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ABSTRACT

Skeletal patterning in the sea urchin embryo requires coordinated signaling between the pattern-dictating ectoderm and the skeletogenic primary mesenchyme cells (PMCs); recent studies have begun to uncover the molecular basis for this process. Using an unbiased RNA-Seq-based screen, we have previously identified the TGF-ß superfamily ligand, LvBMP5-8, as a skeletal patterning gene in *Lytechinus variegatus* embryos. This result is surprising, since both BMP5-8 and BMP2/4 ligands have been implicated in sea urchin dorsal-ventral (DV) and left-right (LR) axis specification. Here, we demonstrate that zygotic LvBMP5-8 is required for normal skeletal patterning on the left side, as well as for normal PMC positioning during gastrulation. Zygotic LvBMP5-8 is required for expression of the left-side marker *soxE*, suggesting that LvBMP5-8 is required for left-side specification. Interestingly, we also find that LvBMP5-8 knockdown suppresses serotonergic neurogenesis on the left side. While LvBMP5-8 overexpression is sufficient to dorsalize embryos, we find that zygotic LvBMP5-8 is not required for normal DV specification or development. In addition, ectopic LvBMP5-8 does not dorsalize LvBMP2/4 morphant embryos, indicating that, in the absence of BMP2/4, BMP5-8 is insufficient to specify dorsal. Taken together, our data demonstrate that zygotic LvBMP5-8 signaling is essential for left-side specification, and for normal left-side skeletal and neural patterning, but not for DV specification. Thus, while both BMP2/4 and BMP5-8 regulate LR axis specification, BMP2/4 but not zygotic BMP5-8 regulates DV axis specification in sea urchin embryos.

Key words: sea urchin, BMP5-8, skeletal patterning, left-right, dorsal-ventral, neurogenesis

Highlights:

- Zygotic LvBMP5-8 is required for PMC positioning and left-side skeletal patterning
- Zygotic LvBMP5-8 is not required for dorsal-ventral specification or development
- Zygotic LvBMP5-8 promotes for left-side serotonergic neurogenesis
- LvBMP5-8 requires LvBMP2/4 expression to dorsalize embryos