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The Normal Endoscopic Pancreatogram in Koreans

Jin Kyung Kang, M.D., Jae Bock Chung, M.D., Young Myong Moon, M.D.
and Heung Jai Choi, M.D.

Department of Internal Medicine, College of Medicine, Yonsei University, Seoul, Korea

The establishment of endoscopic retrograde cholangiopancreatography (ERCP) as a valuable procedure in diagnostic evaluation of patients with suspected pancreatic disease requires the precise delineation of normal pancreatography. Therefore, to establish normal standards in Koreans of pancreatic ductal morphology, such as course, diameter and length including the shape of the ampulla and the success rate of the ERCP procedure, we analyzed the pancreatograms of persons with proven normal pancreatic status. Of the 449 cases showing normal duodenal papilla, the hemispherical type of shape (49.7%) was the most common, followed by the papillary type (36.5%) and flat type (13.8%) in order of frequency. The success rate of ERCP procedure (1,020 cases) was 95.3%, and the selective success rate was 90.9% for the panceatic duct and 79.3% for the biliary tree. In the course of the pancreatic duct (286 cases), the ascending type of extension (51.7%) was the most common followed by the sigmoid type (25.2%), horizontal type (22.4%) and descending type (0.7%). The diameter of the pancreatic duct was 3.3±0.8mm in the head, 2.4±0.5mm in the body and 1.5±0.5mm in the tail portion, and there was a tendency that the diameter of the pancreatic duct progressively increased with age. The length of the pancreatic duct was 17.5±2.8cm. In conclusion we hope that, by utilizing these various parameters of the normal endoscopic retrograde pancreatogram, precise diagnosis will be possible.

Key Words: *Pancreas, Anatomy, Endoscopic retrograde pancreatogram*

INTRODUCTION

Since the first endoscopic cannulation of the papilla of Vater by McCune et al. in 1968[1], endoscopic retrograde cholangiopancreatography (ERCP) has been a valuable procedure in the diagnostic evaluation of suspected biliary and pancreatic diseases. However, this requires the precise definition of normal pancreatographic standards.

For the purpose of increasing ERCP usage along with exact diagnosis and early detection of local disease, our own clear understanding and precise knowledge of normal pancreatographic features is essential. However, most of the papers on pancreatic features have been reported by foreign authors[2,3,4,5]. Therefore, we examined pancreatic morphology by analyzing the normal pancreatographic features of persons without pancreatic diseases at Yonsei Medical Center and made diagnostic references for normal pancreatic features of Koreans in general.

Address reprint requests: Jin Kyung Kang, M.D., Department of Internal Medicine, Yonsei University College of Medicine, C.P.O. Box 8044, Seoul, 120-749, Korea

MATERIALS AND METHODS

Endoscopic cannulation and opacification of the pancreatobiliary system was performed on more than 2,000 patients at this institution from July 1973, when the first examination of ERCP was performed, until September 1985. Of this total, pancreatographic studies were selected on the basis of normal pancreatic status in sufficient numbers of provide an adequate technical study.

ERCP was perormed in the usual way using the Olympus JFB2 or B3 side-viewing duodenscope on patients premedicated with 1/150 grain of atropine and 2cc of buscopan intramuscularly 15 minutes before the procedure. Ten cc of Gascon® was given and xylocaine was applied on the pharynx just before the procedure, which was performed under fluoroscopic control, using 50% angiograffin medium.

During the early period of ERCP (from July 1973 to May 1980) objects for this study were chosen from normal pancreatograms of patients without pancreatic illness, and pancreatic ductal course, diameter and length, and the age dependent change of size and morphology of duodenal papillae were compared and examined. Since the size of the pancreatic duct appears enlarged and is different from the real size on each film, the size of the pancreatographic appearance of the pancreatic duct was calculated using the rate of enlargement of the fiberscopic view on X-ray film, thus enabling measurement of the real diameter and length of the pancreatic duct.

RESULTS

When examining the pancreatic duct and duodenal papillae concurrently with ERCP, the normal main pancreatic duct, main branch, fine branch and Santorini duct can be seen, and a progressive decrease in duct diameter from the head of the pancreas to the tail can be noticed, but the normal pancreatic duct showed morphological variance.

1. Duodenal Papillae Morphology

The morphology of the duodenal papilla was diverse and on classification of 449 normal cases by type and incidence, the hemispherical type (49.7%) was the most common, followed by the papillary type (36.5%) and flat type (13.8%) (Table 1).

