

UNIVERSITATEA DE MEDICINĂ ȘI FARMACIE
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TEZĂ DE DOCTORAT

*COMPUTER TOMOGRAPHY
PREOPERATIVE ASSESSMENT OF
THE PORTAL VENOUS SYSTEM*

SUMMARY

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THE GENERAL PART

INTRODUCTION

The surgery of the gastro-intestinal tract, oncologic liver surgery and liver transplantation requires detailed preoperative analysis regarding the distribution and permeability of the involved blood vessels and bile ducts.

Current non-invasive imaging techniques are more than able to provide the required anatomic and functional information, and in particular, they can provide correct assessment of the portal venous system.

I. The portal venous system - surgical and radiological anatomy

My approach comprises embryological and anatomical considerations of the portal venous system, regarding both affluent and emergence of the portal vein, the accessory portal veins and portocaval anastomoses.

II. Pathology classes of the portal venous system - CT appearance

My approach comprises acquired and congenital pathologies of the portal venous system, from a computer tomography standpoint (portal hypertension, portal venous thrombosis, pylethrombosis, pylephlebitis, portal venous gas, portal venous trauma, portal varices).

III. CT acquisition technique in the evaluation of the portal venous system

I have outlined the main stages of the abdomen and pelvis CT evaluation:

- ✓ patient preparation;
- ✓ patient positioning;
- ✓ intravenous administration of contrast medium;
- ✓ technical considerations regarding CT image generation;
- ✓ considerations regarding the pharmacodynamics of intravenously- administered iodine-based contrast medium;
- ✓ post-processing;
- ✓ general criteria in the redaction of the CT report, for abdominal scans.

THE SPECIAL PART

I. THE OBJECTIVE

The thesis objective is to provide a framework that facilitates communication between radiologists and surgeons, regarding preoperative planning in correlation with issues of the portal venous system.

The contribution of computer tomography in this area has long been documented in the specialty literature. However, successful information transfer between radiologist and surgeon is essentially conditioned by the establishment of common language and common interest.

For this reason, my thesis has been structured into a retrospective study of several illustrative cases of portal venous system pathology, personally documented through computer tomography. Retrospective analysis allows us to gain an understanding of how the imaging diagnostic process can be improved and optimize for a better surgical treatment.

By illustrative, I refer to complex, highly difficult cases, whose exploration technique and written report require special attention, to avoid omitting essential details which weigh on therapeutic decision-making.

The entire imagery included in the special part, as well as its commentary are from personal sources and include all the material in the study.

All comments regarding particular patient preparation, scanning and processing, as well as tailoring the CT reports and the provision of additional detail, are strictly personal contributions.

II. MATERIALS AND METHOD

The study is retrospective, comprising a period of 7 and a half years.

The data set for this study is the result of selecting, from about 3600 abdominal CT scans, of 85 illustrative cases of portal pathology, each one including multidisciplinary approach of radiologist and surgeon.

From the beginning, I draw attention to the small number of multidisciplinary discussions, compared to the large number of CT exams. The present work strives to supplement the radiologist's presence in person in preoperative planning, through comprehensive and readily available transfer of information to the surgeon. In-person

meetings of specialists are seldom possible, especially when the same patient goes through different medical centers, often in different time periods.

Of the 85 cases included in the study, surgical approach has been decided and planned for in 29 cases, of which 13 have benefitted from a curative approach, 6 from palliation, while 10 patients have not consented to the operation.

II.1. Inclusion criteria

The simultaneous validation of 3 conditions has triggered inclusion:

- ✓ the CT exam has been requested and signed by a surgeon (no non-surgical requests have been included);
- ✓ the surgeon has advanced a diagnose suspicion which called for targeted CT evaluation of the portal venous system (liver cirrhosis, hepatic tumors, tumors of the pancreas, digestive hemorrhage, ascites);
- ✓ each exam was debated in a multidisciplinary approach by radiologist and surgeon.

All exams have been reanalyzed at a later time point, during the study, with Professor Nemes Raducu. The diagnostic improvements brought by a second, more mature phase, constitute proof of the experience gathered during the years of research. The surgical indication and consecutive planning have remained unchanged , but the means of communicating of imaging data to the surgeon has been substantially improved, encouraging the implementation in current practice.

II.2. Patient record sheet

II.2.1. Identification data: name, sex, age, year of exam and medical center

Of the 85 selected cases, 36 are female and 49 male, age interval between 16 and 80.

The study is retrospective, starting in February 2002 and ending in August 2012. I have performed and read these exams in 9 different imaging departments.

II.2.2. CT exam technique classification

CT exam technique classification, regarding: oral contrast medium type, scanner performance, patient body mass, scanned region (whole versus upper abdomen), the number and timing of scanning phases before and after intravenous injection of contrast medium.

