Achilles Tendon Allograft Incorporated with Autologous Mesenchymal Stem Cells: an animal model

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Disclosure

The authors declare no conflict of interests related to this presentation.
Our full disclosures are listed in AOFAS mobile app.

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- It is challenging to reconstruct Achilles tendon, because of the large size of the tendon and the limitation in Achilles autograft.
- Allograft of Achilles tendon does not have restrain of supply.
- The biology, particularly revitalization, biomechanics and function of Achilles allograft orthotopic transplantation, however, are unknown.
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Study Goals:
1) Investigating the function, histology and mechanical properties of orthotopically transplanted Achilles allograft in rats and
2) The effects of supplementation of autologous mesenchymal stem cells on Achilles allograft.
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Study Design:

1. Achilles allografts (n = 24) were harvested from 12 donor rats (approved by IACUC) and kept at -80°C before transplantation.

2. Autologous mesenchymal stem cells (MSCs): Subcutaneous adipose tissue was harvested from the would-be allograft recipient rats for isolation of MSCs. MSCs were characterized and cultured for tenogenic differentiation.
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Study Design

- Rats (n = 10)
- Resection of native Achilles tendon
- Achilles allograft + autologous MSCs
- Gait analysis (weekly)
- Biomechanical testing
  - 4 Weeks
- Achilles allograft
- Histology
  - 4 Weeks
Gait: The operated (left) limbs reduced paw print intensity about 20% from the baseline in the Allo group and 30% in the Allo+MSC group in week 1 (A). At week 1, the stance time of the limbs received Achilles allograft was reduced from week 0 in both groups, with Allo+MSC group to a greater degree (B).

Allo group = rats received Achilles allograft; Allo+MSC group = rats received Achilles allograft, which was implemented with autologous MSCs; R = right, non-operated limbs; L = left, transplanted Achilles allograft
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Gait: The duty cycle (percentage of the stance phase in a step cycle) of the reconstructed limbs in both Allo and Allo+MSC groups was reduced, compared with its baseline, through weeks 1 to 4 (C). At week 4, print intensity, stance time and duty cycle were improved in both Allo and Allo+MSC groups (>85% baseline; D).

Allo group = rats received Achilles allograft; Allo+MSC group = rats received Achilles allograft, which was implemented with autologous MSCs; R = right, non-operated limbs; L = left, transplanted Achilles allograft
Gait: Imbalance of stance was calculated as the difference of duty cycle between the non-operated limb and operated limb. While the imbalance of stance was not significant in the Allo group (E), it was significantly increased in the Allo+MSC group in weeks 1 and 2 but diminished in weeks 3 and 4 (F).
Histology:
Cellularity was generally higher in the Achilles allograft in Allo+MSC group than Allo group (average cellularity grade 2.7±0.5 vs 1.7±0.5).
Histology: Type III collagen stained by picrosirius Red was more evenly distributed in the Allo+MSC group than in the Allo group.
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**Biomechanics:** Maximum load of failure was not significantly different among Allo (27±11N), Allo+MSC (28±6N) and normal Achilles tendon (12±10N) groups.

**Conclusion**

1) Orthotopically transplanted Achilles allograft healed with host tissues, regained strength and largely restored Achilles function in 4 weeks in rats.
2) Incorporation of MSCs repopulated Achilles allograft. Large animal models, with long-term follow up, may be more appropriate to reveal the full benefits of supplementation of MSCs to Achilles allograft.