Dual Energy Femoral Run-off CT angiography: Principles and application in patients with peripheral artery disease and renal insufficiency.

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Lower extremity CT angiography is one of the most common radiographic modalities used to evaluate and follow patients with peripheral artery disease (PAD). Unfortunately, these patients often suffer from co-morbidities, such as diabetes and chronic renal insufficiency, which place them at elevated risk of contrast-induced injury. This issue is compounded by the relatively high dose of iodinated contrast required for these exams (typically 100-150 ml). Recent advancements in materials and techniques in CT imaging have yielded a new generation of dual-energy CT (DECT) scanners that have largely overcome the limitations of earlier systems. Many of the applications of DECT can be used with lower extremity CTA's in order to make the exams safer and more efficacious.

The purpose of this poster is to review the aspects of DECT that can make lower extremity CT angiography both safer and more efficacious. It will include example examinations performed at our institution using a single-source, single detector system (GE Discovery HD750).

**Contrast reduction with low photon energy (keV) sequences:** DECT scans allow the operator to view images at calculated photon energy levels ranging from 40-80 keV. A single energy CT scan performed at 120 KVP has an average photon energy of 75 keV. At lower energy levels, the relative attenuation of iodine increases compared to water (soft tissues) and calcium (bone). By taking advantage of this phenomenon, we have been able to significantly reduce the amount of iodinated contrast we use in our exams. We have performed diagnostic CT angiograms of the lower extremity with less than 40 ml of iodinated contrast.

**Detection and characterization of calcified plaque using material density imaging:** Using a dedicated workstation, an operator can manipulate the source data from a DECT scan and create sequences that eliminate specific material densities (water, iodine, calcium). The elimination of calcium (including calcified atherosclerotic plaque) may serve as a useful problem-solving tool for evaluating the patency of heavily calcified vessels on CT angiography.

**Limitations**
A significant limitation of DECT is the increased radiation dose from the dual-energy acquisition. However, most patient’s receiving these exams are above the age at which the carcinogenic risks of medical radiation are a relevant concern. In addition, ongoing developments in dose reduction, including iterative reconstruction, can allow DECT to be performed at levels comparable to single-energy exams.

**Conclusions**
Using dual-energy CT, we have performed diagnostic femoral run-off CT angiograms using significantly lower doses of iodinated contrast. In addition, the ability to eliminate specific materials from the exam has shown to be an effective adjuvant in evaluating these studies.
Multivariate Analysis of Prognostic Factors for primary patency following salvage of permanent hemodialysis access using stent grafts

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To analyze the effects of patient and procedure-related factors on patency following stent graft implantation to repair failing hemodialysis accesses.

An IRB-approved, retrospective analysis was conducted of all initial stent graft implantations within the hemodialysis circuit at our institution over a 43 month period (11/2004 through 5/2008) with follow up through 1/2009. 44 procedures were performed on 43 patients (28 female and 15 male) with 40 grafts and 4 native fistulae. Clinical and imaging databases were queried for potential prognostic factors affecting access patency. Technical success and patency were determined in accord with the 2003 SIR reporting standards. Factors were tested using the Pearson correlation test and one of two factors of a pair with high correlation were eliminated from analysis. Data were analyzed using the Kaplan-Meier method and log rank test. Multivariate analysis was conducted using the Cox proportional hazard model.

Technical success was achieved in 38 out of 44 procedures. Overall percent primary patency at 1, 3, 6 and 12 months were 68, 46, 31 and 12, respectively. Overall percent lesion patency at 1, 3, 6 and 12 months were 73, 59, 54 and 54, respectively. Lesion patency was significantly greater than primary patency (P= 0.001). Primary patency and access patency were significantly greater for patients who presented with flowing access than for those presenting with thrombosed access (P = 0.001 and P=.005). Results of multivariable Cox regression analyses showed that thrombosis detected by physical exam (P=0.0001; HR=3.93) and stent graft diameter less than the median value (P=0.001; HR=3.32) were significant independent factors in primary patency of dialysis access.

Access failure after stent graft implantation was due to factors other than patency of the stent graft in a significant fraction of cases. Thrombosis detected on physical exam prior to intervention stent placement and the diameter of stent graft were the significant independent factors in primary patency of hemodialysis access.
Nontarget embolization of chemoembolic or radioembolic material remains a major challenge for transarterial treatment of hepatic malignancy, potentially resulting in serious complications such as enteric ulceration. Nontarget embolization occurs either through retrograde reflux of embolic agent into upstream arterial branches or through antegrade flow into distal hepatopancreatic branches with hepatofugal flow. Currently, there is no objective method to quantify the degree of embolization achieved during transarterial embolotherapy. Recently, the US FDA has cleared a microcatheter with a funnel-shaped, self-expanding tip (Surefire Medical) that decreases arterial pressure in the downstream arterial bed, thereby producing a pressure gradient between the low-pressure downstream hepatic arterial compartment and the high-pressure systemic arterial compartment. This "protective pressure gradient" (PPG) prevents antegrade reflux into downstream vessels by inducing hepatopedal blood flow.

To test the hypothesis that measurement of the pre- and post-embolization protective pressure gradient is correlated with clinical outcome measures of tumor response and adverse events.

Materials and Methods: Twenty-two procedures in 17 patients with primary or metastatic liver cancer were performed using the antireflux tip. To derive the PPG, blood pressure was measured in the antegrade hepatic arterial compartment with the tip expanded, and then subtracted from the systemic arterial blood pressure measured through a femoral arterial sheath. The pre- and postembolization PPG was compared to independent, blind assessment of tumor response using mRECIST criteria on follow-up multiphasic abdominal CT or MR. PPGs were also compared to rates of adverse events, as assessed by 90 day CTCAE liver toxicity and medical records.

The mean PPG before embolization was 21.8 mm Hg (p=0.0000001). The postembolization PPG in patients displaying complete response (CR) or partial response (PR) was 12.0 mm Hg, whereas the post-embolization PPG in patients displaying stable disease (SD) was 23.0 mm Hg (p=0.03). Two patients died due to massive liver or tumor necrosis. In these two patients, the post-embolization PPG decreased by 87-100% relative to the pre-embolization PPG, and CTCAE liver toxicity score was 3.8. In the remaining patients, the PPG was reduced by 13-48%, and CTCAE liver toxicity score was 1.2.

When using the antireflux tip, intra-procedural assessment of the antegrade hepatic arterial and systemic blood pressures provides critical information regarding the relative embolic saturation of the targeted vascular arterial bed, and can be used to increase the probability of favorable tumor response and minimize the likelihood of adverse events.