Endogenous Cushing syndrome (CS) is associated with systemic manifestations including abnormalities in glucose and lipid metabolism, alterations in coagulation factors, hypertension, cardiovascular disease, depression, and impaired health-related quality of life. Histological changes and molecular pathways involved in CS-dilated cardiomyopathy are poorly understood, whereas structural outcome after cardiac recovery is unknown.

We reported a research case of CS dilated cardiomyopathy in which noninvasive and invasive cardiac studies at baseline and follow-up were obtained after written patient consent.

A 63-year-old woman had CS caused by adrenal adenoma. Echocardiographic left ventricular (LV) end-diastolic diameter, ejection fraction and maximal wall thickness, endomyocardial biopsy with assessment of cardiomyocyte diameter, % myofibrillolysis area, myocardial fibrosis and cell death, and myocardial atrogin-1 were evaluated at presentation and after 1-year cortisol normalization with adrenalectomy confirming the data obtained by speckle tracking echocardiography. Myocardial fibrosis derives from a direct glucocorticoid stimulation of fibroblast activity, likely through Smad and transforming growth factor β-1 pathway, and reducing in our CS patient from 11.7% to 3.0% after adrenalectomy confirming the data obtained by speckle tracking echocardiography.

In conclusion, CS-dilated cardiomyopathy is a reversible entity induced by high levels glucocorticoids. It is characterized by cell hypertrophy, myofibrillolysis, and myocardial fibrosis that revert after cortisol normalization. Atrogin-1 activation has a major pathogenetic role.

Disclosures
None.

References
2. Sandri M, Sandri C, Gilbert A, Skurk C, Calabria E, Picard A, Walsh K, Schiaffino S, Lecker SH, Goldberg AL. Foxo transcription factors induce hypertrophy, myofibrillolysis, and myocardial fibrosis are the main structural abnormalities and that they revert completely at 1-year follow-up from adrenalectomy (Figure 2). Mechanisms involved in cell hypertrophy include pressure overload, a glucocorticoid-mediated increase of angiotensin-II and an enhanced responsiveness of cardiomyocytes to angiotensin-II. Cell myofibrillolysis strictly correlates with myocardial expression of atrogin-1, which is increased >30x control values during failing state and normalizes after cardiac recovery being associated to decrease of myofibrillolysis cell area from 60% to 21%. In humans, these data confirm the atrophic effects of glucocorticoids on skeletal and cardiac muscle obtained in experimental models. The molecular pathway involved includes activation of Foxo transcription factors, overexpression of atrogin-1 and ubiquitin promoting proteasome proteolysis of endogenous contractile elements.

Circ Cardiovasc Imaging is available at http://circimaging.ahajournals.org

© 2016 American Heart Association, Inc.


---

**Figure 1.** Patient 1 with Cushing syndrome (CS) cardiomyopathy: electrocardiographic (A and B), echocardiographic (C and D), and left ventricular (LV) angiographic changes (E–H) at presentation and after 1-y adrenalectomy. It is shown a reduction of heart rate and QRS voltages with normalization of ventricular repolarization, a reduction of LV wall thickness, and a complete recovery of cardiac volumes and function.

**Figure 2.** Effects of glucocorticoid withdrawal on optical and ultrastructural morphology of myocardium after 1-y cortisol normalization with adrenalectomy. A and B, Paraffin-embedded, Masson-stained endomyocardial biopsy samples before (A) and after (B) adrenal adenoma removal. A remarkable decrease of myocyte size is evident in B when compared with A. C and D, Epon resin-embedded, basic fucsin-stained thin sections from endomyocardial biopsy samples. Cell swelling, myofibrillolysis, and partial disorganization of sarcomeres are appreciable in C. An advanced recovery of cell volume, cytosol density, and sarcomeric organization is evident in D. Bar, 50 mm in all A–D. E and F, TEM of uranyl-/lead-stained ultrathin sections from EMB samples before (E) and after (F) surgical removal suprarenal adenoma. E, Myofibrilloysis, sarcomeric disorganization, and cytosol dilution are evident, which completely recover after adrenalectomy (F). Bar, 2 mm for E and F. G and H, Paraffin-embedded, immunohistochemistry for atrogin-1 samples before (G) and after (H) surgical removal suprarenal adenoma. A remarkable increase of atrogin-1 expression is evident in failing state samples (G, immunoperoxidase ×20).
Cushing Syndrome Cardiomyopathy: Clinicopathologic Impact of Cortisol Normalization
Andrea Frustaci, Claudio Letizia, Romina Verardo, Claudia Grande, Luigi Petramala, Matteo Antonio Russo and Cristina Chimenti

_Circ Cardiovasc Imaging_. 2016;9:
doi: 10.1161/CIRCIMAGING.116.004569
_Circulation: Cardiovascular Imaging_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2016 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-9651. Online ISSN: 1942-0080

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circimaging.ahajournals.org/content/9/4/e004569

Data Supplement (unedited) at:
http://circimaging.ahajournals.org/content/suppl/2016/03/18/CIRCIMAGING.116.004569.DC1

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Circulation: Cardiovascular Imaging_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to _Circulation: Cardiovascular Imaging_ is online at:
http://circimaging.ahajournals.org/subscriptions/
Supplemental Material

Movie Legends

Movie 1. 2D echocardiographic movie (2 chamber view) at baseline showing severe mitral regurgitation associated with LV dysfunction.

Movie 2. LV angiography at baseline showing severe dilation and dysfunction.

Movie 3. 2D echocardiographic movie (4 chamber view) at follow-up showing remarkable reduction of mitral incompetence with decrease LV wall thickness and recovery of cardiac function.

Movie 4. LV angiography at follow-up showing reduction of LV dimension and increase of LV function.