II.2.3. Classification of referral diagnosis for CT examination

Classification of referral diagnosis for CT examination, which called for targeted imaging of the portal venous system (liver cirrhosis, hepatocellular carcinoma, hepatic tumors, tumors of the pancreas, upper and low digestive hemorrhage, mechanical jaundice, myeloid metaplasia with myelofibrosis, intestinal infarction, subocclusive syndrome, septic state).

II.2.5. Case classification post CT examination

Case classification post CT examination, by the type or types of portal pathology (portal hypertension, portal stenosis, pylethrombosis, portal cavernoma, portal trauma and portal varices).

III. RESULTS AND DISCUSSION

III.1. The purpose of patient preparation and the choice of CT technique

CT scanning technique is strictly dependent on scanner performance. Throughout the 7 and half years of study, marked improvement of scanning technique has been noted and implicit improvement of imagery.

Several factors directly contribute to the selection of scanning protocol: referral diagnosis, contrast medium tolerance, patient cooperation and cardiac ejection fraction, patient body mass, and the performance of the scanner and power injector.

III.2. The purpose of customized and targeted CT reporting

III.2.1. Specific and indispensable CT report information in each class of portal pathology

In order for the CT report to provide adequate support to the surgeon, it has to state all topographic data required for surgical approach (surgical vs non-surgical, curative vs palliation) and planning.

For each distinct pathology I have designed a preparation and scanning protocol, and also a report template to better index pertinent data for the surgeon.

I have also correlated the CT appearance of portal anomalies with their respective impact on the clinical state of the patient, prospectively offering useful information to the treating physician.

A CT report that is tailored for the surgical patient, as illustrated in the present study, is my proposition in the current work. It includes:

- ✓ vascular assessment (arteries, portal branching, hepatic veins);

- ✓ parenchymal assessment (liver, pancreas etc.);
- ✓ lymph node and metastatic assessment;
- ✓ tracking of suspicious or inconclusive findings (hepatic and pancreatic regenerative nodules);
- ✓ diagnostic and/or therapeutic decision-making;
- ✓ anticipation of upcoming acute clinical events.

The language currently using in imaging reporting is quite rich and often overly abstract; in lack of a more direct and free form of expression, and especially in lack of a colleague-like discussion between radiologist and surgeon regarding key points of the report, the same report can lead to different conclusions.

In certain cases, an overly technical language may mislead the treating physician into believing that CT is insufficient and needs to be supplemented by other means; the definitive diagnosis can be delayed or even missed entirely, but most often, the optimal therapeutic window is missed.

With so many aspects to be taken into consideration in the CT reporting of a complex pathology, it is nearly impossible for two radiologists, no matter how qualified, to redact identical CT reports.

The purpose of implementing a standardized CT reporting protocol is not to transform the imaging terminology into a synthetic language, but to encourage a systematic and to-the-point approach, without major omissions and risk of error.

III.2.2. Mandatory information in the CT report, for the correct defining of the type of portal abnormality:

- ✓ alteration of caliber (increase/dilation, decrease/stenosis), its cause and consequences;
- ✓ alteration of content (cruoric thrombus, bacterial thrombus, tumoral thrombus, gas), its cause and consequences.

III.3. The role of the radiologist's recommendations

The role of the radiologist's recommendations, in the CT report, as to the subsequent diagnostic conduct (imaging monitoring, additional exams/ consultations, interventional procedures, the avoiding of therapy involving clinically unforeseen risks, anticoagulation and CT follow-up on a superior scanner).

III.4. The purpose of image post-processing by the radiologist.

Post-processing is intended to enhance the oversight of vascular pathology and must be provided to the treating physician in the most eloquent form.

It is my opinion that any 3D imagery intended for the treating physician must first be approved by the radiologist, even if they are generated by the technician; if the radiologist finds it inconclusive and misleading, it is worth discarding in favor of a hand-made sketch.

III.5. The purpose of the hand-made sketch

It may be helpful for the surgeon in gaining an overview of the anatomic and pathological context, especially when 2d and 3d reformats are inconclusive or technically possible. It is a seemingly archaic and possibly offensive method, given the astounding technical means currently available; however, with minimal effort from the radiologist, it may bring tangible benefit.

This back-to-the-basics approach is the outcome of my awareness of the support provided by the acknowledged authors, both in radiology and surgery, during my training, through simple, eloquent sketches.

With apparent risk of compromising the scientific level of a medical report, a hand-made sketch of a complex vascular abnormality will always be more conclusive than an elaborate but dubious 3D reformat.

