

Gene specific overwriting of epigenetic signatures to modulate the expression of selected tumor-promoting genes in cancer

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Background

Epidermal Growth Factor Receptor-2 (HER-2) and Estrogen receptor-alpha (ER- α) have been found to be dysregulated in several types of cancer. Their dysregulation is associated with aberrant epigenetic modifications. Additionally, expression of ER- α and HER-2 is inversely correlated; their crosstalk has been shown to be involved in endocrine therapy resistance mechanisms [1]. Therapies targeting either receptor result in cell proliferation inhibition for some cancer types; the anti-cancer effect might be further optimized to be more efficient and applicable for more cancer types by co-targeting the genes at the DNA level. As epigenetic modifications provide a way to modify expression of genes in a sustained manner we aim to downregulate HER-2 and ER- α by inducing epigenetic silencing marks specifically onto their promoters (Epigenetic Editing [2]). We also aim to discover the possible crosstalk of ER- α with HER-2 and other important genes in cancer.

Methods and materials

Towards downregulation of HER-2 and ER- α , expression and epigenetic modification status of promoter of these genes were assessed in a panel of cancer cell lines (bisulfite sequencing and ChIP). Designed zinc finger proteins (ZFPs) targeting genes promoters were fused to a transcription repressor domain [SKD, histone methyltransferases (G9a, SUV39H1), or a DNA methyltransferase domain (C141S [3])] and expressed in cancer cells through viral transduction.

Results

HER2-ZFP fused to G9a or SUV39H1 induced the intended silencing histone methylation marks (H3K9me₂, H3K9me₃) on the HER-2 promoter. Up to 4-fold induced H3K9me₂ mark was associated with up to $54 \pm 2.9\%$ downregulation of HER-2 expression ($P < 0.0001$). Of note, downregulation of HER-2 by induced H3K9 methylation mark was associated with inhibition of cell proliferation and clonogenicity. Additionally, up to 50% downregulation of ER- α was obtained by a ZFP specific to ER- α fused to SKD, G9a, and C141S.

Conclusions

These results show that targeted induction of epigenetic marks is instructive in downregulation of HER-2 and ER- α expression. We conclude that Epigenetic Editing might provide a novel and synergistic approach to modulate (onco)genes. In addition, investigation of ER- α crosstalk with HER-2 and other genes might be promising to better interfere with pathways involved in cancer.

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References

1. Arpino G, Wiechmann L, Osborne CK, Schiff R: Crosstalk between the estrogen receptor and the HER tyrosine kinase receptor family: molecular mechanism and clinical implications for endocrine therapy resistance. *Endocr Rev* 2008, **29**(2):217-233.
2. de Groote ML, Verschure PJ, Rots MG: Epigenetic editing: Targeted rewriting of epigenetic marks to Modulate Expression of selected target genes. *Nucleic Acids Res* 2012, **40**(21):10596-10613.
3. van der Gun BT, Maluszynska-Hofman M, Kiss A, Arendzen AJ, Rutgers MH, McLaughlin PM, Weinhold E, Rots MG: Targeted DNA methylation by a

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DNA methyltransferase coupled to a triple helix forming oligonucleotide to down-regulate the epithelial cell adhesion molecule. *Bioconjug Chem* 2010, **21**(7):1239-1245.

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