Activation of MET via Diverse Exon 14 Splicing Alterations Occurs in Multiple Tumor Types and Confers Clinical Sensitivity to MET Inhibitors

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ABSTRACT

Focal amplification and activating point mutation of the MET gene are well-characterized oncogenic drivers that confer susceptibility to targeted MET inhibitors. Recurrent somatic splice site alterations at MET exon 14 (METex14) that result in exon skipping and MET activation have been characterized, but their full diversity and prevalence across tumor types are unknown. Here, we report analysis of tumor genomic profiles from 38,028 patients to identify 221 cases with METex14 mutations (0.6%), including 126 distinct sequence variants. METex14 mutations are detected most frequently in lung adenocarcinoma (3%), but also frequently in other lung neoplasms (2.3%), brain glioma (0.4%), and tumors of unknown primary origin (0.4%). Further in vitro studies demonstrate sensitivity to MET inhibitors in cells harboring METex14 alterations. We also report three new patient cases with METex14 alterations in lung or histiocytic sarcoma tumors that showed durable response to two different MET-targeted therapies. The diversity of METex14 mutations indicates that diagnostic testing via comprehensive genomic profiling is necessary for detection in a clinical setting.

SIGNIFICANCE: Here we report the identification of diverse exon 14 splice site alterations in MET that result in constitutive activity of this receptor and oncogenic transformation in vitro. Patients whose tumors harbored these alterations derived meaningful clinical benefit from MET inhibitors. Collectively, these data support the role of METex14 alterations as drivers of tumorigenesis, and identify a unique subset of patients likely to derive benefit from MET inhibitors. Cancer Discov; 5(8); 1–10. © 2015 AACR.

See related commentary by Ma, p. 802.
See related article by Paik et al., p. 842.

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INTRODUCTION

Personalized medicine offers great promise in cancer treatment by matching patients with targeted therapies that act based on the specific molecular alterations present in their tumors. Targeted therapies have the potential to be more effective than conventional cytotoxic chemotherapies, often with fewer side effects (1). Consequently, the identification of new subsets of patients likely to benefit from targeted therapy is critically important for improving cancer patient care.

The hepatocyte growth factor (HGF) receptor, encoded by the \textit{MET} oncogene, is a receptor tyrosine kinase that plays a fundamental role in regulating development and cell growth. Upon stimulation, MET induces a cellular program known as invasive growth, which promotes mitogenesis, motility, invasion, and morphogenesis. Pathologic activation of MET, through both gene copy-number amplification and point mutation, is a well-characterized driver of oncogenesis that occurs in many different types of tumors. In cancer, activation of MET promotes tumor proliferation, invasive growth, and angiogenesis (2).

Accumulating evidence suggests that patients with tumors harboring MET alterations can benefit from targeted therapies (3). A number of drugs have been developed that repress MET activation and/or signaling, including small-molecule kinase inhibitors and monoclonal antibodies targeting MET or its ligand, HGF. For example, treatment with crizotinib has benefited patients with tumors containing high-level MET amplifications, including non–small cell lung carcinoma (NSCLC), gastroesophageal cancer, glioblastoma, and carcinoma of unknown primary origin (4–8), and the dual MET/VEGFR2 inhibitor foretinib provided benefit to patients with MET-mutated papillary renal cell carcinoma (9). MET-targeting antibodies onartuzumab and MetMAb have elicited responses in patients with MET-amplified NSCLC and gastric cancer (10, 11). In addition, high MET expression has been suggested to predict the response of patients with gastro-esophageal junction carcinoma to a therapy regimen involving rilotumumab, a monoclonal HGF-targeting antibody (12).

Somatic mutations affecting splice sites of exon 14 of the MET gene (\textit{METex14}) were first reported in primary lung cancer specimens and in a lung cancer cell line (13–15). These METex14 alterations were shown to promote RNA-splicing–based skipping of MET exon 14, which results in activation of MET kinase activity through a unique mechanism. The portion of the protein encoded by exon 14, most prominently Y1003 in a DpYR motif, is required for efficient recruitment of the ubiquitin ligase CBL, which targets MET for ubiquitin-mediated degradation (16–18). Loss of MET exon 14 maintains the reading frame and leads to increased MET stability and prolonged signaling upon HGF stimulation, leading to increased oncogenic potential (19, 20). Inclusion of MET exon 14 into an oncogenic TPR–MET fusion, in which exon 14 is conspicuously excluded, leads to reduction of TPR–MET oncogenic potential (21). Thus, in cancer, genomic alterations that promote METex14 skipping lead to oncogenic MET activation.