Table 1. Shapes of Duodenal Papilla

Type	No. of Cases	%
Hemispherical	223	49.7
Papillary	164	36.5
Flat	62	13.8
Special	0	0.2
Total	449	100.0

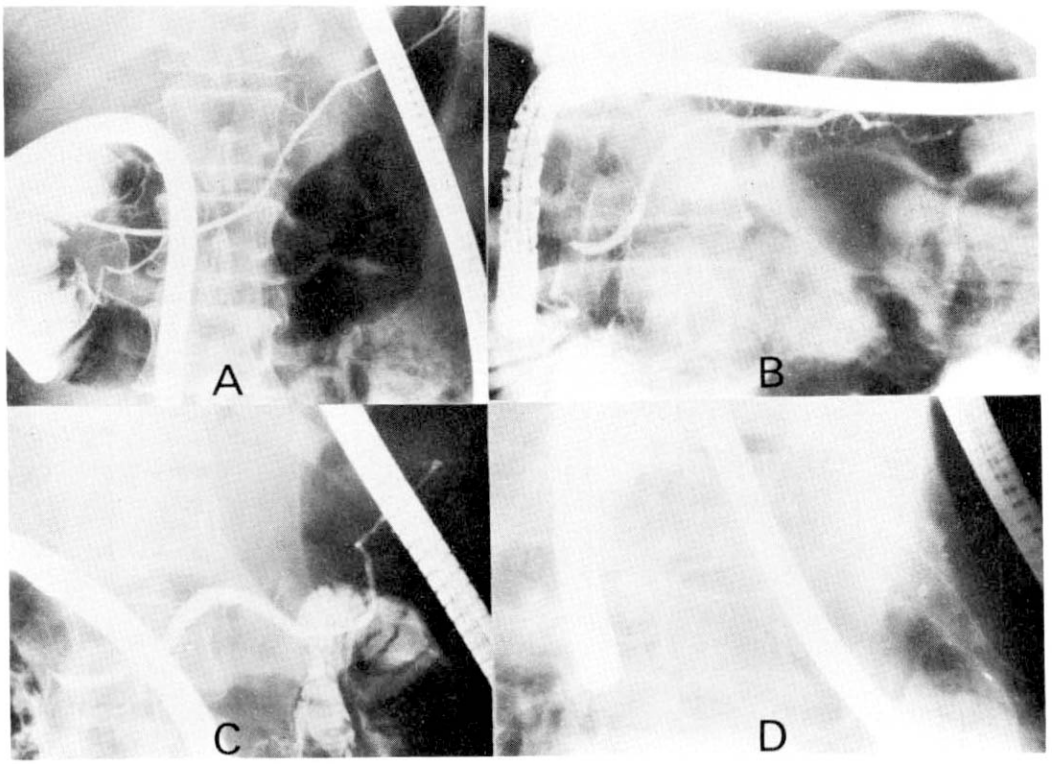

Fig. 1. *Types of course of the main pancreatic duct on endoscopic pancreatogram. A, the ascending type. The duodenum is demonstrated simultaneously with a pancreatogram. B, the horizontal type showing the fine pancreatic duct. C, the sigmoid type. D, the descending type.*

Table 2. ERCP Success Rates

Authors		Total Cases	Overall success (%)	Selective Success	
				Pancreatic duct	Biliary tree
Kasugai et al.	(1972)	270	74		
	(1974)		96.2	98.7%	91.2%
Vennes et al.	(1972)	80	75		
Cotton	(1972)	132	83	78.0%	73.0%
Ogoshi et al.	(1972)	283	88		
	(1973)	126	96		
Bilbao et al.	(1976)*	10,435	70		
Choi	(1981)	1,020	95.3	90.9%	79.3%

* Survey of 222 hospitals in USA

2. Success Rate of ERCP

ERCP was performed on 1,020 cases from July 1973 to March 1981 and the success rate was 95.3%. The selective success rate according to the study purpose was 90.9% for the pancreatic duct and 79.3% for the biliary tree (Table 2).

3. Pancreatic Duct Course

Pancreatic ductal extensions are various in that they can be classified as ascending, horizontal, sigmoid and descending types (Fig. 1). Of 286 cases studied, the ascending type was most prominent at 51.7%, sigmoid type 25.2%, horizontal type 24.2% and descending type 0.7% (Table 3.)

Table 3. Type of Course of Main Pancreatic Duct

Type	No. of Cases(%)
Ascending	148 (51.7)
Sigmoid	72 (25.2)
Horizontal	64 (22.4)
Descending	2 (0.7)
Total	286 (100.0)

4. Diameter and Length of the Main Pancreatic Duct

Of the 126 cases measured after classifying the normal pancreatic duct as consisting of a head, body and tail, the largest average diameter was the head at 3.3±0.8mm, the body was 2.4±0.5mm, and the tail was 1.5±0.5mm. The length was 17.5±2.8cm (Table 4).

