amined and was the chief component of four in the present study, no relation could be observed between crystal structure and fluoride concentration.

Summary. Thirty-three samples of urinary and 9 samples of biliary tract calculi from individuals with known histories of exposure to water-borne fluoride were analyzed for fat, ash, calcium, phosphate and fluoride. (1) Concentration of fluoride in urinary tract calculi was significantly higher than that in the bones. (2) Mean concentration of 0.25% fluoride in urinary tract calculi of individuals from low fluoride area was not significantly different from that (0.37%) of calculi of individuals whose drinking water contained 2.6 ppm fluoride. (3) No relation was apparent between the calcium and fluoride concentrations of urinary tract calculi. (4) Fluoride was present in biliary tract calculi in very low concentration (0.000-0.006%).

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Technic for Collection of Thoracic Duct Lymph of Man. (23836)

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Studies of transport of fat *via* the intestinal lymphatic pathway have been of fundamental importance for our understanding of the mechanism of fat absorption. Great progress has been made in this field during recent years due to utilization of new analytical technics and isotopic labelling of fats, and to a new method for collecting chyle in unanesthetized animals over long periods of time(1). Opportunities for studying chyle in the human have been rare and have been confined to patients with abnormal lymph connections as in the classical experiments that Munk and Rosenstein(2) performed on a girl with spontaneous lymph fistula. Subsequently, a number of cases of chylothorax have been observed (*cf.* Fernandes *et al.*(3)). Recently an extensive investigation was carried out by Blomstrand *et al.*(4) in a case of chyluria, where patient was studied under rigidly controlled conditions for 8 weeks, during which time a series of absorption experiments was conducted. Suitable cases such as those described above are extremely rare, and it is therefore desirable to have a method for collection of lymph from humans under standardized conditions. The present report describes a technic of cannulation of the thoracic duct in man, which has permitted collection of lymph of a given subject for periods of 2-5 days. With this technic for introduction of catheter into the thoracic duct it is possible

TABLE I. Clinical Data on 6 Adult Patients Subjected to Cannulation of the Thoracic Duct. None of the cancer patients had clinical evidence of gastrointestinal dysfunction.

Age	Sex	Clinical diagnosis	Scalene node biopsy	Operation after withdrawal of thoracic duct cannula	Total time for cannulation of thoracic duct, days
48	♀	Bronchogenic carcinoma of left lung with advanced node metastasis	+	Inoperable	5
62	♂	Bronchogenic carcinoma of right lung with mediastinal node metastasis and infiltration in pericardium	—	Pneumonectomy + pericardial resection and removal of node metastasis	4
44	♂	Bronchogenic carcinoma in left lung	—	Pneumonectomy + bloc dissection of the mediastinum	4
62	♂	Bronchogenic carcinoma of left lung with advanced lymphogenic spread	+	Inoperable	2
55	♂	Bronchogenic carcinoma in left lung	—	Pneumonectomy	3
47	♂	Non-tropical sprue			5

to collect the major part of lymph flow without ligation of the thoracic duct. With our method the function of the thoracic duct is thus intact after withdrawal of the catheter in contrast to the technic of Bierman *et al.* (5), who ligated and cannulated the thoracic duct in patients with advanced malignancy. The present method has been useful in the study of absorption of different isotopically labelled compounds and for the study of different aspects of lymph flow.

Methods. Cannulation of the thoracic duct with a polyethylene tubing has been performed on patients with diagnosed cancer of lungs. Relevant clinical data are listed in Table I. The diagnosis has usually been made with the aid of bronchoscopy and histopathological examination of biopsy material taken during this procedure. The routine procedure was then to perform a supraclavicular biopsy of the lymph nodes to exclude metastasis. In connection with this minor surgical procedure the thoracic duct is exposed and a plastic cannula inserted. *Operative procedure.* About two hours before operation, the patient is fed a fat-rich meal to get the thoracic duct better visualized. For cannulation of the thoracic duct a polyethylene tubing (PE 90) is used. The left supraclavicular region is prepared aseptically and the region is anesthetized by infiltration with xylocain. An incision is made parallel to clavicle and structures involved for cannulation of the thoracic duct are carefully localized (Fig. 1). Some lymph nodes are excised for histopathological examination according to the technics of Daniels(6). The thoracic duct is exposed for 20-30 mm (Fig. 2) by gentle blunt dissection just before its entrance to vena jugularis interna. The thoracic duct is 5-12 mm in diameter and is embedded in connective tissue and fat. A stay suture

