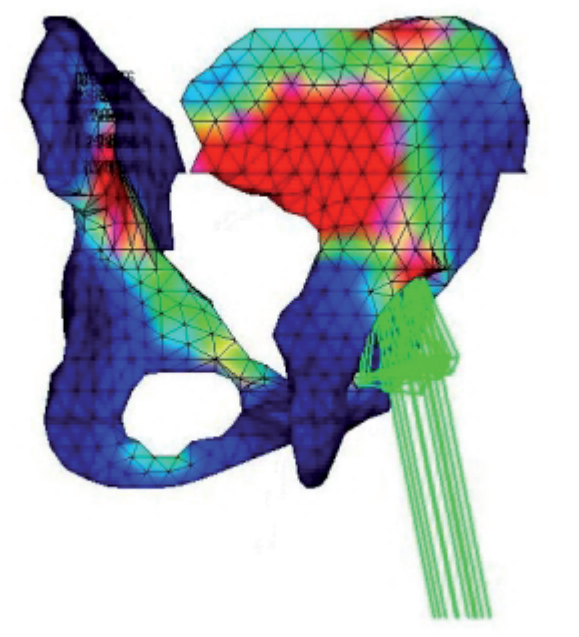




Force Transmission In Offset Broach Handles Used For Hip Replacement: Comparison Of Three Different Designs



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INTRODUCTION:

In minimal invasive direct anterior total hip arthroplasty double offset broach handles are used, in order to facilitate the preparation of the femoral canal¹⁻⁵. The aim of this study was to quantify the differences in force and impulse transmission in the impact direction of the broach tip between two versions of double offset broach handles (A European version, B American version) and a single offset broach handle (S).

METHODS:

Two types of double offset broach handles were compared to a single offset broach handle (all Stryker, Mahwah, NJ-USA) **Fig 1**. An impact hammer was used to carry out 30 measurements for five different falling heights for each broach handle **Fig 2**. The force variations measured by a load cell connected to the broaches were used to obtain the maximum force peak and to calculate the impactation impulse. Since not all data was normally distributed the non-parametric U-Test was used for further analysis. Partial η^2 of multivariate analysis of variances model with repeated measures was used to determine the amount of variance explained by the model.