METex14 alterations have since been shown to occur in approximately 3% of lung adenocarcinoma cases (15, 22–26) and have also been observed in neuroblastoma and gastric cancer cell lines (27, 28). In total, fewer than 20 distinct METex14 sequence variants have been described, and their full diversity and prevalence across tumor types have not been characterized (Supplementary Table S1).

In vitro preclinical studies indicate that MET-targeted agents can counteract oncogenesis resulting from MET exon 14
loss (14, 17). This suggests that targeted therapies inhibiting MET signaling would be beneficial for patients with MET ex14 alterations. Recently, three case reports have demonstrated clinical response to crizotinib, a tyrosine kinase inhibitor, in lung carcinoma patients with MET ex14 alterations (29–31).

We present a large series of genomic profiles of advanced cancers, assayed in the course of clinical care, with MET ex14 alterations. We also present in vitro studies, further demonstrating the oncogenic potential of MET ex14 alterations. Finally, we report durable responses to MET-targeted therapy in three patients with tumors harboring MET ex14 alterations.

RESULTS

Comprehensive cancer genome profiling (32) was performed on 38,028 tumor specimens from unique patients in the course of routine clinical care, in a Clinical Laboratory Improvement Amendments (CLIA)–certified laboratory, between April 2012 and February 2015. Base substitution, indel, copy-number alteration, and rearrangement alterations were examined to identify those likely to affect splicing of exon 14 of the MET gene (MET ex14 alterations). In total, 224 distinct MET ex14 alterations were identified, occurring in 221 specimens. These alterations displayed remarkably diverse sequence composition, with 126 different genomic sequence variants represented. The alterations comprised base substitutions (n = 2) and indels (n = 33) at splice acceptor sites, base substitutions (n = 102) and indels (n = 31) at splice donor sites, and base substitutions (n = 2) and indels (n = 49) in the ∼25 bp intronic noncoding region immediately adjacent to the splice acceptor site (Fig. 1A).

We also identified five samples with whole exon deletions of MET exon 14 (Fig. 1A and B). Indels were predominantly deletions, but several insertions and complex indels were detected (Supplementary Table S2).

MET ex14 alterations were detected in 221 cases and were distributed among primary disease sites as lung adenocarcinoma [3%; 131/4,402; 95% confidence interval (CI), 2.5%–3.5%], other lung neoplasms (2.3%, 62/2,669; 1.8%–3%), brain glioma (0.4%; 6/1,708; 0.1%–0.8%), tumors of unknown primary origin (0.4%; 15/3,376; 0.3%–0.7%), and other tumor types (<0.1%; 7/25,873). MET ex14 alterations were not found in tumors of the female reproductive system (n = 7,436), colon and rectum (n = 3,714), pancreas (n = 1,424). We did

Figure 1. The genomic position of MET ex14 alterations. Genome coordinates are human genome build GRCh37/hg19. Genomic positions with alterations occurring in more than one case are indicated with * for two and the number of cases for greater than two. A, chr7:116,411,600-116,412,200. B, chr7:116,411,300-116,415,300.
MET Exon 14 Alterations Confer Response to Targeted Therapy

Figure 2. Comprehensive genomic profiling of 4,402 lung adenocarcinomas. A, co-mutation plot of frequently altered genes. The known clinically relevant driver genes and other most frequently altered genes are shown. The type of mutation is indicated by colors described in the key. Data for this figure are available in Supplementary Table S4. B–D, co- and anti-occurrence of genes containing known driver and other frequently occurring alterations in lung adenocarcinoma. Statistically significant (FDR < 5%) co- and anti-occurrence was tested using the Fisher exact test with FDR correction for multiple-hypothesis testing and is indicated with *. Color scale, fold change of enrichment (red) or exclusivity (green), versus random assortment. Data for this figure are available in Supplementary Table S4.

not observe a statistically significant difference among the rates of METex14 alterations in the various subtypes of lung carcinoma. In addition, the distribution of the genomic position and type (base substitution, deletion, insertion, or complex indel) of METex14 alterations did not vary significantly among the different sites of tumor primary origin.

