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Mapping Single Platelet Forces Directly by Fluorescence Imaging

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Abstract: Platelets are important blood cells mediating hemostasis and thrombosis. Integrin tension plays a critical role in most platelet functions, such as adhesion, activation, aggregation and contraction. Visualizing and measuring single platelet forces are desired in both research and diagnosis of platelet functions. Here we developed integrative tension sensor (ITS) which converts integrin molecular tension to fluorescent signal, therefore enabling cellular force mapping directly by fluorescence imaging. With the ITS, we mapped integrin-transmitted platelet force at 0.4 μm resolution during platelet adhesion and contraction. We found that platelet force distribution has strong polarization which is sensitive to treatment with anti-platelet drugs, suggesting that the ITS force map can report anti-platelet drug efficacy. Furthermore, the tension threshold required for ITS activation is tunable, allowing the selective imaging of integrin tension at different force levels in cells. This feature helped to reveal two distinct integrin tension levels in platelets: 12~54 piconewton tensions generated during platelet adhesion and tensions above 54 piconewton generated during platelet contraction. Overall, the ITS is a powerful tension sensor for measuring and mapping integrin tension in platelets and many other adherent cells, therefore holding great potential in the study of cell mechanobiology.

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