



Figure 16 Feedback efficacy of the training system during the patient intervention study.

**Comparison of therapist and training system.** From literature it is known that therapists may disagree amongst them or could make errors when assessing training performance [42]. We analysed the therapist's assessment in comparison to our ground truth. With this analysis, we could estimate an adequate performance level for our training system. Our analysis showed that the therapist performs better than our training system for the performance class Correct (96% vs. 90%). For all error performance classes, the training system shows better performance. Overall, performances match each other closely suggesting that the training system is suitable for providing exercise feedback.

### 3.7 Discussion

Our training error classification technique is based on a sinusoidal motion model, which showed good results in detecting movement errors for both, healthy adults and chronic patients. We chose this method over others for two reasons: (1) using machine learning techniques requires a training set to obtain the classifier model. In particular, a sufficient number of exercise error instances would be required. For our application, it was not feasible to let patients perform exercise errors due to the risk of injuries. (2) With machine learning techniques, it is difficult to differentiate variations in performance of the same exercise from execution errors. Hence, we formalized error classes by considering deviations from the correct execution using our sinusoidal model. We consider that other exercises can be integrated in our training system by selecting a suitable motion feature that reflects the sinusoidal pattern and estimating the initial hill-climbing parameter threshold. Subsequently, speed and range of motion can be considered to determine the performance classes. The relevance of a Teach-mode was confirmed by the parameter ranges obtained after estimating exercise model parameters for every patient. Hence, we expect that our exercise analysis approach is scalable to other patient groups requiring