Different types of conjugation operations and hidden symmetry for matrix non-Hermitian Hamiltonians

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It is known [A. Andrianov and A.S., NP B **660** (2003) 25 and NP B **773** (2007) 107] that in the scalar case one can construct with the help of transposing polynomial algebra of supersymmetry from two non-Hermitian, in general, Hamiltonians and arbitrary differential operator that intertwines these Hamiltonians. Moreover, in the case of extended algebra of supersymmetry one can build with the use of transposing antisymmetric hidden symmetry operators for both intertwined Hamiltonians and these operators possess by interesting properties closely related with spectral properties of these Hamiltonians. In the matrix case transposing cannot, in general, to help find for a given intertwining operator an operator that intertwines the same Hamiltonians in the opposite direction since these Hamiltonians are not symmetric, in general. In the report we seek for such generalization of transposing that allows us to construct polynomial algebra of supersymmetry from two non-Hermitian, in general, matrix Hamiltonians and arbitrary matrix differential operator that intertwines these Hamiltonians. As well we consider properties of hidden symmetry operators built in the case of extended algebra with the help of the indicated above generalized operation.