We perform molecular dynamics simulations using the extended simple-point-charge model for water to study the structural relaxation through the glass transition region. We follow the same standard protocol used in differential scanning calorimetry experiments. Specifically, we cool liquid configurations at different cooling rates to produce a glass, and then we heat the glass back to the liquid state. We also study aging effects in the glass before heating. We find that MD simulations can reproduce the phenomenology observed in experiments. We review the Tool-Narayanaswamy-Moynihan phenomenological approach, introduced to describe the behavior of the specific heat upon heating glass to the liquid phase. The TNM approach requires, as an ansatz, an expression for the temperature dependence of the relaxation time. We compare the simulation results with the prediction of the TNM approach supplemented with two well-known expressions for the relaxation time: the Narayanaswamy-Moynihan and the Adam-Gibbs-Scherer expressions. We find that, in the case of slow cooling rates, our simulations are well represented by the TNM approach, but only if the AGS expression is adopted. We also find that the TNM approach fails in the case of fast cooling rates for both NM and AGS expressions. Several attempts to provide more freedom to the fitting procedure by allowing the fitting parameters to depend on temperature, cooling, and/or heating rates do not improve the agreement between the simulation data and the TNM predictions. PHYSICAL REVIEW E 72, 011203