We examined the other genomic alterations co-occurring with METex14, focusing on the cohort of 4,402 lung adenocarcinoma specimens (Fig. 2A; Supplementary Table S3). Multiple other receptor tyrosine kinase or MAPK pathway driver mutations in lung adenocarcinoma have been described, including activating mutations in KRAS, EGFR, ERBB2, BRAF, and MET as well as gene fusions involving ALK, RET, and ROS1 (25, 33, 34). Examining co-occurrence among mutations in each of these genes, we observed that they were mutually exclusive (Fig. 2B). This exclusivity of lung adenocarcinoma driver alterations has been observed previously and is confirmed in this large cohort of lung adenocarcinoma specimens. Tumors with METex14 alterations rarely harbored the other known drivers of lung adenocarcinoma, as has been previously observed in other cohorts (23–26), supporting the role of METex14 alterations as oncogenic driver mutations. We also observed that mutations in KRAS, EGFR, ERBB2, and MET each frequently co-occurred with copy-number amplification of the same gene, highlighting the cumulative effect of gene activation by both mutation and amplification.

We next examined co-occurrence of other frequently occurring genomic alterations in lung adenocarcinoma (Fig. 2C and D). In addition to their mutual exclusivity, each of the driver mutations had a distinct pattern of co-occurring alterations, further supporting the hypothesis that they define
distinct molecular subtypes of lung adenocarcinoma. Notably, METex14 alterations, copy-number amplifications of MET were not significantly coincident with MDM2/CDK4 amplification. We also observed strong and statistically significant co-occurrence of mutations in several pairs of genes, some of which have been described previously (35, 36), most significantly co-occurrence of mutations in several pairs of genes, notably some of which have been described previously (35, 36), most significant co-occurrence of mutations in several pairs of genes, notably some of which have been described previously (35, 36), most significant co-occurrence of mutations in several pairs of genes, notably some of which have been described previously (35, 36), most significant co-occurrence of mutations in several pairs of genes, notably some of which have been described previously (35, 36), most significant co-occurrence of mutations in several pairs of genes, notably some of which have been described previously (35, 36), most significant co-occurrence of mutations in several pairs of genes, notably some of which have been described previously (35, 36), most significant co-occurrence 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MET Exon 14 Alterations Confer Response to Targeted Therapy

RESEARCH ARTICLE

variants lacking exon 15 in soft-agar colony-forming assays. METΔ15 increased anchorage-independent colony formation 10-fold, as compared with METWT (Fig. 3B). These findings are consistent with the previous reports noting the oncogenic nature of MET variants lacking exon 14–mediated CBL binding, and further highlight the evolutionarily conserved role of the MET exon 14-encoded portion of the juxtamembrane domain in attenuation of MET signaling.

Capmatinib (INC280) is a highly selective and potent small-molecule inhibitor of the MET receptor tyrosine kinase (IC50 value of 0.13 nmol/L). It is highly specific, with >10,000-fold selectivity for c-MET in biochemical studies with a panel of human kinases. Capmatinib demonstrates potent activity (IC50 values of 0.2–2 nmol/L) in cell-based biochemical and functional assays that measure c-MET signaling and c-MET–dependent cell proliferation and survival (38, 39).

To determine if METΔ15-expressing cells are sensitive to capmatinib, proliferation was measured by CellTiterGlo assay 72 hours after treatment. NIH3T3 cells expressing METWT or METΔ15 showed dose-dependent inhibition of cell proliferation with capmatinib treatment, and at 20 nmol/L concentration, cell survival rate of METΔ15 is significantly lower than RFP control. Cells expressing either METΔ15 or HRASG12V were sensitive to trametinib, a MEK1/2 inhibitor. In comparison, cells expressing HRASG12V were resistant to capmatinib, suggesting a high selectivity of capmatinib to MET-driven cells (Fig. 3C and D). These in vitro results suggest that genomic alterations resulting in MET exon 14 skipping or loss are oncogenic; cells expressing these forms of MET are dependent on its aberrant signaling, and potentially sensitive to inhibition with MET-selective agents.

Given preclinical evidence suggesting sensitivity to MET inhibitors, the clinical outcomes for patients harboring METex14 alterations were investigated. We were able to successfully identify a small number of patients who had been treated with appropriate targeted therapies. All cases had been subjected to comprehensive genomic profiling in the course of routine clinical care. Although only a subset of cases were available for evaluation, in this limited sampling, the outcomes for those obtaining MET inhibitors tended very strongly to favorable responses.

