Copy Number Variation Contributes to Sporadic and Familial Thoracic Aortic Aneurysms and Dissections

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Study Hypothesis
The genetic origins of thoracic aortic aneurysms and dissections (TAAD) are relatively unknown. Twenty percent of cases have similarly affected family members, but genes previously identified for familial TAAD have exhibited reduced penetrance and variable severity. The genes previously implicated in familial TAAD (ACTA2, MYH11, TGFBR1, TGFBR2) have all been found to be involved in vascular smooth muscle cell (SMC) contractility and adhesion. Copy number variations (CNVs) have been found previously to disrupt genes regulating vascular smooth muscle cell adhesion and contractility in sporadic thoracic aortic aneurysms and dissections. Am J Hum Genet. 2010;87(6):743–756. PMID: 21092924.

How Was the Hypothesis Tested?
Four hundred eighteen unrelated cases of sporadic TAAD (TAAD in patients not reporting a family history of vascular disease) served as the discovery cohort for the sporadic disease; the replication cohort consisted of an additional 387 unrelated individuals with sporadic TAAD. All patients were non-Hispanic, of European descent, and had their condition confirmed by imaging. Patients aged <31 years were excluded because of higher prevalence of Mendelian disorders in this age group. The familial TAAD cohort consisted of 88 affected probands from families with multiple members who did not have a genetic mutation previously identified as the cause of their TAAD. Controls came from 5 publicly available data sets from the Database of Genotypes and Phenotypes and were confined to unrelated individuals of European descent aged >31 years with Illumina genotypes. Genotyping of cases was done using the Illumina HumanCNV370-Quad Bead Chip for the sporadic TAAD samples and the Illumina Human660W-Quad BeadChip for familial TAAD samples.

Principal Findings
In a genome-wide analysis of sporadic TAAD cases, a total of 2063 CNVs in 123 separate chromosomal regions were detected by both calling algorithms. Nine predicted CNV regions that were associated with sporadic TAAD. In the replication cohort, the authors identified 57 rare CNVs, none of the other loci have been previously reported to play a role in TAAD. In case-control analyses of familial TAAD, 47 CNV regions were enriched or unique to the sporadic TAAD discovery patients compared with controls. Of the 5 CNV regions (4 gain, 1 loss) involving 31 genes (including MYH11) were present in both the replication and the discovery groups. Other than MYH11, none of the other loci have been previously reported to play a role in TAAD. In case-control analyses of familial TAAD, 20 unique or rare CNV regions (15 gains in base pairs, 5 losses in base pairs) involving 84 genes were identified. The overall prevalence of rare CNVs was significantly increased in familial TAAD compared to sporadic TAAD (23% versus 13%, P=0.03). Gene ontology, expression profiling, and network analysis found that TAAD-associated CNVs were enriched for genes that regulate cell adhesion or the actin cytoskeleton through interaction with the smooth muscle-specific isoforms of actin and myosin. Mutations in the genes encoding these proteins have been previously associated with familial TAAD. Enrichment of genes with these functions was replicated in both the discovery and replication groups.

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sporadic TAAD replication cohort and the familial TAAD cohort. The authors concluded that the findings support a common underlying mechanism for the pathogenesis of both familial and sporadic TAAD through which any one of multiple, individually rare variants can predispose to the disorder through disruption of SMC function, specifically cell adhesion and contraction.

Implications
Timely surgical repair of aneurysms can prevent death, but they often are asymptomatic until dissection. Determining the genetic origins of TAAD may allow for the prospective identification of patients at risk for TAAD and possibly prevent sudden death from the disease. These findings provide evidence that both familial and sporadic TAAD involve multiple rare CNVs that are enriched for genes involved in an interacting network that regulates vascular SMC adhesion and contractility.

Disclosures
None.
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