Delayed Radiation Soft Tissue Injury Following Coronary Angiography and Fluoroscopy

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ABSTRACT / INTRODUCTION

The benefits of hyperbaric oxygen therapy to treat radiation injury are well described.(1) Treatment with hyperbaric oxygen results in decreased post-operative morbidity when surgery is performed in areas of prior radiation treatment.(2) The majority of studies document delayed tissue damage following radiation cancer treatment. Advanced diagnostic and treatment modalities in invasive cardiology have permitted an alternative to surgery to correct cardiac pathologies. Angioplasty and stenting of coronary vessels has eliminated or prolonged the need for open surgical procedures such as coronary artery bypass grafting (CABG). As cardiac catheterization becomes more sophisticated so does the complexity of the procedure, and the time it takes to perform it. The number of needed interventions (per patient) has also increased. Some procedures are only separated by hours, days, or weeks. Combined, these intensify each individual radiation exposure per procedure and the cumulative dose absorbed by the patient. Although the stochastic effects of radiation are best described for cancer radiation patients, they are not well delineated for diagnostic and technical radiation exposure.(3)

A case of soft tissue radiation damage elicited by cardiac fluoroscopy, along with the patients clinical course and outcome are presented. A retrospective review of the patients cardiac catheterization records was performed. A dermatologic biopsy confirmed the pathologic diagnosis of soft tissue radiation damage. The patient was referred for plastic surgical intervention and pre-surgical hyperbaric treatment. A PET/CT fusion study was performed and used as a morphological map to determine the depth of the lesion and feasibility of performing advanced wound care modalities in lieu of a major plastic surgical intervention (the patient initially refused). A review of the relevant literature pertaining to radiation injury during cardiac catheterization was completed. The patient required radiation injury education, extensive pain management, and advanced wound care modalities including adjuvant perioperative hyperbaric oxygen therapy. He eventually agreed to rotational flap closure by plastic surgery.

Lengthy, frequent, and multiple cardiac radiologic procedures are becoming increasingly prevalent resulting in a new etiology for delayed radiation injury.(4) (5) The lack of patient and healthcare team education regarding delayed soft tissue injury post diagnostic radiation exposure contributes to delay in diagnosis. In this case, the delay in diagnosis contributed to worsening of the radiation soft tissue damage. This also lead to an under reporting of the the radiation injury. Education of the patient and cardiac catheterization team needs to be instituted or improved to ensure early diagnosis and treatment intervention of delayed radiation soft tissue injury following cardiac diagnostic radiological procedures.

CARDIAC CATHETERIZATION & CLINICAL EVENTS CHRONOLOGY

Date of the Coronary Intervention	Angiography & Procedure Performed
December 1996	Angiography / Coronary Artery Bypass Grafting 2 Vessels
January 2001	PTCA Single Vessel: Proximal Right Coronary Artery and Stent Placement
June 2003	Severe Native Vessel Disease R dominant 1. Distal RCA 100% occluded 2. Circumflex 95% Occlusion Coronary Stent Placement: 1. Angiojet and Distal RCA Native occlusion
February 13, 2009	PTCA Multiple Vessels: 1. Distal Circumflex Coronary Artery (collaterals to RCA 2. Unsuccessful PTCA Small OM2 Drug Eluting Stent Placements: 1. Proximal 1st Obtuse Marginal Vessel 2. Distal Left Main Coronary Artery
September 11, 2009	PTCA Multiple Vessels as follows: 1. Mid Left Circumflex Coronary Artery 2. Proximal Left Anterior Descending Coronary Artery Drug Eluting Stent Placement: 1. Distal Left Anterior Descending Coronary Artery*** 2. Left Circumflex *** Driver stents used to crush an old Promus Stent against the wall of the vessel.
December 4, 2009	Coronary Angiography Recurrent Occlusion Distal Left Anterior Coronary Artery Occlusion re-opened