An 84-year-old female never-smoker had a palpable left upper anterior chest mass incidentally identified during the course of an examination after a minor trauma. Imaging demonstrated a mass 13 cm in the largest dimension traversing the left lung and chest wall, which was deemed to be unresectable, stage III disease. Morphologic and immunohistochemical characterization of a biopsy of the chest wall mass demonstrated histocytic sarcoma (Fig. 4A and B). Comprehensive genomic profiling demonstrated that the tumor harbored a METex14 alteration (c.2888-5_2944del62) as well as TP53 p.R175H and ZMYM3 c.3008-1G>A. The patient was not a candidate for surgical therapy, so systemic treatment options were investigated. After 4 months of treatment with capmatinib, the lesion decreased >60% in volume, deemed a "major response" per RECIST 1.1.

Figure 4. Histocytic sarcoma of the thorax harboring a METex14 alteration has a major response to capmatinib. A and B, photomicrographs demonstrate a neoplasm with pleomorphic, polygonal cells with scattered mitotic activity as well as apoptotic cells. Tumor cells were focally positive for CD68 by immunohistochemical staining, consistent with a histiocytic origin. Stains for CD45 and vimentin were positive (data not shown). CK7, CK20, CK5/6, CK AE1/AE3, CK CAM5.2, p63, CD43, CD30, and smooth muscle actin were negative (data not shown). Contrast-enhanced chest CT images at (C) 0 months, (D) 2 months, and (E) 4 months after therapy with capmatinib. Left anterior chest wall mass (white arrow) demonstrated decrease in bulk and heterogeneity after 2 and 4 months of treatment with capmatinib. At initiation of treatment, the tumor was measured as 13.8 × 11.7 cm, and decreased to 8.9 × 6.5 cm at 4 months, a reduction of >60% volume and a partial response per RECIST 1.1.
partial response under RECIST criteria 1.1 (Fig. 4C–E). The patient experienced minimal toxicity on crizotinib, but did have disease progression as assessed by imaging at 11 months.

In a separate clinical trial (NCT01324479), two NSCLC cases with METex14 alterations were identified by comprehensive genomic profiling. This trial is a phase I open-label, dose-escalation study with expansion to assess the safety and tolerability of the investigational MET inhibitor capmatinib in patients with MET-dependent advanced solid tumors. Both patients received capmatinib, described in detail above, and were treated at Sarah Cannon Research Institute, Nashville, TN.

An 82-year-old female, with a 25 pack-year smoking history, was diagnosed with stage IV large cell lung carcinoma with right hilar node metastases. Initial therapy included complete surgical resection; the patient declined perioperative chemotherapy and was monitored until recurrence of disease 3 years and 3 months later. The patient declined treatment with standard-of-care chemotherapy regimens and instead elected to enter the clinical trial above. Comprehensive genomic profiling was performed on the primary resection and demonstrated that the tumor harbored a METex14 alteration (c.3028G>C) and TP53 p.N30fs*14. MET gene copy number was six, in a triploid cancer genome, as measured by next-generation sequencing based comprehensive genomic profiling. MET IHC performed on the same specimen was 3+ (H-score 270). MET FISH was not performed. The patient was treated with capmatinib for more than 5 months and had a tumor reduction of 53%, a partial response (Fig. 5A and B).

A 66-year-old female, with a 4 pack-year smoking history, was diagnosed with stage Ib poorly differentiated squamous cell carcinoma of lung (LSCC), which was resected and followed immediately with adjuvant gemcitabine and carboplatin, which were discontinued after a single cycle due to toxicity. The patient was then monitored only. After 9 months, her disease recurred in the soft tissue of the axilla and chest wall; she was also later noted to have central nervous system, bone, and renal metastases. The patient then underwent several courses of palliative radiotherapy including whole brain radiotherapy, weekly paclitaxel and carboplatin for 4 months, and subsequently was enrolled in a phase I clinical trial for a CHK1 inhibitor, but progressed after 2 months on this therapy. Upon enrollment into the capmatinib study, comprehensive genomic profiling demonstrated the LSCC harbored a METex14 alteration (c.3028+1G>T) and no other known alterations. MET gene copy number was four. Additional molecular testing indicated MET FISH 13.8 copy number (MET:CEBP7 ratio 2.3) and IHC 3+ (H-score 300). The patient was treated with capmatinib for 13 months with tumor reduction of 61%, a partial response. On disease progression, the patient’s tumor burden remained significantly decreased from baseline, and disease-related pain did not recur (Fig. 5C and D).
**DISCUSSION**