5. Relationship Between the Main Pancreatic Duct and Age

Changes in the size of the main pancreatic duct were compared at diferent age levels and the result is that the diameter increased with age in people 40 years old or more (Table 5).

DISCUSSION

ERCP development has contributed much to the diagnosis of biliary and pancreatic diseases and, more importantly, to the study of anatomical morphology and structure which were previously dependent on autopsy and surgery. Normally, the morphology and size of the pancreatic duct and duodenal papilla of each person are different, and accordingly, many diagnostic references have been reported by many researchers on normal pancreatography[3,4,6,7].

The recognition of gross pancreatographic abnormalities has presented little problem. To recognize minor and hopefully early changes, however, a precise definition of the normal radiographic range is essential. The pancreas, which is 12 to 25cm in length and weights 70 to 100gm depending on the sex, lies retroperitoneally on the posterior abdominal wall and possesses an ill-defined connective tissue capsule[8]. Embryologically, the pancreas begins as two premordial doudenal diverticula, a dorsal and a ventral. The ventral enlarge is smaller and, because of the asymmetrical growth of the doudenum, it shifts in a dorsal and inferior direction and comes to lie on the same side of the duodenum as the dorsal one. Fusion of the two occurs at about 7 weeks gestation.

Anatomically, the pancreas passes from right to

Table 4. Parameters of the Pancreatic Duct in Normal Subjects

Maximum diameter (mm)			Length (cm)	No. of Cases
Head	Body	Tail		tested
3.3±0.8	2.4±0.5	1.5±0.5	17.5±2.8	126

Values are Mean ± S.D.

Table 5. Parameters of the Pancreatic Duct in Normal Subjects by Age

Age	Maximum Diameter (mm)			Length (cm)	No. of Cases
(yrs)	Head	Body	Tail		tested
10-19	2.6	1.7	0.8	13.2	1
20-29	2.7	2.1	1.5	15.0	9
30-39	3.0	2.3	1.5	16.8	35
40-49	3.2	2.3	1.6	17.9	29
50-59	3.5	2.5	1.7	18.0	35
60+	4.0	3.0	2.1	18.6	17

left, usually in a cephalad direction; the shape of the gland has been described as oblique (36% of cases), sigmoid (19%), transverse (3%), horseshoe (8%), L-shaped (33%) and inverted (11%)[9].

The major papilla is a smooth elevation that usually lies in the second part of the duodenum on the posterior or posteromedial wall. The major papilla generally lies about 8cm from the pylorus, but some authors have found it to be as close as 5cm or as far away as 14cm, which means that it can be located at any point from the junction of the first and second parts of the duodenum to within the third part[10,11,12]. Schwartz and Birnbaum[13] reported that 74% of papillae were found in the second part of the duodenum, 18% at the junction of the second and third parts, and 8% in the third part. In our cases, the major papilla was situated on the upper third or inner aspect of the mid third of the descending portion of the duodenum.

The external appearance of the major papilla has been described as flat, papillary or hemispherical[14]. Whereas the hemispherical type would appear to be the most common form, other shapes such as unformed, swollen, villus, cone-shaped, nipple-shaped and sharply pointed have been described[15]. In our cases, the hemispherical type was the most common (49.7%) and the other types were the papillary type (36.5%) and flat type (13.8%) (Table 1). The average size of the major papilla is about 1cm in diameter but a diameter as large as 3cm has also been reported[12].

In a survey of more tthan 10,000 ERCP procedures, Bilbao et al.[16] found the overall success rate for visualizing the biliary tree to be 70%. There was a significant difference in the success rate between experienced endoscopists (200 or more procedures) versus inexperienced endoscopists (25 or less procedures); 85% vs. 38%, respectively. Many authors reported that the success rate of ERCP ranged from 76.0% to 96.2%, the selective success rate for the pancreatic duct ranged from 78.0% to 98.7%, and for the biliary tree, from 63.0% to 91.2%[2,4,16,17,18,19]. In our cases, the overall success rate of the ERCP procedure was 95.3% and the selective success rates for the pancreatic duct and biliary tree were 90.9% and 79.3%, respectively (Table 2).

