Doppler & US Findings in Liver Cirrhosis & Portal Hypertension

by Monzer M. Abu-Yousef, MD, Professor

The normal portal vein (PV) Doppler waveform has biphasic pattern with mild undulations (Fig. 1). All waves are above baseline, V-Max = 19, +/-3, V-Min = 13, +/-3 with V-min / V-max ≥ 0.5. With Valsalva, flow becomes non-phasic. Postprandially, flow velocity and volume and PV diameter increase.

The normal hepatic (HV) Doppler waveform is multiphasic, results from right atrial pressure changes during each cardiac cycle, follows EKG tracing events and is synchronous with the jugular pulse pressure tracing (JPPT) (fig. 2). The systolic wave (S), the largest antegrade wave, is caused by movement of the atrioventricular septum towards the cardiac apex, with a mean velocity 27 cm/s. It follows the EKG QRS complex and corresponds to the x-descent on the JPPT. It is followed by a slowing v-wave that results from atrial overfilling, corresponding to the EKG T-wave and to the JPPT v-wave. This is followed by the diastolic wave (D), a smaller antegrade wave that results from tricuspid valve opening with a mean velocity of 22 cm/s and an S:D mean, 1.4 (1.1-2.8). It follows the EKG T-wave and corresponds to the JPPT Y-descent. This is followed by the reversed a-wave that is caused by atrial contraction, with a mean velocity of 10 cm/s, following the EKGT P-wave and corresponding to the JPPT a-wave.
Notes From the Chair

2012 was a transition year in the Department of Radiology. My role was one of keeping the doors to the store open; that is, encouraging continuing activity and improvement in all of our academic missions – patient care, research, and teaching, while in this interim period. Another major part of my role was to create an environment that would attract world class academic radiologists to the chair’s job here. As I write this, we have not yet identified that person, but it seems the goal is attainable.

We were lucky to attract two faculty recruits during this period: Howard O’Rourke in musculoskeletal radiology and Josh McDonald in body imaging. Both are top notch academicians and add greatly to our program.

At the same time one of our stalwarts, Dr. Wendy Smoker, announced her retirement as of June 31, 2013. Wendy precedes even me in departmental longevity. She was a second year resident in Radiology when I arrived here in 1979. Joining her in retirement was Dr. Bill Stanford. All three of us plan to carry on volunteer activities with the department in teaching, small group sessions, etc.

The institution has launched a major new program in a brand new building – the Iowa River Landing facility. This is a 100% outpatient facility located in the Iowa River Landing project in Coralville. It is designed as a one-stop destination for our patients with medical needs not requiring intense subspecialty consultation. Radiology is represented at the Iowa River Landing with several radiographic rooms, ultrasound units, and CT. At the moment, radiological interpretation of the images is handled by teleradiology from our parent site.

Five academic promotions occurred last year. These include Drs. Lee Bennett, Joan Maley, Toshio Moritani, and Shiliang Sun to the rank of Clinical Professor; and Dr. Fadi Youness to the rank of Clinical Associate Professor.

We are now facing the inevitable problem of reduced professional income. Like all radiology practices, our reimbursement has fallen. And changes for compliance with the Affordable Care Act will cause a substantial further reduction in both professional and hospital income. We will cope, but it will be a difficult time.

I again appeal to our alumni for financial support. It is even more difficult in these times to maintain a teaching program for medical students, conduct top notch residency and fellowship programs, and allow research by our faculty. I ask those who trained here, either in medical school, residency, or fellowship, to consider a contribution to the University of Iowa Foundation for radiology research and teaching. Such support is critical to maintaining quality in our academic mission.

From my own standpoint, it was an interesting one and one half years to return as interim chair and full time faculty member. Most of the experiences were positive during this period; others I’ll hopefully forget about in a few months. I hope my performance during this time has added value to Iowa Radiology.

(continued next page)
The US findings in liver cirrhosis include enlarged caudate lobe, nodular liver surface, compressed HVs, coarse liver echotexture, increased then decreased liver size (Fig. 3). The Doppler findings are less specific and include decreased HV phasicity (Fig. 4) and increased hepatic arterial resistive indices. The US and Doppler findings in portal hypertension include increased PV diameter, splenomegaly, ascites, loss of PV flow phasicity, decrease PV flow velocity, reversed PV flow and dilated portosystemic collaterals. The latter include recanalized umbilical vein (UV) (Fig. 5), flow reversal in coronary vein, dilated gastric varices, splenorenal collaterals, recanalized ductus venosus, gallbladder varices and perihepatic collaterals.

