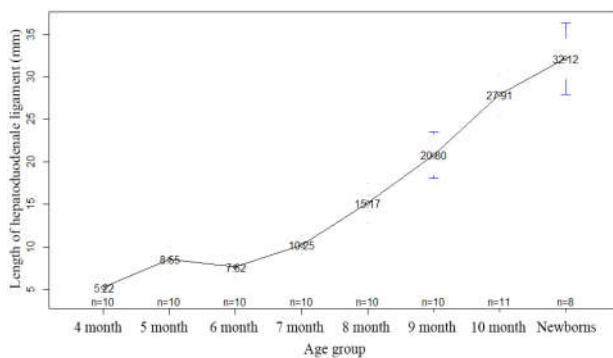


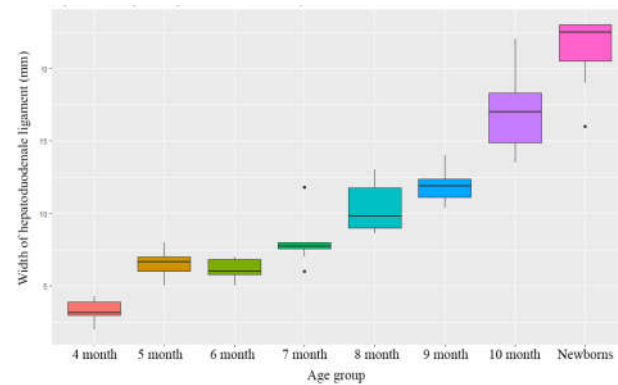
Fig. 1. Box diagram of length of hepatic-duodenal ligament by age groups.

**Table 1.** Descriptive statistics of hepatic-duodenal ligament length during the perinatal ontogeny period.

Age group	Average	Standard error for the average	Confidence interval for the average
4 month	5.224	0.572	(4.090; 6.352)
5 month	8.551	0.681	(7.021; 10.08)
6 month	7.627	0.485	(6.543; 8.753)
7 month	10.25	0.48	(9.171; 11.33)
8 month	15.17	1.04	(12.81; 17.53)
9 month	20.80	1.20	(18.09; 23.51)
10 month	27.91	1.09	(25.48; 30.34)
Newborns	32.12	1.779	(27.94; 36.30)



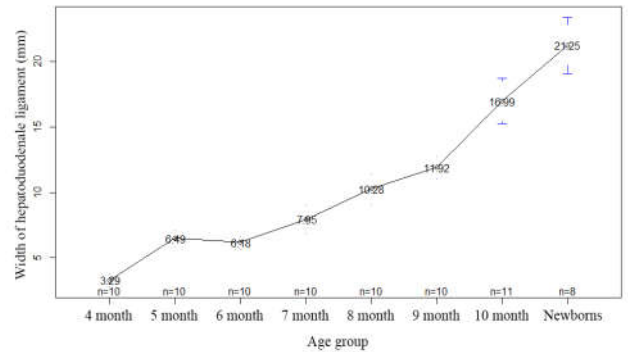
**Fig. 2.** Schedule average values of hepatic-duodenal ligament length in age groups.



**Fig. 3.** Box diagram of hepatic-duodenal ligament width by age groups.

**Table 2.** Descriptive statistics of hepatic-duodenal ligament width during the perinatal ontogeny period.

Age group	Average	Standard error for the average	Confidence interval for the average
4 month	3.292	0.227	(2.811; 3.786)
5 month	6.495	0.282	(5.862; 7.127)
6 month	6.184	0.211	(5.754; 6.667)
7 month	7.952	0.471	(6.894; 9.015)
8 month	10.28	0.51	(9.134; 11.43)
9 month	11.92	0.37	(11.08; 12.76)
10 month	16.99	0.79	(15.24; 18.74)
Newborns	21.25	0.90	(19.26; 23.38)



**Fig. 4.** Graph of mean hepatic-duodenal width by age groups.

diagram (see Fig. 3), it can be seen that the difference between the medians of the samples (horizontal line in the box) is statistically significant. The Kruskal-Wallis test performed the following results: since  $p < 0.05$ , the difference between the medians of the groups is statistically significant. Using the Conover-Iman test, when comparing the organometric parameters of the width of the hepatic-duodenal ligament of fetus of different age groups and newborns revealed certain peculiarities of their dynamics. Width of hepatic-duodenal ligament of fetus 4 months significantly less than in fetus of all subsequent age groups (5 months - newborns) ( $p < 0.05$ ). However, this parameter is not significantly different from such fetus for 5 months and 6 months ( $p > 0.05$ ), the latter in turn significantly smaller than the width of the hepatic-duodenal ligament of the fetus for 7 months - newborns. In the following, the parameters of the width of the hepatic-duodenal ligament from fetus 7 months to newborns significantly outweigh those of the previous month and significantly less than the parameters of the following months.

