A 33-year-old woman who reported syncope and dyspnea on exertion was diagnosed with hypertrophic cardiomyopathy and scheduled to undergo surgical septal myectomy to relieve a severe obstruction in the left ventricular (LV) outflow tract. On transthoracic echocardiography, asymmetrical septal hypertrophy and systolic anterior motion of the mitral leaflet were noted, and the peak velocity in the LV outflow tract was 4.4 m/s. Cardiac computed tomography (CT) was performed to evaluate geometric changes in the LV myocardium and coronary artery disease. A CT 3-chamber view (Figure A) and a color-coded myocardial thickness map (Figure B) generated by CT data showed asymmetrical thickening of the LV myocardium that predominantly involved the ventricular septum and had a maximal thickness of 26 mm.

For better visualization of LV anatomy and to improve surgical planning, 3-dimensional (3D) printing of the heart was performed by using the cardiac CT data. A stereolithography file of a myocardial 3D model (Figure C) was generated by a dedicated software (A-view Cardiac; Asan Medical Center, Seoul, Korea) and transferred to a 3D printer system (Objet 500 Connex3; Stratasys, Minnesota, MN). The LV myocardium, papillary muscle, and intraventricular muscle band, including accessory papillary muscle, were generated with different colors by using rubberlike, transparent, and flexible materials (Tango Series; Stratasys; Figure D through F). The 3D printing enabled visualization of the geometric relationship among the hypertrophied myocardium, papillary muscle, intraventricular muscle band, and mitral annulus. For myectomy planning, the surgeon could handle and disassemble the myocardial 3D model (Movie I in the online-only Data Supplement). Extended septal myectomy was performed via an apical incision into the left ventricle (Figure G), and the hypertrophied septum and prominent muscle band were excised. Papillary muscle splitting with mitral valvuloplasty was performed to resolve the systolic anterior motion of the mitral valve. In a follow-up echocardiography obtained 4 days after surgery, the peak velocity of the LV outflow tract had decreased to 1.9 m/s.

Surgical myectomy is required in hypertrophic cardiomyopathy patients with severe disabling symptoms because of LV outflow obstruction. Although surgical myectomy performed in experienced centers shows low mortality in hypertrophic cardiomyopathy patients, a complex LV outflow tract anatomy, combined anomalies of the papillary muscle, and limited visualization of the LV cavity in the surgical field may increase the risk and technical challenge of the surgery.

Although 3D printing of the heart has been used for surgical planning in patients with complex congenital heart disease, cardiac tumor, and LV aneurysm, the use of 3D printing is poorly established in hypertrophic cardiomyopathy patients. In our patient, the 3D printed model generated from cardiac CT provided intuitive information on the LV geometry, including the extent of the hypertrophied septum, location and length of the papillary muscle, and intraventricular muscle band, allowing preoperative simulation of the surgical myectomy.

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Disclosures
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References

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Figure. A, A cardiac CT 3-chamber view shows a hypertrophied interventricular septum (asterisks), posterior papillary muscle (P), and intraventricular muscle band or accessory papillary muscles (arrowhead). B, A bull’s-eye map generated by using the end-diastolic phase of the CT imaging shows the extent of the hypertrophied myocardium (red area, >15 mm in thickness). An onscreen 3D model (C) and a 3D-printed model of the myocardium (D through F) show the geometric relationship among the hypertrophied septum (asterisks), papillary muscle (A, anterior; P, posterior), and intraventricular muscle band (asterisks). Intraoperative photography (G) via the apical approach shows the limited visual field of the LV cavity. The base of the anterior papillary muscle is exposed after excision of the muscle band (not shown) near the anterior papillary muscle. AO indicates aorta; LA, left atrium; LV, left ventricle; and MV, mitral valve.
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