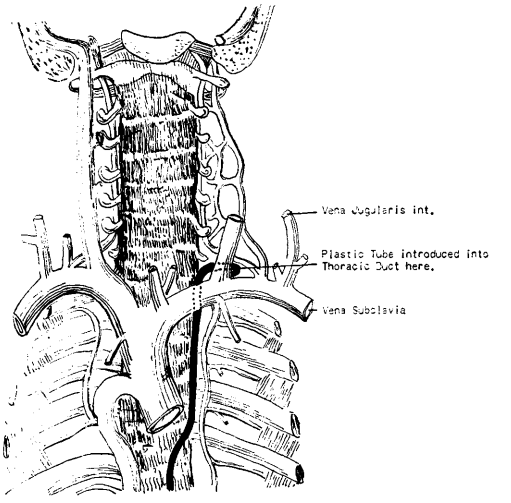

FIG. 1. A schematical drawing to show the anatomical structures involved for the cannulation of the thoracic duct.

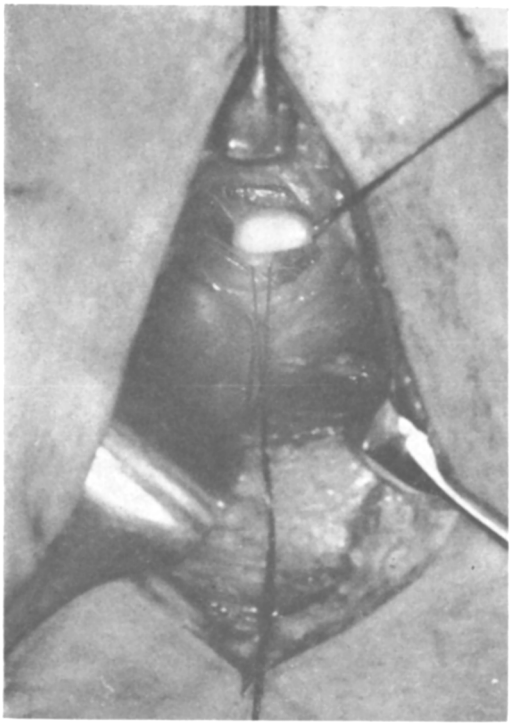

FIG. 2. Photograph of thoracic duct after being prepared free from fat and connective tissue.

is passed into wall of the thoracic duct about 20 mm before its entrance into the vein system. A second suture is placed caudal to the first, and a small longitudinal incision is made in the exposed surface of the thoracic duct close to the stay suture (Fig. 2). A bevelled end of plastic tube is then slipped gently into the duct for 10-20 mm and tied firmly in place with the 2 sutures. The tube is arranged so that it will lie relatively straight in the duct and this can be accomplished by having a suitable bend in the catheter. Before insertion of cannula this is heated and bent in a suitable angle about 10-20 mm from tip. This bend also facilitates introduction of catheter and reduces tension on tube after introduction. By inserting the cannula in the described way it has been possible to collect 100-200 ml of lymph/hour, which is about the same volume as that described by Bierman *et al.*(5) after ligation of thoracic duct cranial to inserted catheter. Apparently gravity drip is enough to drain the major part of lymph flow outside through the plastic catheter, and only a small part of lymph of the thoracic duct is able to reach the vein system. These results thus demonstrate that it is unnecessary to ligate the thoracic duct to collect the major part of the thoracic duct lymph. The present method is apparently a minor surgical procedure compared to complete ligation of thoracic duct and therefore the scope of this operation can be widened to include patients with other diseases than cancer, where it might be expected that the lymph constituents are abnormal. When chyle is not collected the cannula is filled with heparin. In this way we have been able to keep the cannula working for 2-5 days. If aseptic precautions are strictly held there might be no contraindications to collecting thoracic duct lymph for even longer periods as indicated by Bierman *et al.*(5). During the whole time of drainage it is important to control plasma electrolytes and plasma proteins continuously to be able to replace the loss of these substances through the lymph. When the experimental period was ended the wound is partly reopened under local anesthesia. The stay sutures and the catheter were removed and the opening in the thoracic duct is closed with a fine atraumatic catgut suture. In 2 cases after lymph drainage was completed, the tube was sealed and lymph within allowed to clot. The tube was uneventfully withdrawn 2 days later. In one case the catheter was accidentally drawn out during collection of lymph, but the opening in the thoracic duct closed of itself and no leakage was observed.