Doppler US also plays an important role in evaluating porto-systemic shunts, the most commonly used of which is the TIPS shunt (Fig. 6). Doppler US signs of TIPS shunt malfunction can be direct or indirect. Direct signs include velocity in any stent segment of <60 or >200 cm/s, Interval velocity Δ in same area of >50cm/sec, velocity transition zone of > 2 times, TIPS non-filling or trickle flow, narrowing of the stent or the HV that drains it and aliasing seen in any segment of the stent on color Doppler. Indirect signs include decrease in PV velocity to < 30 cm/sec, decrease in PV velocity of >33% of baseline, antegrade flow in PV branches, flow seen in umbilical vein, loss of triphasic flow pattern in PV and worsening ascites and splenomegaly.
This fall, the first classes of the Carver College of Medicine’s new curriculum will be held. Three years ago the College began a curriculum renewal process. Driven by our desire to be an innovative leader in medical education as well as factors such as the exponential increase in medical knowledge, changes to the MCAT and USMLE and the continuing development of better teaching methods, literally hundreds of faculty across the college have reconsidered the needs of future physicians and how best to educate them. As a result, the College has developed an educational structure that will address significant anticipated societal needs; improve integration of basic, clinical and social sciences within and across all four years; provide earlier clinical experiences and appropriate skill development; and promote learner centered education, student well being, engagement and active learning.

One of the most significant innovations in the new curriculum is that our curriculum will be organized along three threads that will be woven throughout the 4 years rather than by discipline or organ system. In considering various organizing principles, the College recognized that there are a limited number of biologic mechanisms by which humans respond to injury. Understanding these mechanisms reveal the integrated homeostatic systems that underlie health. Social behavior and environmental factors largely act through these same basic mechanisms to produce disease. Thus, a fundamental organizing principle the curriculum will use is the Mechanisms of Health and Disease (MOHD). The basic and applied clinical sciences will be organized along the six fundamental mechanisms of oxygenation/ischemia, metabolism, genetics/neoplasia, musculoskeletal/integument, behavioral/neuroscience and immunologic/infection. These mechanisms will weave through both the preclinical and clinical courses.

However, the richness of the practice of medicine requires more than just understanding these mechanisms. Thus, two additional strands, Clinical and Professional Skills (CAPS) and Medicine and Society (MAS) will also be woven across the 4 years. CAPS will address needed skills ranging from how to perform a physical exam to biomedical ethics, patient safety, interprofessional education, personal wellness and others. MAS will address the behavioral, cultural, environmental and socioeconomic factors that effect health.

A second key innovation is the spiral nature of the curriculum. There will be a deliberate integration/revisiting of core principles/topics/skills/attitude occurring at regular intervals throughout the 4 years. Each revisiting will review and build on previously introduced material extending it in depth, breadth and application. This revisiting will continually reinforce the integration of the basic and clinical sciences across the curriculum, helping our students develop into the most competent of physicians.

The third innovation tying this all together will be in expanding our teaching methods. Although there will always be a place for interactive engaging lectures, other pedagogies including team-based learning, “flipped” classrooms, and interprofessional education will play a prominent role in how student experience the curriculum.

Last fall, the new CAPS and MAS strands replaced our previous course, Foundations of Clinical Practice. In fall 2014, the entire new first year will be rolled out. After 3 years of planning, discussion and design, the new curriculum begins. It’s an exciting time.
Sectional Update
Neuroradiology
Joan E. Maley, MD
Professor & Interim Chair of Radiology; Director of Neuroradiology Section

The Neuroradiology Section continues to move forward to try to meet the demands of our clinical colleagues and patients. Seven Neuroradiologists, Drs. Andres Capizzano, Jack Kademian, Jinsuh Kim, Toshio Moritani, Bruno Policeni, Wendy Smoker and I make up the faculty in our section. We have four fellows in our ACGME accredited Neuroradiology Fellowship program and one position in our non-accredited Head and Neck fellowship program, which is not currently filled.

Recently, we purchased updated perfusion imaging and functional MR software. The perfusion imaging software allows us to perform tumor and mass perfusion as well as stroke imaging. As physiologic imaging continues to grow, we are expanding our role in this area and receive increasing requests for functional imaging, primarily in seizure and preoperative patients.