Descriptive statistics of the width of the hepatic-duodenal ligament during the perinatal ontogeny period are presented in Table 2.

The graph of mean hepatic-duodenal ligament lengths by age group (Fig. 4) of the perinatal period indicates the intensity of change in hepatic-duodenal ligament width during the perinatal period.

### Discussion

Comparing the graphs of the average values of the length and width of the hepatic-duodenal ligament at each of the stages of the perinatal period, it is worth noting that some processes of increasing organometric parameters are not synchronous.

The graph of average values of the length of the hepatic-duodenal ligament by age groups of the perinatal period indicates the presence of two periods of accelerated development (4-5 months and 7-9 months) and a period of slow development (5-7 months). Regarding the width of the ligament, we found that there were two periods of accelerated development (4-5 months and 9 months - newborns) and a period of slow development (5-8 months).

It is worth noting that at some stage of development (6 months), the length of the hepatic-duodenal ligament is even slightly reduced, which can probably be associated with an increase in the adjacent organs - the liver and the duodenum in this period [13-20].

The presence of periods of accelerated and delayed development is confirmed by the validity of the differences in indicators of width and length of hepatic-duodenal ligament. The period of slow increase in the ligament length is 5-7 months, coincides with periods of no significant difference between organometric parameters ( $p>0.05$ ). At the same time, the periods of accelerated growth coincide with the periods of significant difference in the morphometric parameters of the ligament (4-5 months and 7-9 months,  $p<0.05$ ). A similar situation was observed with periods of intensive and slow growth of the link width. For 4-5 months we observe a period of accelerated increase in the width of the hepatic-duodenal ligament at the same time, the morphometric parameters significantly increase and differ ( $p<0.05$ ). While in the period of slow development (5-6 months), the morphometric parameters of the ligament width do not differ ( $p>0.05$ ).

### Conclusions

1. During the perinatal period, the length of the hepatic-duodenal ligament increases from  $5.224\pm 0.572$  mm in

fetuses for 4 months to  $32.12\pm 1.77$  mm in newborns. The chart of change of the average values of its length by months of prenatal development indicates uneven increase of organometric parameters. From 4 to 5 months observed a significant increase in the length of the hepatic-duodenal ligament, while from 5 to 7 months of development observed a period of relative slowdown of its length, and from 5 to 6 months of development even a relative decrease in length. The period from 7 to 10 months determines the period of accelerated growth of ligament.

2. The indices of the width of the hepatic-duodenal ligament in the perinatal period increase from  $3.292\pm 0.227$  mm in the fetus in 4 months to  $21.25\pm 0.93$  mm in newborns. The width increases are not uniform. The periods of accelerated development (4-5 months and 9 months - newborns) and the period of slow development (5-8 months) were observed.

3. It is proved that there are periods of accelerated and delayed development, according to which, during periods of intensive development, organometric indicators always differed significantly, were smaller than the previous ones and outweighed the following ones respectively (4-5 months and 7-9 months,  $p<0.05$ ). Regarding the periods of slow development, the organometric indicators in these periods did not differ significantly ( $p>0.05$ ).

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#### ОРГАНОМЕТРИЧНІ ПАРАМЕТРИ ПЕЧІНКОВО-ДВНАДЦЯТИПАЛОЇ ЗВ'ЯЗКИ У ПЕРИНАТАЛЬНОМУ ПЕРІОДІ

Юзько Р.В., Слободян О.М.