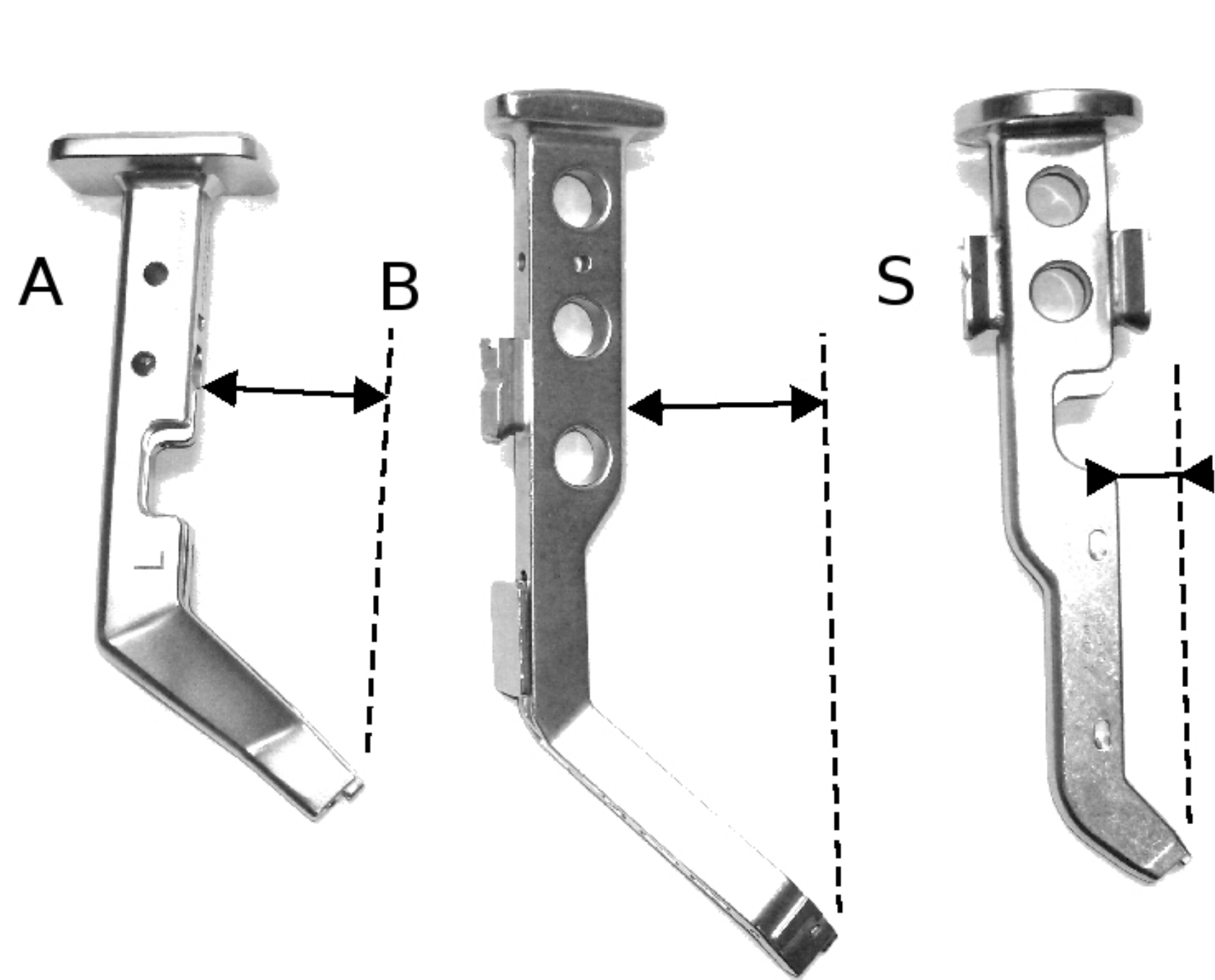


Fig. 1: Frontal and lateral view of Double offset A (European version), Double offset B (American version) with anterior and lateral offset and single offset broach handle S with anterior offset.