**MET** ex14 alterations are important recurrent alterations that are clinically and therapeutically relevant, occurring in approximately 3% of lung adenocarcinomas, 2% of other lung neoplasms, 0.5% of brain gliomas, and 0.5% of carcinomas of unknown primary origin. Consequently, the assessment of **MET**ex14 alteration status will be appropriate for many advanced cancer patients. In the context of NSCLC, the demonstration of mutual exclusivity between **MET**ex14 alterations and other oncogenic drivers is consistent with **MET**ex14 itself being such a driver. Three cases with durable responses to MET-targeted therapy presented in this study included response to crizotinib, an FDA-approved inhibitor targeting MET and ALK, as well as capmatinib, a highly selective and potent small-molecule MET inhibitor that is in clinical development.

In addition, three other such reports of response to targeted therapy in cases with **MET**ex14 alterations have been recently published, further extending the evidence of potential clinical benefit (29–31). As there are no clinical trials at present focusing on the **MET**ex14 advanced cancer population, the accumulation of clinical responses presented in vignette form is the sole form of clinical evidence demonstrating the targetability of **MET**ex14. In the near future, it may become possible to light that cancer cases with **MET**ex14 alterations were fortuitously enrolled in trials for anti–MET-targeted therapy on the basis of other eligibility criteria, and responses of such cases will further buttress the notion of possible clinical benefit presented here.

The early data presented here suggest that **MET**ex14 alterations present a viable therapeutic target and could be added to the growing list of known oncogenic drivers in NSCLC as well as other tumor types. Moreover, the frequency of **MET**ex14 alterations in NSCLC presented here is comparable to, if not exceeding, the frequency of MET amplifications in NSCLC, and effectively doubles the number of NSCLC cases that could respond to anti–MET-targeted therapy. We also note that the **MET**ex14 alterations reported here are not all likely to result in the same amount of **MET** exon 14 skipping and pathogenicity, indicating that further study of these alterations is warranted.

It is interesting that in two of our clinical cases, as well as in one recently published case (29), a **MET**ex14 alteration was accompanied by MET overexpression by IHC, with one of those cases also containing an apparent **MET** gene copy-number amplification. In the third presented case, neither IHC nor FISH analysis was performed. In preclinical studies, lack of CBL binding to both human and murine **MET** exon 14 regions (**MET** exon 15 in mouse), such as via skipping of **MET** exon 14, has been shown to impair MET downregulation and degradation, leading to increased MET protein expression (14, 17, 19, 20). Indeed, MET overexpression has been previously noted in lung tumors with **MET**ex14 alterations, and **MET** variants lacking exon 14 were noted to be preferentially overexpressed in those cases rather than the full-length **MET** (14). As mentioned above, **MET** amplification, presumably leading to **MET** overexpression, has been shown to confer sensitivity to **MET** inhibitors in a variety of tumor types. Thus, the functional basis for **MET** inhibitor sensitivity may be similar in patients with **MET**ex14 alterations and **MET** amplification in their tumors.

The levels of MET protein lacking exon 14 compared with full-length MET in the tumors of the 3 patients who achieved responses to MET inhibitors are not known. Therefore, the possibility of overexpression of full-length MET being a driver alteration responsible for sensitivity to MET inhibitors cannot be excluded. However, the lack of detectable **MET** amplification in two of the three sensitive tumors, the report of **MET** variants lacking exon 14 being preferentially expressed over full-length MET in lung cancer samples (14), and the oncogenic nature of **MET**ex14 alterations all suggest that the inhibition of **MET** variants lacking exon 14 contributed to the observed clinical responses.

It is also interesting to note that none of the three responders in our cohort had either **MDM2** or **CDK4** amplification in their tumors. As mentioned above, gene copy-number amplification of **MDM2**, and less frequently of **CDK4**, is highly coincident with **MET**ex14 alterations. Whether amplification of either **MDM2** or **CDK4** might affect sensitivity of tumors with **MET**ex14 alterations to MET inhibitors is currently unclear. Among the three recently published case studies, a patient with a **MET**ex14 alteration and amplification of **MDM2** and **CDK4** in their tumor (29) exhibited the shortest response to a MET-targeted agent of the six responses known to date, but a patient with a **MET**ex14 alteration and amplification of **MDM2**, but not of **CDK4**, in their tumor exhibited a major response (31). However, it is difficult to draw conclusions regarding the effect of **MDM2** or **CDK4** amplification on the responsiveness to MET inhibitors at this time. Because numerous inhibitors of **MDM2** and **CDK4** are currently being clinically evaluated in a variety of cancer types, including the CDK4/6 inhibitor palbociclib, which has been FDA approved for the treatment of breast cancer, the efficacy of combined MET and **MDM2**/CDK4 inhibition in preclinical models is worth investigating.

