Although structural changes on the sarcomere level of skeletal muscle are known to occur due to various pathologies, rigorous studies of the reduced sarcomere quality remain scarce. This scarceness can be mainly be accounted for by the lacking of an objective tool for analyzing and comparing sarcomere images across biological conditions. We propose a method to assess the sarcomere quality of skeletal muscle tissue imaged by second harmonic generation (SHG) microscopy. SHG microscopy is a label free technique based on the SHG signal originating from the highly ordered myosin thick filaments. This degree of ordering decreases upon muscle degradation, resulting in alterations in the regular appearance of the sarcomeres. The proposed analysis method is based on a fully automated implementation of a Gabor filter. With this Gabor wavelet approach, we can not only localize but also score sarcomere anomalies that could be related to muscle degradation. The method is rather insensitive to the signal to noise ratio and is implemented in such a way that it is independent of global intensity variations. Therefore, the resulting Gabor values allow for data comparison across various biological conditions. Using our newly introduced Gabor analysis method, we studied the effect of muscle disuse on sarcomere quality in the context of multiple sclerosis using an experimental autoimmune encephalomyelitis (EAE) rat model. Based on the gathered data, the interpretation of the Gabor values is addressed by linking them to specific anomalies (Fig. 1), and we show that a correlation exists between the sarcomere quality and EAE related muscle disuse.
Fig. 1: Interpretation of Gabor histograms for typical sarcomere structures imaged by SHG microscopy. (a) raw Gabor data of normal sarcomeres; (b) Amplitude corrected version of (a); (c)+(d) typical examples of pitchforks; (e) myocyte border effect; (f) typical transition to double band patterns; (g)+(h) representative examples of double band structures.