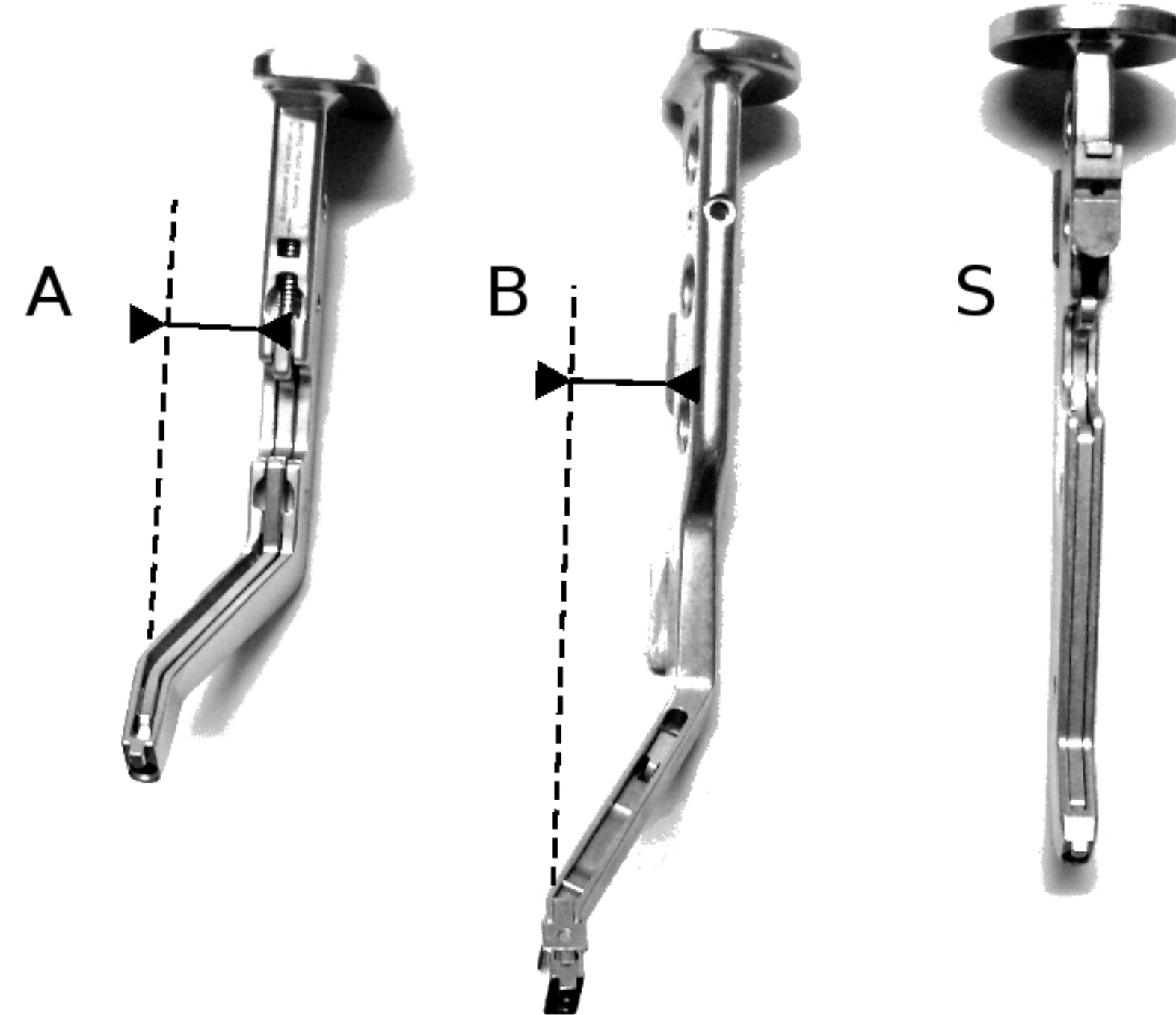
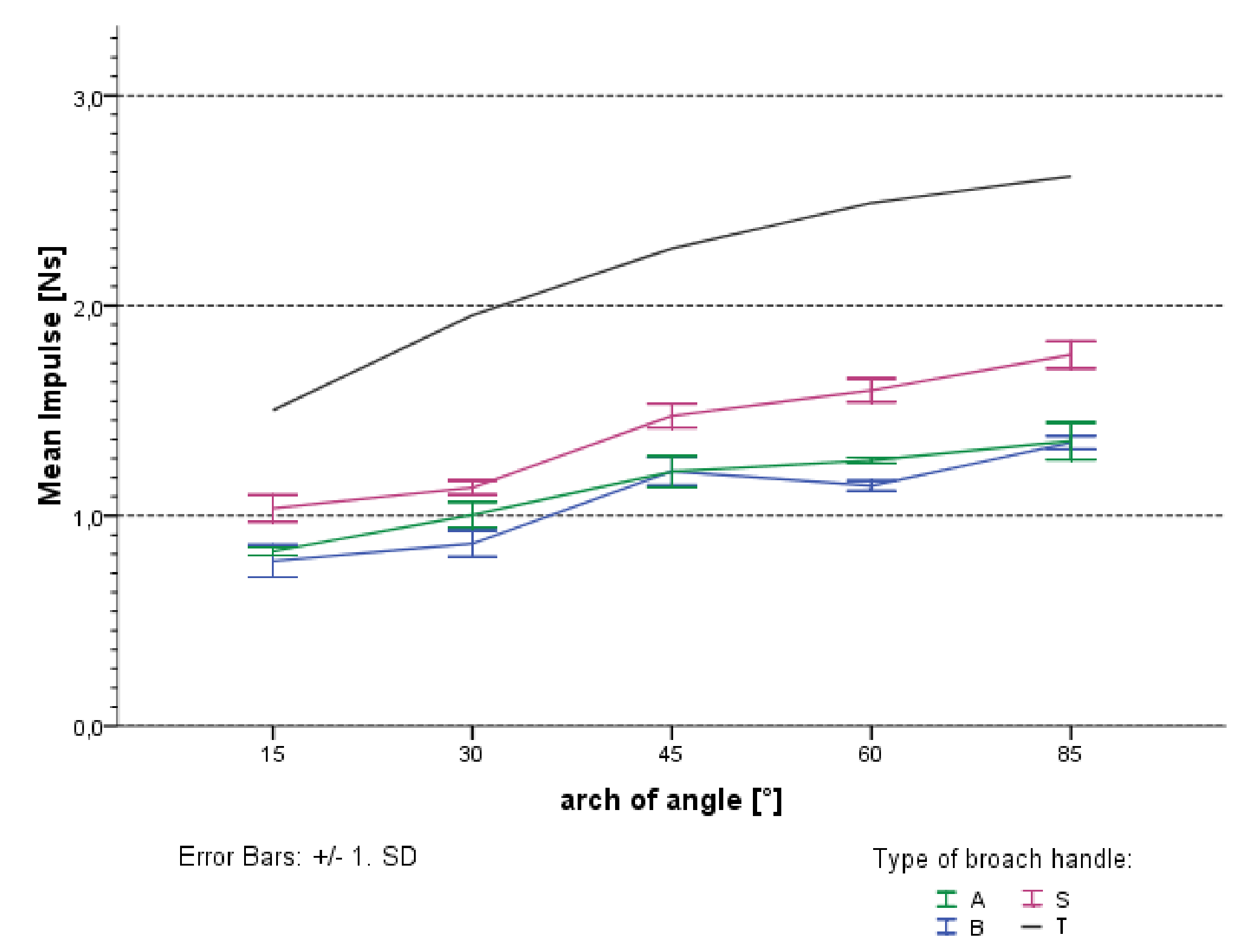
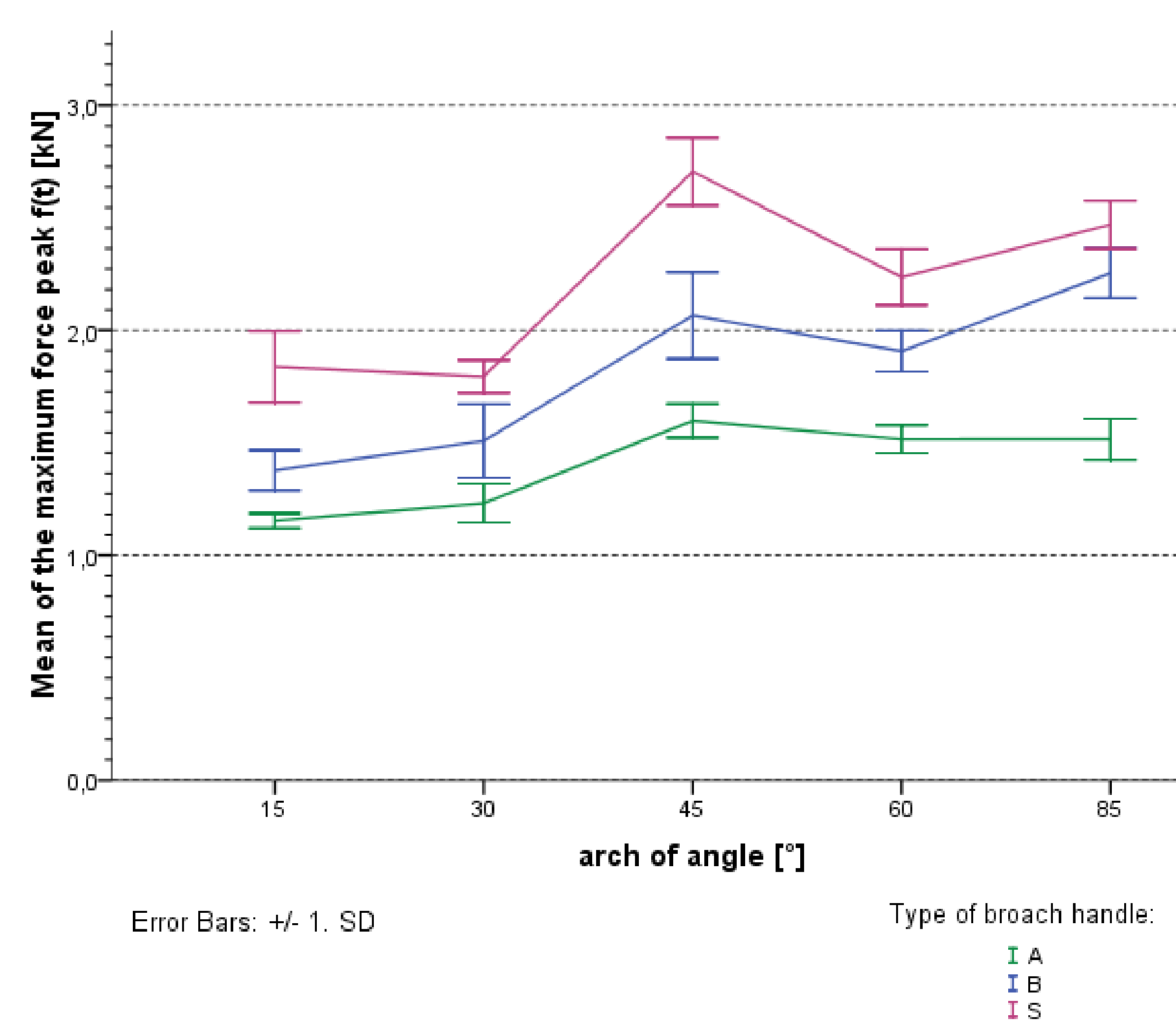