We continue our three-part mission of excellent clinical care, education to our students, residents and fellows, and research. We have been fortunate to be very successful academically with publications and multiple national and international presentations. Dr. Smoker hosted two “Midwest Head and Neck Meetings” this year, which gave everyone an opportunity to hear superior lectures right here in Iowa City.

We are fortunate to work with excellent colleagues and trainees. We welcome the opportunity to catch up with everyone at meetings or here in Iowa City if you happen to make it back for a visit.

A Letter from the UI Foundation: Investing in a Healthier Future

Through first-rate education, outstanding clinical practice, and groundbreaking research, the University of Iowa Department of Radiology is helping to change peoples’ lives. Whether it is treating patients or training students at all levels—undergraduate, graduate, and postgraduate—the department offers world-class care and expertise.

It does so through visionary support from alumni and friends such as you. I would like to thank you for your generous contributions, which help the department invest in educational resources covering everything from endowed faculty positions to seed money for research—which is more important than ever, now that National Institute of Health funding can be difficult to secure.

I relish the opportunity, in my new role as executive director of development for major gifts for the Roy J. and Lucille A. Carver College of Medicine and University of Iowa Hospitals and Clinics—and as interim director of development for radiology—to work with our alumni and friends in enhancing the department’s excellence.

Together, we can assist the UI Department of Radiology in continuing to innovate and educate. It’s an honor to build upon the success of an exceptional program that will help transform the future of health care for generations to come.

For additional information about how private support benefits the UI Department of Radiology, please contact Bridget Hoffman, the UI Foundation’s executive director of development for the Carver College of Medicine and UI Hospitals and Clinics, at bridget-hoffman@uiowa.edu or at 319-335-3305 or 800-648-6973.
Edmund A. (Tony) Franken, Jr., MD, Steps Down as Interim Chair

Following a national search in 1979, Dr. E. A. Franken was appointed Professor and Chairman of the Department of Radiology at The University of Iowa. He came to Iowa after serving eight years as the Director of Radiology at the James Witcomb Riley Hospital for Children in Indianapolis.

Dr. Franken’s leadership and vision quickly propelled the Department of Radiology at The University of Iowa into the first tier among academic departments. He founded the Iowa Imaging Perception Laboratory, which has been continuously funded by NIH grants since 1986. This laboratory is internationally recognized for its studies in mathematical modeling in the field of perception. Dr. Franken also encouraged basic scientists to join the department and he helped establish the Imaging Pulmonary Physiology Lab.

Dr. Franken never lost sight of the fact that radiology is a technology driven discipline and he strived to keep Iowa at the cutting edge of innovation. It is hard to believe that a rural state like Iowa was among the first group to introduce every new technology in diagnostic imaging. CT was started at The University of Iowa as a clinical service in 1973, MRI in 1984, electron beam CT in 1987, PACS technology in 1986, PET scanning in 1989 and teleradiology in 1987. Before anyone heard of the internet, Dr. Franken committed department resources to the start-up of the Virtual Hospital, which has become a major institutional initiative and at that time it was recognized as one of the foremost medical information sites available on the web.

During his 17 year tenure as a Chairman, and twice as the Interim Chairman, more than 240 residents and fellows completed their postgraduate training at The University of Iowa Department of Radiology.

Some of the many highlights of Dr. Franken’s career of service to radiology include:

- 1978 – 1979, Dr. Franken served as the President of the Indiana Radiological Society
- 1989 – 1990, Dr. Franken was President of The Society for Pediatric Radiology (Gold Medal 1999)
- He served as the International Visiting Professor of the RSNA in Kenya (January-February 1987) and Turkey (June 1999)
- 1991-1994, Chairman of the Scientific Exhibits Committee of the RSNA
- May 2001, he was awarded the Association of University Radiologists prestigious “Gold Medal Award” for service and leadership to organized radiology.
- In 2005, Dr. Franken was awarded the Radiological Society of North America (RSNA) Gold Medal.
- In 2013, he was given an “Honorary Member Award” from the Japan Radiological Society.

Dr. Franken’s positive influence on Radiology will be everlasting and his legacy enduring.