The main pancreatic duct (MPD) was described by Wirsung in 1642. In the body and tail it is descendent from that of the dorsal anlarge. The remnant of the proximal duodenal portion of the duct of the dorsal anlarge, when present, is the accessory pancreatic duct which was described by Santorini in 1742. The MPD in the head region is formed from the duct of the ventral anlarge[20]. The proximal MPD has been shown by rotentgenography to be consistently located at the level of the second lumbar verbetra.[3]

The extension direction of the normal pancreatic duct was so various that displacement of the pan-

creas was not very useful for diagnosis of pancreatic disease.[21] Extension from the doudenal papillae vertically to the left upper direction, so that the tail portion appears after on the 12th thorax, is the typical extension for the pancreatic duct, but according to Cotton, Varley et al. and others there have been at least 13 different types of extension introduced[2,21,22]. In general, like Kasugai et al.[4] most researchers utilize 4 types of extension direction of the pancreatic duct which are the upward, sigmoid, horizontal and downward types. Kasugai et al.[4] reported an upward type in 48.5% of cases, vertical in 26.5%, sigmoid in 16.2%, and downward type in 8.8% but Varley et al.[21] reported that the sigmoid type was the most frequent and Kreel et al. reported that the oblique type occurred in 37%, sigmoid type in 27% and L-type in 27%. In our cases, the ascending type was the most common (51.7%), and the other three types were sigmoid (25.2%), horizontal (22.4%) and descending (0.7%) (Table 2).

Diameter and length of the pancreatic duct also showed a difference among individuals and it has been reported that there is about a 30% difference among studies due to differences in X-ray filming and techniques of the reporting institutions[7]. Moreover, if the pancreas is not situated horizontally in the abdominal cavity, the X-ray does not get transmitted vertically and even if it is corrected by the fiberscopic enlargement ratio, the head is more accurately meassured than the tail. The diameter of the normal pancreatic duct shows a gradual decrease from the head to tail portion and Trapnell and Howard[23] reported in 1966 that a normal pancreatic main duct shows a 1mm change in diameter during its extension. In the extension of the pancreatic duct where the Santorini duct and duct of Wirsung meet at the boundary of the head and tail portion, it is a well known fact that there exists a physiological narrowing[7,20,24,25], and Berman[20]reports that there may exist another physiological narrowing where the superior splanchnic artery passes the center of body portion.

The largest diameter of the main pancreatic duct was reported to be larger by autopsy than by fiberscope[22] and, after studying various fiberscope and autopsy results, the average was 3-4mm for the head, 2-3mm for the body and 1-2mm for the tail. In our cases the average was 3.3 ± 0.8mm for the head, 2.4 ± 0.5mm for the body and 1.5 ± 0.5mm for the tail, which were similar to the reports by others[2,3,4,9,18] (Table 5). The length of the duct also showed a difference and in our cases it was 175 ± 28mm and others reported $142 \sim 203$mm[4,9,24].

After classifying the size of the main pancreatic duct according to age, the diameter progressively increased with age after 40 years of age (Table 4) and this coincides with the results by Millbourn[26], Kasugai et al.[4] and Kreel et al. Kasugai et al.[4] reported that it was greater for males than females. However, some other authors believe that there is no relationship between age and the size of the pancreatic duct[2,21]

Therefore, even though there can be minor variations due to the age difference, Cotton[2] and Varley et al.[21] determined the maximum limit of the diameter of the duct as 5-6mm, and if a diameter surpassed this they decided that it was an abnormal sign.

Not infrequently, the Santorini duct, branch, and microbranch do not get visualized and this is not a feature of a disease state but is due to low injection pressure of visualization. From the main pancreatic duct, about 15-30 branches come out alternatively and superiorly decrease in diameter, but sometimes a large branch gets visualized around the uncinate process or body. In about 10% of cases, the tail portion of the main duct divides into superior and inferior ducts[21]. Also, as an embryonic characteristic of the pancreas, the Santorini duct may fail to meet the duct of Wirsung such that the ventral pancreas (pancreatic divisum) occupies 3% of the pancreatic duct and in this case only 5-7cm from the major papilla gets visualized. Thus, if pancreatic disease is suspected, visualization of the Santorini duct must be performed through the minor papilla even if it is technically difficult to do so.

Because the excretion of contrast media is very rapid, the time that the contrast media remains within the pancreas is important. Normally the remaining time is 1-2 minutes and thereore if more than 5 minutes pass, it can be thought that there is an abnormality, Kasugai et al.[4] reported that the time can be as long as 10 minutes in the elderly. Pancreatic acinalization or pyelogram can be experienced in 22-26% of total ERCP and this is due to technical problems rather than disease of the pancreas[4,21]. In our study reported previously[17], the remaining time was 1-2 minutes in normal pancreatograms and 3-15 minutes in abnormal pancreatograms.

As described above, due to the increased utilizatin of ERCP for the diagnosis of pancreatic disease, various forms of the normal pancratic duct were clarified and reference values for the normal pancreatic duct of Koreans were made. In the future, when using pancreatography, a miss-diagnosis can be avoided and minor or local disease should not

be overlooked by utilization of the reference values, and thus we hope that precise diagnosis will be possible.

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