Під час проведення будь-якого оперативного втручання, окрім факторів, що викликали патологію, необхідно оцінити індивідуальні особливості анатомії тієї чи іншої ділянки, або комплексу органів. Актуальність таких даних підтверджується результатами численних досліджень, котрі показують, що половині пацієнтів характерні певні анатомічні варіанти, зокрема, і розташування артерій та жовчовивідних шляхів. Мета роботи - встановити особливості морфометричних параметрів компонентів печінково-дванадцятипалої зв'язки. Матеріалом дослідження послужили 50 препаратів трупів плодів (від 4 до 10 місяців) та 10 новонароджених без зовнішніх ознак анатомічних відхилень або вроджених вад розвитку. Під час дослідження використовували адекватні анатомічні методи: макропрепарування, ін'єкцію кровоносних судин, виготовлення топографо-анатомічних зрізів, морфометрію. Статистичний аналіз отриманих даних проводили за допомогою ліцензованої програми RStudio. Встановлено, що впродовж перинатального періоду довжина печінково-дванадцятипалої зв'язки збільшується від  $5,224 \pm 0,572$  мм у плодів 4 міс. до  $32,12 \pm 1,77$  мм у новонароджених. Графік зміни середніх значень її довжини по місяцям внутрішньоутробного розвитку вказує на нерівномірне збільшення органометричних параметрів. Так, з 4 по 5 міс. спостерігали істотне збільшення довжини печінково-дванадцятипалої зв'язки, в той час як з 5 по 7 місяць розвитку спостерігали період відносного уповільнення збільшення її довжини, а в період з 5 по 6 місяці розвитку навіть і відносно зменшення довжини. У період з 7 по 10 місяці визначається період прискореного росту зв'язки. Показники ширини печінково-дванадцятипалої зв'язки у перинатальному періоді збільшуються з  $3,292 \pm 0,227$  мм у плодів 4 міс. до  $21,25 \pm 0,938$  мм у новонароджених. Збільшення ширини відбувається нерівномірно. Спостерігали наявність періодів прискореного розвитку (4-5 міс. та 9 міс. - новонароджені) та період уповільненого розвитку (5-8 міс.). Було доведено наявність періодів прискореного та уповільненого розвитку, за котрими у періоді інтенсивного розвитку органометричні показники завжди достовірно відрізнялись, були меншими за попередні та переважали наступні, відповідно (4-5 міс. та 7-9 міс.,  $p < 0,05$ ). Щодо періодів уповільненого розвитку, то органометричні показники в дані періоди достовірно не відрізнялись ( $p > 0,05$ ). Отже, аналізуючи динаміку змін морфометричних параметрів компонентів печінково-дванадцятипалої зв'язки, виявлені періоди їх прискореного та уповільненого росту.

**Ключові слова:** печінково-дванадцятипала зв'язка, плід, анатомія, людина.

#### ОРГАНОМЕТРИЧЕСКИЕ ПАРАМЕТРЫ ПЕЧЕНОЧНО-ДВНАДЦАТИПЕРСТНОЙ СВЯЗКИ В ПЕРИНАТАЛЬНОМ ПЕРИОДЕ

Юзько Р.В., Слободян А.Н.

Во время проведения оперативных вмешательств, кроме факторов, повлекших за собой патологию, необходимо учитывать и индивидуальные особенности анатомии той или иной области, или комплекса оперируемых органов. Актуальность таких данных подтверждается результатами множества исследований, которые указывают на то, что в половине случаев пациентам характерны определенные анатомические варианты размещения артерий и желчевыводящих путей. Цель работы - установить особенности морфометрических параметров компонентов печеночно-дванадцатиперстной связи. Материалом исследования послужили 50 препаратов трупов плодов (от 4 до 10 месяцев) и 10 новорожденных без внешних признаков анатомических отклонений или врожденных пороков развития. Во время исследования использовали адекватные анатомические методы: макропрепарирование, инъекцию кровеносных сосудов, изготовление топографоанатомических срезов, морфометрию. Статистический анализ полученных данных проводили с помощью

лицензированной программы RStudio. Установлено, что в течение перинатального периода длина печеночно-двенадцатиперстной связки увеличивается от  $5,224 \pm 0,572$  мм у плодов 4 мес. до  $32,12 \pm 1,77$  мм у новорожденных. График изменения средних значений ее длины по месяцам внутриутробного развития указывает на неравномерное увеличение органомерических параметров. Так, с 4 по 5 мес. наблюдали существенное увеличение длины печеночно-двенадцатиперстной связки, в то время как с 5 по 7 месяц развития наблюдали период относительного замедления увеличения ее длины, а в период с 5 по 6 месяц внутриутробного развития даже относительное уменьшение длины. В период с 7 по 10 месяц определяется период ускоренного роста связки. Показатели ширины печеночно-двенадцатиперстной связки в перинатальном периоде растут с  $3,292 \pm 0,227$  мм у плодов 4 мес. до  $21,25 \pm 0,938$  мм у новорожденных. Увеличение ширины происходит не равномерно. Наблюдали наличие периодов ускоренного развития (4-5 мес. и 9 мес. - новорожденные) и период замедленного развития (5-8 мес.). Было доказано наличие периодов ускоренного и замедленного развития, по которым в периоды интенсивного развития органомерические показатели всегда достоверно отличались, были меньше предыдущих и преобладали над последующими, соответственно (4-5 мес. и 7-9 мес.,  $p < 0,05$ ). Относительно периодов замедленного развития, то органомерические показатели в данные периоды достоверно не отличались ( $p > 0,05$ ). Итак, анализируя динамику изменений морфометрических параметров компонентов печеночно-двенадцатиперстной связки, выявлены периоды их ускоренного и замедленного роста.

**Ключевые слова:** печеночно-двенадцатиперстная связка, плод, анатомия, человек.

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