Georges Y. El-Khoury, MD
Neuroradiologist Wendy R. K. Smoker, MS, MD, FACR Retires

I am very bittersweet as I write this short summary about the career of Dr. Wendy Smoker because it means she has entered retirement. I am happy for Dr. Smoker as she now gets to focus on teaching and mentoring but we no longer have her around daily to guide us and, yes, sometimes push us. It is hard to “summarize” a career as productive as Dr. Smoker’s, but here I go.

Dr. Smoker had education in her genes. She was born in Evanston, Illinois while her parents were graduate students in Chemistry at Northwestern University. After living in Pennsylvania for a few early years, she returned to Park Ridge, Illinois, and completed grade school and high school before attending The University of Iowa. While at Iowa, she completed undergraduate and graduate degrees, medical school training and all of her radiology training.

Dr. Smoker subsequently joined the faculty at the University of Iowa as an Assistant Professor, relocated to the University of Utah in 1986 as an Associate Professor, and, in 1990, accepted a position as Professor and Director of Neuroradiology at the Medical College of Virginia. She returned to The University of Iowa in 2001 where she was a Professor of Radiology, Neurology, and Neurosurgery, as well as Director of the Division of Neuroradiology.

Dr. Smoker has lectured widely, both nationally and internationally more than 300 times and is highly regarded as an outstanding educator. She has been on the AFIP and now AIRP faculty for many years and has received numerous teaching awards. She has been a reviewer for more than 10 major journals, served as Deputy Editor for Radiology, and was on the Editorial Advisory Board for the American Journal of Neuroradiology for many years. She has authored 135 articles, 44 book chapters, and 128 scientific and educational exhibits, winning many awards over the years for these exhibits. Dr. Smoker has served on numerous committees for at least 15 societies, serving on the executive committees of many of these societies, and was the ASHNR president in 1998. Everyone knows that if Dr. Smoker is involved, whatever the task at hand is, it will be done to the very best.

Dr. Smoker has been, and will continue to be, an inspiration to her colleagues and trainees. She is highly admired as a scholar and for her many years of service and contributions to the ASHNR. She was awarded the 2010 Gold Medal as a symbol of her outstanding achievements and for fostering the field of head and neck radiology. Dr. Smoker will continue to have a presence in our department as she continues to lecture and mentor students, residents and faculty on projects.

Wendy has one son Andrew, his wife Allison and a granddaughter, Addison.

All of us in Radiology are greatly appreciative of Dr. Smoker’s contribution to the department and her unwavering dedication to academic radiology.

Joan E. Maley, MD

Georges Y. El-Khoury, MD, FACR Receives 2013 ISS Medal

Musculoskeletal radiologist, Dr. Georges Y. El-Khoury, was presented the Medal of the International Skeletal Society (ISS) at the 40th Annual Meeting and Musculoskeletal Imaging Course on October 1, 2013. This medal is “presented to persons who have provided outstanding support to the endeavors of the International Skeletal Society.”
Dear Department of Radiology:

I am thrilled to be your feature Department of Radiology alumnus for this newsletter. I was born and raised in Ottumwa, IA. I had always aspired to go to medical school, so I went to The University of Iowa as a freshman in 1980 where I received a BS degree in Mathematics. Once in medical school at The University of Iowa, I had lectures in Radiology Anatomy from Dr. Mary Kathol and Dr. Wendy Smoker. I thought those women professors were amazing and I wanted to do what they did. With my mathematics background, I did physics research with Dr. Erhardt in MRI during medical school. I was honored to do my Radiology Residency at The University of Iowa where I was Chief Resident 1991-1992. That same year I was elected Chairman of the American Association of Academic Chief Residents in Radiology (A3CR2). I stayed on staff at The University of Iowa, Department of Radiology in the Abdominal Imaging Section, mainly due to my admiration for Dr. Tony Franken. In 1999, I decided to try private practice and joined a number of my fellow University of Iowa radiology residents in Davenport, IA. Because I enjoyed the teaching aspects of academics so much, I continued that endeavor in my new position. My efforts were recognized by being awarded the Preceptor of the Year, University of Iowa Family Practice, Quad Cities in 2003 and by becoming a Fellow of the American College of Radiology in 2013.

In my free time, my husband Chester and I are raising 3 children (Rachel and Chester IV 17 y/o twins and Charles 13 y/o), all born at The University of Iowa Hospitals and Clinics. Rachel hopes to follow in my footsteps! The wonders of the University of Iowa Hospitals and Clinics continue as I received a kidney transplant there in 2012. Due to their expertise, I am able to continue working full time in Radiology.