Fig. 2: Schematic overview of experimental setup: A Surgical hammer, B broach handle, C modified broach, D guide, E Load Cell. Arrow indicates the direction of the impact hammer, which describes an angle of arch α .

RESULTS:

Results have demonstrated that the highest values of the main force peak and transmitted force impulse were found in the single offset broach handle. Broach handle A had higher impulse values and lower maximum force values compared to broach handle B. The differences between the maximum force peaks and between the impulse values of the three broach handles were statistically significant ($p < 0.001$). Impulse values calculated from theoretical model are reported as T. The partial η^2 value of the force peaks was 0.90 and for the impulse values 0.96.



DISCUSSION & CONCLUSIONS:

The single broach handle has the highest force peaks in the direction of the tip, followed by broach handle B (22% lower than S) and A (36% lower than S). Higher instantaneous force peaks could increase the risk of bone fracture. We assume that the contact surface during the impact is a determining factor in reducing the maximum force peak. However as the material properties of the broach handles were unknown, this behavior can be attributed also to the dumping behavior of the broaches. The impulse values are very similar between the two double offset broach handles (A has 6% higher impulse value than B) and different compared to the single offset broach handle (S had 31% higher impulse value than B and a 19% higher impulse value than A). Therefore the introduction of the lateral lever arm has a measurable effect in double offset broach handles, as less energy is transmitted in the direction of the tip.

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