In summary, these results demonstrate that **MET**ex14 alterations occur in multiple tumor types, particularly lung carcinoma, and can confer clinical sensitivity to targeted therapies. Identification of this new patient population is an important step toward making appropriate targeted therapies available for all cancer patients.

**MET**ex14 alterations pose a challenge for diagnostic testing. They exhibit highly diverse sequence composition, many are novel, and more than half are indel mutations (up to 3 kb in length), which are challenging to detect with high sensitivity and specificity. Consequently, assessing **MET**ex14 alteration status requires appropriate laboratory and analytic methods that are capable of accurate sequencing, statistical detection, annotation, and reporting of this diverse class of alterations.

As the number of targeted therapies and molecular alterations that are relevant for routine cancer patient treatment continues to grow, comprehensive genomic profiling will be increasingly required to accurately stratify patients for appropriate therapy. Finally, the diversity of **MET**ex14 alterations highlights the need for profiling of large numbers of cancer genomes to identify and fully elucidate cancer driver mutations that have degenerate genomic sequence signatures.

**METHODS**

**Comprehensive Cancer Genome Profiling**

Comprehensive cancer genomic profiling was performed using the FoundationOne test. The laboratory and computational methods employed in the FoundationOne DNA assay have been described in
Disclosure of Potential Conflicts of Interest

G.M. Frampton has ownership interest (including patents) in Foundation Medicine. S.M. Ali has ownership interest (including patents) in Foundation Medicine. M. Rosenzweig has ownership interest (including patents) in Foundation Medicine. J.A. Elvin has ownership interest (including patents) in Foundation Medicine.

Cell Culture, Transfection, Plasmids, and Virus Packaging

The HEK293 cell line, obtained in January 2014, was a gift from Davide Ruggiero [University of California, San Francisco (UCSF)]. HEK293 cells were cultured in DMEM (Mediatech Inc.; Cellgro) with 10% FBS (SH30910.03; HyClone) and transfected with TransIT-LT1 reagent (MIR2300; Mirus) according to the manufacturer’s instructions.

The NIH3T3 cell line, obtained in March 2014, was a gift from Martin McMahon (UCSF). NIH3T3 cells infected with retrovirus were selected with 1.5 μg/ml puromycin for 5 days to get stable expression of indicated protein.

pcDNA3-human-MET WT 3xFlag was a gift from Sourav Bardhan (UCSF), and pBabe puro c-MET WT was a gift from Joan Brugge (Addgene plasmid #17493; ref. 40). Exon 14 deletion in human MET and exon 15 deletion in mouse Met were created by site-directed PCR mutagenesis. pBABE-GFP and pBABE-HRASG12V were gifts from Eric Collisson (UCSF). Ectopic retrovirus was made from PLAT-E packaging cells after transfection of indicated pBABE plasmid with TransIT-LT1 reagent (MIR2300; Mirus) according to the manufacturer’s instructions.

All cell lines tested Mycoplasma negative (Mycoplasma Detection Kit; Cat. 13100-01; SouthernBiotech) within 6 months of performing the experiments. Cell line authentication was not performed.

Soft-Agar Assay

Soft-agar assays were performed as described previously (21). Briefly, 25,000 NIH3T3 cells were suspended in 0.4% agarose (50101; Lonza) with 10% calf serum in DMEM and plated in a 6-well plate. The sum of colonies from 5 random fields of each well at week 3 was reported as the mean of duplicates.

Cell Viability Assay

NIH3T3 cells (2,500) were plated in 96-well format and then treated with indicated concentration of capmatinib, trametinib, or 0.1% DMSO on the second day for 72 hours. Cell survival was measured by CellTiter-Glo assay (G7570; Promega) following the manufacturer’s instructions. Relative cell survival rate was normalized to the DMSO-treated group as 100%. Each data point shows biologic duplicate of triplicate well experiment.

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Activation of MET via Diverse Exon 14 Splicing Alterations Occurs in Multiple Tumor Types and Confers Clinical Sensitivity to MET Inhibitors

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