I will always be connected to the University of Iowa and especially to the Department of Radiology. Thank you the wonderful education, support, and memories!

Sincerely,
Retta E. Pelsang, MD, FACR

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A note to our alumni...

If you received an award or special distinction or have any other news you’d like to share with your fellow alums, let us know! E-mail us at radiology-alumni@uiowa.edu, and we’ll include it in our upcoming newsletter and/or department website (with your permission).

Transitions

Last fall we were saddened by the loss of two friends of the Department of Radiology:

Frank Hsieh-Fu Cheng, PhD, died at his home on August 4, 2013

William Edward Erkonen, MD, died December 6, 2013
Our New Residents

Back row left to right: Simon Roh, MD, University of Kansas; Joseph Gastala, MD, Loyola University; Steven Morales, MD, Drexel University; Adam Liudahl, MD, University of Iowa; Michaelangelo Fuortes, MD, State University of New York

Front row left to right: Kyungmin Kang, MD, Chicago Medical School; Serine Baydoun, MD, American University of Beirut, Beirut, Lebanon; Charmi Vijapura, MD, University of Missouri, Kansas City

NUCLEAR MEDICINE RESIDENT
Sarah German, MD, PhD, Chicago Medical School; University of Iowa Diagnostic Radiology Residency

2013-2014 Fellows

Seth Anderson, DO Neuroradiology
Manish Bajaj, MBBS Neuroradiology
Tariq Balawi, MBBS Musculoskeletal
Jeffrey Gronkiewicz, MD Musculoskeletal
Nadine Mallak, MD Neuroradiology
Patrick McDonough, DO Musculoskeletal
Catherine Metz, MD Body Imaging
Oscar Pinzon, MD Pediatric
Janet Pollard, MD Body Imaging
Lonnie Vaughn, MD Neuroradiology
Myka Veigel, DO Musculoskeletal
Christine Walsh, MD Breast Imaging
Honors & Awards... 

D. Lee Bennett, MD  
- Recipient of the UI Carver College of Medicine Faculty Service Award, which “recognizes an individual who consistently and repeatedly provides outstanding service to the college, going well beyond his or her job description, pitching in when needed most”

Georges Y. El-Khoury, MD  
- Reviewer of Distinction recognition from Skeletal Radiology for his above and beyond “quantity, timeliness and quantity” of reviews

Kyungmin Kang, MD  
- Selected to serve on the Resident & Fellow Section of Women in IR Committee for the Society of Interventional Radiology (SIR)

Brian F. Mullan, MD  
- Selected to chair the Clinical Experiences Committee in the Carver College of Medicine, overseeing the entire clinical portion of the curriculum, including all clerkships and electives

Michael M. Schultz, PhD  
- Inventor Recognition Award, 1st Annual University of Iowa Entrepreneurial Summit for recent patent applications filed with the University of Iowa Research Foundation.

Michael K. Schultz, PhD, Fulbright Scholar

Dr. Mike Schultz was made Fulbright Scholar in Radiochemistry from the Fulbright Specialist Program 2013. The Fulbright Specialist program is awarded to academics who have distinguished themselves in their careers through research, teaching, and service in their specialization. With the approval of Dr. Schultz’s application by the Fulbright Specialist Program Review Committee, Dr. Schultz traveled to the Siberian Federal University in Krasnoyarsk, Russia to work on an International Masters in Radiochemistry.

The following Department of Radiology’s physicians were recognized in US News and World Report’s list of Best Doctors® for 2014.

Monzer Abu-Yousef, MD  
Thomas Barloon, MD  
David Bushnell, MD  
Georges El-Khoury, MD  
Michael Graham, MD, PhD  
Minako Hayakawa, MD  
Daniel Kahn, MD  
David Kuehn, MD  
Joan Maley, MD  
Yusuf Menda, MD  
Yutaka Sato, MD, PhD  
Alan Stolpen, MD, PhD
MEDICAL STUDENT TEACHING

