European Journal of Radiology 101 (2018) 129–135

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Dynamic contrast enhanced magnetic resonance lymphangiography: Categorization of imaging findings and correlation with patient management

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ARTICLE INFO

Keywords:
MR lymphangiography
Intra-nodal lymphangiography
Central conducting lymphatics
Chylothorax
Chylous ascites

ABSTRACT

Objective: To review the technical aspects and categorize the imaging findings of dynamic contrast enhanced magnetic resonance lymphangiography (DCMRL) and correlate the findings with patient management options.
Materials and methods: A retrospective review of patients who underwent DCMRL between June 2012 and August 2017 at a tertiary care paediatric hospital was performed. Twenty-five DCMRL studies were performed in 23 patients (9 males, 13 females, 1 ambiguous gender) with a median age of 4 years (range: 1 month–29 years). DCMRL imaging findings were reviewed, categorized and the impact on patient management was studied.
Results: DCMRL was technically successful in 23/25 (92%) studies. DCMRL findings were categorized based on the status of central conducting lymphatics (CCL) and alternate lymphatic pathways as follows: *Type 1* – normal CCL with no alternate lymphatic pathways, *Type 2* – partial (*2a*) or complete (*2b*) non-visualization of CCL with reflux of contrast into alternate pathways and *Type 3* – normal CCL with additional filling of alternate pathways. *Type 1* DCMRL patients (n = 5) were reassured and conservative management was continued, *Type 2* patients (n = 10) had evidence of CCL obstruction hence thoracic duct ligation or embolization was avoided and other options such as lymphatic fluid diversion using Denver® shunt or lympho-venous anastomosis were used, and *Type 3* patients (n = 8) were evaluated for elevated central venous pressure as a cause of lymphatic backflow in addition to Denver® shunt, lympho-venous anastomosis, thoracic duct ligation or embolization.
Conclusion: DCMRL is an evolving imaging technique for understanding abnormalities of the central conducting lymphatics. Categorization of imaging findings may be helpful in guiding selection of management options.

1. Introduction

Disorders of the lymphatic system present as a wide clinical spectrum from self-limiting traumatic leaks easily managed by conservative methods to multi-system disorders that are progressive, unresponsive to currently available treatment options and often result in death from malnutrition or infection. Imaging techniques of the central conducting lymphatics (CCL) have undergone major developments in the recent years since the first application of intra-nodal injection of contrast agents for dynamic study of the CCL [1–10]. The combination of intra-nodal injection of gadolinium and simultaneous dynamic acquisition of MR images of the chest and abdomen has led to a new lymphatic imaging technique called dynamic contrast enhanced magnetic resonance lymphangiography (DCMRL). This technique provides a time resolved study of lymphatic flow with good spatial resolution. It is particularly useful in patients with right-to-left intra- and extra-cardiac shunts who could develop cerebral embolism from the use of conventional iodinated oil-based contrast agent for lymphatic imaging [4]. Since the utilization of this technique has increased, new insights into patterns of lymphatic flow in different clinical conditions and their implications on patient management are evolving [8,9]. The purpose of this study is to retrospectively review technical aspects, categorize

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https://doi.org/10.1016/j.ejrad.2018.02.021
Received 15 January 2018; Received in revised form 12 February 2018; Accepted 14 February 2018
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Table 1
Clinical diagnosis, DCMRL indication, DCMRL type, patient management and outcome in 23 patients.

Patient	Clinical diagnosis	Indication for DCMRL	DCMRL Type	Patient management	Outcome
1	post resection of pancreatic SPEN tumor	PLE, lymphedema	1	SMV stent for stenosis, SMV bypass graft	unchanged PLE and lymphedema
2	abdominal chylous LM	failed sclerotherapy	1	Sirolimus, Sorafenib	metastatic angiosarcoma, died in 9 months
3	lymphedema	lymphedema	1	compression stocking, lymphatic massage	unchanged lymphedema
4	Nemaline myopathy	chylothorax	1	chest tube	resolution of chylothorax
5	ASD, PDA, pulmonary valve stenosis	post-op chylothorax	1	TPN, chest tube	resolution of chylothorax
6	prematurity, congenital heart disease	chylous ascites	2a	TPN, Sirolimus, abdominal drainage	unchanged ascites
7	heterotaxy, TAPVR, single ventricle, Fontan	chylothorax, chylous ascites, plastic bronchitis, PLE	2a	TPN, chest tube	orthotopic heart transplant
8	Single ventricle, Glenn (12 mmHg), PHT, CHF	post-op chylothorax	2a	TPN, chest tube	resolution of chylothorax
9	GLA	chylothorax, chylous ascites, PLE, lymphedema,	2a	compression stocking, lymphatic massage, Sirolimus, LVA	improvement in chylothorax,lymphedema and PLE
10	GLA, post TD ligation and pleurodesis	chylothorax, lymphedema	2a	diuretics, TPN, chest tube	progressive disease, died in 30 months
11	lymphedema post liver transplant	lymphedema	2a	compression stocking, lymphatic massage, Sirolimus, LVA evaluation	unchanged lymphedema
12	lymphedema	lymphedema	2b	compression stocking, lymphatic massage, LVA evaluation	unchanged lymphedema
13	GLA (2 DCMRL studies)	abdominal wall edema, lymphorrea from labia	2b (n = 2)	sclerotherapy, Sirolimus, Interferon, Denver® Shunt	cessation of lymphorrea
14	GLA	chylothorax, chylous ascites, lymphedema, scrotal wall lymphorrea	2b	lymphatic massage, Sirolimus, Interferon, LVA evaluation	cessation of lymphorrea, persistent chylothorax and chylous ascites
15	HLHS, Fontan (18 mmHg), PHT	post-op chylothorax	3	TPN, Octreotide, chest tube	resolution of chylothorax
16	HLHS, Glenn, (15–22 mmHg) PHT, CVT	post-op chylothorax	3	TPN, chest tube, central venous thrombectomy and angioplasty	resolution of chylothorax
17	Orthotopic heart transplant, PHT, CHF, CVT	post-op chylothorax	3	TPN, venous angiolasty, pleurodesis,TDE	resolution of chylothorax
18	GLA	chylothorax PLE	3	TPN, Sirolimus, chest tube	progressive disease, died in 9 months
19	GLA (2 DCMRL studies)	chylothorax, chylopericardium	3 (n = 2)	TPN, chest tube, Sirolimus, Denver® Shunt	progressive disease, died in 15 months
20	lymphedema	lymphedema, lymphorrea right groin	3	compression stocking, lymphatic massage	improvement in lymphedema, occasional lymphorrea
21	Single ventricle, Glenn (11 mmHg)	chylothorax	3	TPN, chest tube	improvement in chylothorax
22	Weaver syndrome	chylothorax	Technical failure	low fat diet, chest tube	resolution of chylothorax
23	Pulmonary atresia, Glenn	post-op chylothorax	Technical failure	TPN, chest tube, pleurodesis	resolution of chylothorax

Abbreviations;: SPEN: Solid pseudopapillary epithelial neoplasm, SMV: superior mesenteric vein, GLA: Generalized lymphatic anomaly, LM: lymphatic malformation, PLE: protein losing enteropathy, PHT: pulmonary hypertension; CHF: congestive heart failure; CVT: central venous thrombosis; post-op: post operative, TPN: total parenteral nutrition, TD: thoracic duct, TDE: thoracic duct embolization, LVA: lympho-venous anastomosis, HLHS: Hypoplastic left heart syndrome, ASD: atrial septal, defect, PDA: patent ductus arteriosus, TAPVR: total anomalous pulmonary venous return.

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