Date	Event
February 8, 2010 (6 weeks post cardiac intervention)	Appearance of rash
March 9, 2010	Dermatologic Biopsy
March 23, 2010	Plastic Surgery Consult
May 4, 2010	Initial Hyperbaric Medicine Consult
May 26, 2010	Second Hyperbaric Medicine Consult
May 28, 2010	Initiation of HBO_2T
August 11, 2010	Excision and Split Thickness Graft HBO_2T 39 Tx's Prior
December 9, 2010	Cutaneous Flap HBO_2T 86 total Tx's prior HBO_2T 10 total Tx's Post
February 18, 2011	Complete Healing

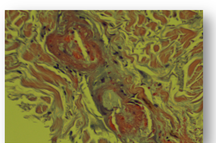
Time from delay in diagnosis until complete healing: 1 Year (February 8, 2010-February 18, 2011)

CASE PRESENTATION

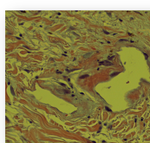
The patient is a 64 year old Caucasian male with a long standing history of cardiovascular disease. The patient underwent cardiac catheterization for the first time in 1996 with immediate coronary artery bypass grafting (CABG). He required an additional five (5) coronary interventional procedures between December 1996 and December 2009 with variable doses of radiation. The dates and procedures are listed in the table below.

Approximately eight 8 weeks after the final cardiac procedure the patient noticed a painful rectangular rash on the upper left posterior thorax just below the scapula. He visited his primary care physician who initially treated him with various medications for presumed ectopic dermatitis. This continued over the course of a few weeks with various combinations of medications that were not relieving the patients' symptoms. The rash worsened and eventually developed a central area of ulceration that prompted an additional visit to the primary care physician who prescribed Silver sulfadiazine. The lesion persisted despite treatment with a variety of topical and systemic therapies without a definitive diagnosis. His condition worsened as evidenced by increasing pain, diameter of the rash, and a new area of central necrosis.

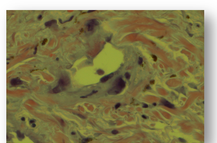
A dermatologic tissue biopsy was then performed confirming a histologic diagnosis of delayed soft tissue radiation damage. (Radiation Dermatitis)



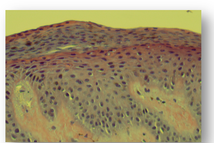
Fibrotic and thickened dermal vessels containing fibrin thrombi. 200 X



Dilated dermis vessels, perivascular lymphoplasmacytic infiltrates and irregular dermal fibrosis. 200 X



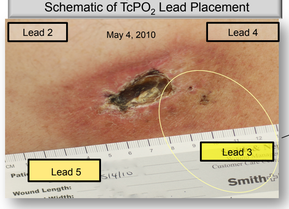
Large atypical "radiation" fibroblasts present around dermal blood vessel. 200 X



Epidermis showing acanthosis and parakeratosis (thickened epidermis with nuclei present in cells at surface, reflecting brisk turnover of kin cells). 200 X

The patient was then referred to us for perioperative hyperbaric oxygen support.

Wound Photograph / Initial Consult
Schematic of $TcPO_2$ Lead Placement



Peri-Wound Transcutaneous Oxygen Values ($TcPO_2$)

Lead #	Air Baseline	Air Baseline	100% O2 5 Min	100% O2 10 Min	% Change
Lead 1 L Chest Reference	61 mmHg	63 mmHg	145 mmHg	171 mmHg	182%
Lead 2 L Upper Wound	51 mmHg	51 mmHg	235 mmHg	276 mmHg	437%
Lead 3 **R Lower Wound**	15 mmHg	18 mmHg	185 mmHg	216 mmHg	1,297%
Lead 4 R Upper Wound	52 mmHg	47 mmHg	230 mmHg	249 mmHG	378%
Lead 5 **L Lower Wound**	38 mmHg	41 mmHg	175 mmHg	200 mmHg	421%

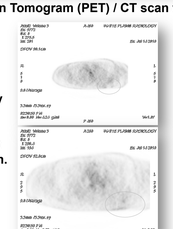
The patient was indecisive regarding our plan of perioperative hyperbaric oxygen therapy (HBO_2T) and plastic surgical intervention. He sought additional opinions and returned 4 weeks later with increasing pain, necrosis, and overall size of the wound.