**Gillies Award for Outstanding Senior Medical Student**
Amanda Schaefer

**Fellow Teacher of the Year**
Charles Smittkamp, MD

**Senior Faculty Teacher of the Year**
Simon Kao, MD

**Junior Faculty Teacher of the Year**
Parren McNeely, MD
Maheen Rajput, MD

**Resident Educators of the Year**
Eric Carolan, MD
Casey Swenson, MD

RESIDENT AWARDS

**Resident Research Award**
Sarah German, MD, PhD: “A simple approach to improve inter-observer agreement in IHP-based interpretation of post-therapy PET/CT in patients with lymphoma”

**Resident Teacher of the Year**
Edwin Butler, MD

**Resident Award for Outstanding Clinical Service**
Seth Anderson, DO

**Resident Award for Professionalism**
Catherine Metz, MD

**Chief Resident Recognition**
Brendan O’Shea, MD
Christine Walsh, MD

**Iowa Radiological Society Recognition Award**
David Zander, MD

FACULTY AWARDS

**Krabbenhoft Award for Excellence in Teaching**
Archana Laroia, MD

**Fellow Teacher of the Year**
Kousei Ishigami, MD

**Outstanding Departmental Service Award**
D. Lee Bennett, MD

**Faculty Teacher of the Year**
Kousei Ishigami, MD

DEPARTMENTAL TEACHING AWARDS 2013

NEW GRANTS

**PI: Casey Johnson, PhD**
Co-Investigator: Vincent Magnotta, PhD
Title: Quantitative Magnetic Resonance Imaging of Bipolar Disorder
Sponsor: Brain & Behavior Research Foundation
Amount: $60,000
Duration: 1/15/2014 - 1/14/2016

**PI: Vincent Magnotta, PhD**
Title: T1rho MR Imaging in Schizophrenia
Sponsor: Nellie Ball Trust
Amount: $22,000
Duration: 3/1/2013 - 2/28/2014

**PI: John Newell, MD**
Title: Obesity, Inflammation, and Lung Injury After Lung Transplantation
Sponsor: Columbia University
Amount: $60,000
Duration: 4/1/2013 - 3/31/2017

**PI: Kevin Schartz, PhD**
Title: Compromised Diagnostic Radiology Interpretation from Observer Fatigue
Sponsor: University of Arizona
Amount: $137,500
Duration: 7/1/2013 - 6/30/2014
Grants continued from previous page

PI: Michael Schultz, PhD  
Title: Mitochondrial Targeted Metastatic Melanoma Therapy  
Sponsor: US Department of Health & Human Services, National Institutes of Health  
Amount: $874,448  
Duration: 7/2/2013 - 6/30/2018

PI: Michael Schultz, PhD  
Title: Eichrom Scholar Radiochemistry Education Experience Pilot Program  
Sponsor: Eichrom Technologies, Inc.  
Amount: $30,415  
Duration: 1/28/2013 - 1/27/2014

PI: Michael Schultz  
Title: Method Evaluation - Radiochemical Method for Gross Alpha and Gross Beta Analysis in Flowback and Produced Water from Hydraulic Fracturing Operations  
Sponsor: Environmental Management Support (EMS)  
Amount: $114,933  
Duration: 04/01/2013 - 06/20/2013

PI: Jessica Sieren  
Title: Regional Computed Tomography Derived Biomarkers for Lung Cancer Risk Assessment  
Sponsor: American Lung Association  
Amount: $99,703  
Duration: 07/01/2013 – 06/30/2014

PI: John Sunderland  
Title: Movember GAP 2 – Collaborative Global Imaging Project  
Sponsor: Movember Foundation Australia  
Amount: $168,750  
Duration: 11/1/2013 – 10/31/2015
RADIOLOGY UPDATE • summer 2016 • What Will Your Legacy Be? Your support ensures the future of the Russell H. Morgan Department of Radiology and Radiological Science. To learn more about these and other creative ways to support the Department of Radiology and Radiological Science, contact: Christie Vera Senior Associate Director of Development Russell H. Morgan Department of Radiology and Radiological Science 443-287-7958 cvera3@jhmi.edu rising.jhu.edu/giftplanning.

Radiology is a vast subject and there are tons of books available. Here is a list of recommended radiology books for residents! Last Updated on June 9, 2019.

Table of Contents.

Introduction.

Subjectwise list of radiology textbooks for radiology residents.

- General Radiology
- Chest Radiology
- Body Imaging
- Gastrointestinal Imaging
- Musculoskeletal Radiology
- Neuroradiology
- Head and Neck Imaging
- Emergency Radiology
- Ultrasound (including Fetal imaging)
- Radiology Physics