AutoCart Procedure: Impact of Different Arthroscopic Shavers on Cartilage Particulate Size, Chondrocyte Viability, and In Vitro Migration

Arthrex Research and Development

Objective

Cartilage injuries notoriously lack the capacity for self-repair. A recent single-stage technique developed for the treatment of osteochondral defects uses cartilage particulate collected via arthroscopic shaver. Autologous particulate cartilage is advantageous because it contains viable chondrocytes that can augment matrix repair.[1,2] Arthroscopic shavers can vary widely in physical features, aggressiveness, and resection performance.[3] It remains unclear how the type of shaver used affects the short- and long-term viability of cartilage particulates and the ability of an autograft to remodel. The purpose of this study is to investigate the size and viability of cartilage particulate produced by five different shavers, and the potential for chondrocyte migration within a fibrin matrix.

Methods and Materials

Bovine knees (Animal Technologies) were dissected to expose the articular surfaces. Control tissue was excised with a scalpel. Five different Arthrex instruments—the 4 mm Bone Cutter shaver (BC4); 4 mm Torpedo™ shaver (T4); 4 mm Sabre shaver (S4); 3 mm Sabre shaver (S3); and 4 mm Excalibur shaver (E4)—were evaluated. Two shavers were randomly assigned to each of six knees (n=2-3 per shaver). The cartilage particulate for each shaver was collected with a GraftNet™ autologous tissue collector (Arthrex). After harvesting was complete, the particulate was cultured in chondrocyte growth medium (Lonza).

To visualize particulate size, a portion of the cartilage shavings were stained with 28 µM DTAF. Fluorescent images were analyzed with ImageJ software to measure the cross-sectional area of each particle. The particle size distributions were compared with a Kruskal-Wallis ANOVA on ranks and a post-hoc Dunn's test (α=0.05). The viability of the chondrocytes within the particulate was assessed at 24 hours, 4 days, and 7 days post-collection using a LIVE/DEAD assay (Invitrogen). Mean viability was normalized to control tissue at 24 hours. The normalized viability of shavings was compared with a one-way ANOVA and post-hoc Tukey test (α=0.05). The relationship between particle size and normalized viability was evaluated with Pearson's coefficient at each timepoint (α=0.05).

Lastly, the potential for chondrocytes to migrate out of the cartilage chips and into a fibrin matrix was assessed. Bovine blood was processed on the Angel® system (Arthrex) to isolate platelet-poor plasma (PPP), which was used with the Thrombinator™ system to generate autologous serum. Shavings were mixed with a fibrinogen source (PPP) and thrombin serum in a 2:1:1 ratio to yield cylindrical constructs. The constructs were cultured for two weeks, then stained with the LIVE/DEAD assay. The constructs were examined for evidence of chondrocyte migration.

Figure 1. Representative images of cartilage particulate (differing letters denote $p<0.05$)[4]

Results

The five shavers produced cartilage particulate of significantly different sizes (Figure 1, $p<0.001$). E4 produced the smallest particles, with a median area of 0.116 mm^2. S4 produced the largest particles, with a median size of 1.07 mm^2, while S3, T4, and BC4 produced similarly medium-sized particles.

There were insignificant differences in the normalized viabilities of the shavings at 24 hours, 4 days, and 7 days (Figure 2). The normalized viability of all five shavers increased from 24 hours to 7 days. At 24 hours, a positive relationship was observed between particulate size and normalized viability ($r=0.581$, $p=0.0474$). This relationship lessened over time.

At two weeks, migrations of cells from the cartilage shavings into the fibrin matrix of the constructs was observed for all five shavers (Figure 3).

References

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Conclusion

Despite the varying size of the cartilage particulate produced by the different shavers, the normalized viability of the chondrocytes within the particulate was not significantly different at any timepoint. Furthermore, the normalized viability of all shavers increased from 24 hours to 7 days, indicating that the cells can recover from the tissue harvest and proliferate. This, in combination with the observation of chondrocyte migration into the fibrin matrix, shows that autologous cartilage shavings are an acceptable method for obtaining autologous cells with the potential to remodel and regenerate the matrix within a cartilage defect.

Figure 2. Normalized viability of chondrocytes in cartilage shavings[4]

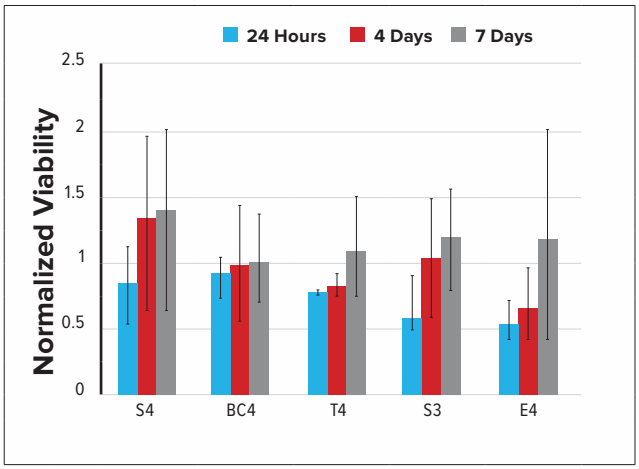
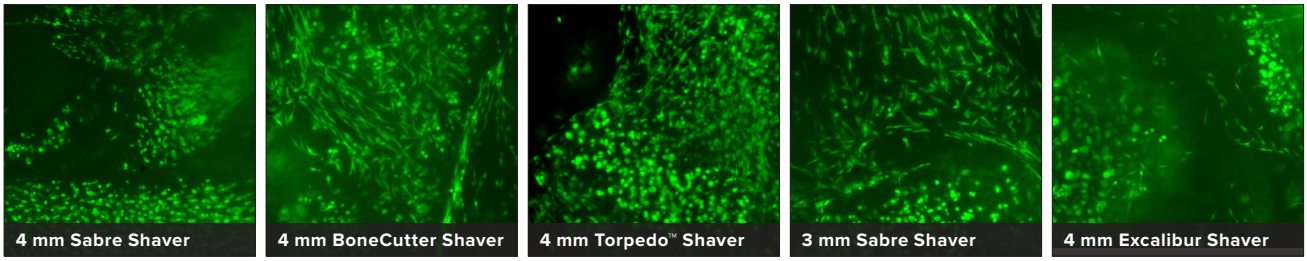


Figure 3.
Representative images of chondrocyte migration out of cartilage particles (P) within fibrin constructs[4]



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