Biochemical methods: Analyses of the different components of serum and lymph were done mainly according to procedures described earlier(4). The alkaline phosphate activity was determined according to Bessey *et al.*(7), the acid phosphate activity according to Fishman and Lerner(8). Aldolase activity was determined according to Sibley and Lehninger(9). Transaminase activity was measured according to Karmen *et al.*(10), and lactic dehydrogenase was determined according to Wrobleski *et al.*(11).

Results. The thoracic duct has been cannulated in 6 adult patients for 2-5 days. Relevant clinical data are listed in Table I. There was no evidence of clinical dysfunction in any of these subjects during or after drainage

TABLE II. Biochemical Data of Serum and Thoracic Duct Lymph from a Patient with Cancer of the Lungs. The thoracic duct was cannulated with a plastic catheter during local anesthesia and the lymph was collected intermittently for 3 days.

		Fasting serum	Fasting lymph	Lymph obtained during fat absorption
Sodium	meq/l	142	138	140
Potassium		4.7	3.3	4.2
Calcium		4.8	4.4	5.5
Chlorides		98	97	94
Inorg. phosphorus	mg %	2.9	2.7	3.8
Glucose		110	140	120
NPN		29	23	28
Uric acid		4.2	4.1	4.0
Bilirubin		1.0	.8	1.1
Total fat	g %		1.1	5.1
Cholesterol–Total	mg %	207	60	78
Free		57	36	32
Total protein	g %	7.6	5.1	4.1
Paper electrophores	Alb.	4.30	3.42	2.83
	α_1	.34	.26	.22
	α_2	.62	.25	.17
	β_1	.39	.25	.20
	β_2	.29	.15	.11
	γ	1.46	.78	.61
Aldolase	u/ml	6	10	44
Alkaline phosphatase		2.3	1.9	6
Acid prostatic phosphatase		.3	.7	
Transaminase GOT		13	12	12
Lactic acid dehydrogenase		134		173

period. The procedure was well tolerated in all cases. Bowel movements occurred without change. Patients became acclimatised to the cannula very quickly and were ambulatory in the ward.

In Table II are shown some analyses of simultaneously obtained fasting serum and lymph and also lymph on peak of fat absorption during a representative study on a 52-year-old man with bronchial carcinoma of the left lung. The analyses are mainly in accordance with those reported for human thoracic duct lymph by Bierman *et al.*(5). Total cholesterol content of blood was markedly higher than that of lymph. Some interesting observations were made on enzyme concentration of the lymph. Aldolase activity of fasting lymph was higher than that of fasting serum. Some hours later during active absorption the activity increased 4 times. The same phenomenon was observed for alkaline phosphatase. The lactic acid dehydrogenase activity was also higher in lymph than in fasting serum. The acid phosphatase and transaminase did not show any significant difference between fasting serum and fasting lymph. However, if enzyme activity in lymph is corrected for the lower protein concentration both aldolase activity and acid prostatic phosphatase activity are significantly higher than in blood. This phenomenon thus suggests that some enzymes are carried *via* the lymphatic pathway to the blood stream and that it might be of value to determine certain enzyme concentrations in the lymph for diagnostic purposes.