III.6. The role of accumulation of personal experience, in parallel with advents in CT imaging

Together with the performance increase in newer scanners, during the 7 and a half years of retrospective study, substantial improvement of acquisition technique and image quality is noted.

Increase in acquisition quality, as well as the development of post-processing techniques, and the establishment of a tradition in multidisciplinary talks with the surgeons serves to facilitate the gain of personal experience, and ability towards clinical judgment, which may have seemed unconventional in the early days of CT.

III.7. Multidisciplinary approach

In view of the large volume and substantial diagnostic value of the information gathered from computer tomography, I regard as essential the multidisciplinary approach.

It would be ideal to provide full details necessary for surgical treatment in all CT findings, but it requires outstanding intuition of the radiologist, which is nearly impossible in the absence of a targeted CT examination request.

A CT exam is requested only after exhausting other methods, with the intention of it being the end-point of the diagnostic process. However, I do not think of the CT report as being the end of the medical information transfer, but merely a point of view regarding a diagnosis that may be subsequently refined and integrated in the clinical context.

In complex scenarios, the radiologist and surgeon will contact each other, if the surgeon is in doubt and/or requires additional information for planning.

IV. Conclusions

Conclusions for radiologists

During the 7 and a half years of study, the performance of CT scanners has known marked improvement, making adequate image acquisition much more feasible, regardless of case difficulty and the requirement to fine-tune the technique.

A low-dose scan by itself allows reducing the radiation dose by as much as 12.5%, and allows for subsequent narrowing of the scanned range in the post-contrast phases.

It is my opinion that native and tardive scans can be dropped without fear of losing pertinent data, only when reevaluating known cases. This allows a reduction in radiation dose and scan time of up to 50%.

However, arterial and venos-phase scans remain mandatory for portal venous system assessment, preferably with angio-CT grade image acquisition, suitable for post-processing.

In the current favorable technical context, low-dose native scan and 3-phase post-contrast scan allows examining any patient without requiring fractional ingestion of oral contrast.

Instead, neutral oral contrast (water) may be administered. Ingestion time can be cut down by half an hour, and patient compliance is improved.

In cases when the radiologists knows or suspects a benefit by surgical approach, the report should include information required in surgical planning, to prevent the surgeon from requesting a supplemental CT exam.

Due to the large number of images and disproportionally short available time, there is a tendency for technicians to standardize scanning, and for the radiologist to intervene only after the scan, which leads to the radiologist being isolated from patient, surgeon and technician.

For the radiologist, it is important not to drop the suspicion of portal pathology if the base diagnosis may correlate with it, even if referral diagnosis does not specifically include it. In these cases, scanning protocol must be comprehensive.

If the CT scanner or the patient's vascular dynamics does not allow for conclusive VRT processing, a basic hand-made sketch may prove more useful to the surgeon.

Conclusions for surgeons

“Portal hypertension and subsequent visceral changes lead to numerous anatomical changes and obstacles which only an experimented surgeon can perceive and surmount”.

Prof Dr Serban Bancu

Obviously, the surgeon's experience cannot be substituted by preoperative imaging analysis. However, imaging information will help any surgeon decide quickly and correctly, even if it means choosing a different technique or cancelling the intervention in favor of a palliative strategy.

Given the large proportion of patients with portal pathology in whose case a curative approach is not feasible (38 of the 85 cases in the study presented an inoperability CT criterion that is 45%), I conclude that all patients with clinical suspicion of portal venous involvement, a whole-abdomen CT exam must be requested before admission in the surgical department.

General conclusions

In a long-term retrospective study, marked by technical and procedure advances in the evolution of CT assessment, reaching a single conclusion is like chasing a moving target.

My thesis' main contribution is in a prospective manner, for improving the relationship between radiologist and surgeon, the examination technique and the template for CT reporting.

In light of the diminishing possibilities for multidisciplinary approach, the challenge in optimizing the contribution of CT in the diagnostic/therapeutic process requires preemptive judgment of the radiologist, in order to anticipate further information requirements.

The present study aims, apart from coherently transforming an image into a phrase, to root out any sources of error and ambiguity (in communication, examination and reporting), and also to eliminate perception errors of the treating physician, which together with the patient is the end beneficiary of the CT exam.

Personal conclusions

This retrospective study has helped raise my level of training, by understanding the situations where my contribution in the diagnostic process has been insufficient or even misguided. Acknowledging medical error is emotionally difficult, especially when the physician aspires to assert himself. In addition, I have learned that the written report is not just a "snapshot" of a disease, but also especially a means of integrating preliminary clinical findings with imaging findings in a customized per-case approach. In this way, therapeutic solutions can be implemented from a superior vantage point.

This kind of preemptive approach and clinical foresight is feasible and can be achieved by the multidisciplinary consultation of the radiologist and surgeon.

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