Lead 3 $TcPO_2$ value indicating critical tissue ischemia was consistent with the area of ongoing soft tissue necrosis

A Positron Emission Tomogram (PET) / CT scan with Fusion Images was performed to help evaluate the depth and extent of tissue necrosis (7/14/2010).

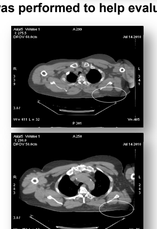
PET Scan

Minimally increased activity in the skin and subcutaneous tissue consistent with inflammation.



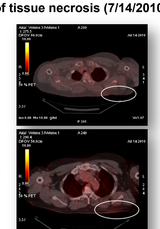
CT Scan

Shows loss of tissue and mild inflammatory changes limited to the subcutaneous tissue and fat. Increased density of the sub-Q fat is consistent with inflammation and edema.



PET/CT Fusion Images

The synergistic use and correlation of functional PET information with the anatomical detail from CT. (Overlay Images)



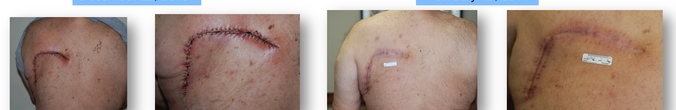
CLINICAL COURSE / RESULTS

The patient was started on a course of (HBO_2T) in a multiplace setting at 2.36 ATA (45 FSW) for 90 minutes daily with appropriate 5 minute air breaks, combined with optimized pain management and advanced wound care modalities. The wound stabilized and following thirty (30) HBO_2 treatments he refused rotational flap surgery but agreed to operative intervention with full thickness skin grafting. The patient was non- compliant with the post operative hyperbaric treatments. The initial graft had < 20% viability at seven (7) days. The patient initially refused reoperation but continued HBO_2T and advanced wound care including a combination of enzymatic and sharp debridement, negative pressure wound therapy, and bi-layered, biological skin substitutes. The wound elicited signs of progressive healing circumferentially with healthy granulation tissue and re-epithelialization but with persistent central wound fibrosis.

August 18, 2010 | August 18, 2010 | September 6, 2010 | September 18, 2010

The patient eventually agreed to reoperation with debridement of the fibrosis and flap closure.

December 22, 2010 | February 18, 2011



Postoperatively the patient was compliant with HBO_2T and healed without incident.

DISCUSSION/CONCLUSION

Radiation induced soft tissue damage during interventional cardiac procedures is a significant Public Health risk. A major contributing factor is the variability of all aspects of the procedure, and the lack of a direct assessment tool to accurately measure total skin radiation dose. There is also a deficiency in both knowledge and education of the patients regarding the late effects of diagnostic radiation exposure.(6) The general practitioner and patient's paucity of knowledge regarding interventional radiation exposure results in delayed diagnosis leading to progression of the initial lesion, the need for more extensive surgical procedures (plus their co-morbidities), and hospitalizations, escalating the cost of healthcare. Progression of our patients wound severity resulted in intractable pain, hydrocodone addiction, profound depression, and a significant decrease in quality of life. Wound progression may be halted or delayed with early institution of appropriate therapeutic options including adjuvant HBO_2T. Following complete healing our patient was easily withdrawn from his pain medications, no longer required intervention for depression, and had a moderate improvement in quality of life as objectively assessed by an SF-36 Health Survey completed prior to treatment and following complete healing. Early diagnosis and treatment intervention may decrease or prevent progression of the necrosis which may have lessened these additional psychophysiological responses. The need for effective radiation education for patients having interventional cardiac procedures needs to be implemented. Patient awareness of this type of skin injury could effectively decrease delay in diagnosis and expeditious treatment of the radiation damage. This type of Public Health educational process would serve to benefit both patients and medical professionals and decrease healthcare cost. With the current CMS healthcare changes, hospitals may not be reimbursed for services attributed to this pathology.

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