After adding C^{14}-labelled fatty acids to food a prompt appearance of the isotope was observed in cases with normal fat absorption. These results thus clearly demonstrate the usefulness of this method for studying absorption of different labelled fats *via* the lymphatic pathway in man (to be published). One patient with non-tropical sprue has been cannulated and the thoracic duct lymph collected for several days. The results of this investigation will be published elsewhere.

For investigational purposes, a method for collecting thoracic duct lymph in man has long been needed. The present method of cannulating the thoracic duct is a relatively simple procedure to perform on patients in whom for diagnostic and prognostic purposes a supraclavicular lymph node biopsy has to be carried out. No evidence of chylous fistula appeared in any of our cases, nor were any other untoward reactions observed. It is therefore suggested that this cannulation technic might also be used for investigational purposes in other selected patients with *e.g.* malabsorption syndrome, hypercholesterolemia, cancer, hematological disorders, etc. where metabolic disturbances in the lymph constituents can be expected.

Summary. A method for introducing a plastic cannula into the thoracic duct of man is described. The major portion of the thoracic duct lymph can be collected intermittently for 2-5 days. No complications have been encountered. Some preliminary analyses

of human thoracic duct lymph are given. This method has been useful in the study of intestinal absorption of different labelled compounds *via* the lymphatic pathway.

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Tryptophan-Nicotinic Acid Metabolism in Schizophrenia. (23837)

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It is now fairly established that tryptophan is the dietary precursor of 5-hydroxytryptamine(1) which is then oxidatively deaminated by way of 5-hydroxyindolacetaldehyde to yield 5-hydroxyindolylacetic acid(2). The presence of 5-hydroxyindolylacetic acid in normal urine indicates that an appreciable proportion of tryptophan is metabolised *via* 5-hydroxyindole route(3). 5-hydroxytryptamine also occurs in the central nervous system and Woolley and Shaw(4-6) consider it to play a vital part in normal mental processes. They have attributed some naturally occurring psychotic states such as schizophrenia to be the result of an altered metabolism of this compound. Both deficiency as well as excessive formation of serotonin in the brain(4,7) have been held as possible aetiological factors of schizophrenia. 3-indoleacetic acid is also a normal constituent of human urine, but it is not yet settled whether it is a product of metabolism of body tissues or is derived entirely from plant material in diet and bacterial action on tryptophan in the gut(8). In view of these conflicting opinions it was considered worthwhile to study the various metabolic routes of tryptophan in patients suffering from schizophrenia and in normal men.

Material and methods. Twenty adult male patients suffering from schizophrenia admitted in the Lumbini Park Mental Hospital, Calcutta were selected for study. Normal studies were also made on 10 research workers of the laboratory. Their diets did not vary from day to day. The 24-hour urine was collected in bottle containing 10 cc toluene. Urinary excretions of 5-hydroxyindolylacetic acid and 3-indoleacetic acid were determined for 2 consecutive days in 10 subjects of schizophrenia. At end of second day's collection of urine, they were fed 5 g DL-tryptophan and 24-hour urine samples collected daily for 3 subsequent days and analyzed as before. Similar studies were also made on 10 normal subjects. Daily urinary excretions of nicotinic acid, quinolinic acid, N'-methylnicotinamide (NMN), 6-pyridone, tryptophan, kynurenin, anthranilic acid, and 3-hydroxyanthranilic acid before and for 3 days after a similar dose of tryptophan were determined on another 10 patients suffering from schizophrenia. The results of such studies on normal subjects by the authors have already been reported(9). 5-hydroxyindolylacetic acid was estimated chemically by the method of Udenfriend, Titus and Weissbach(3). 3-indoleacetic acid was estimated