Maximizing Gain from Rectangular Tissue Expanders

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Numerous studies have evaluated the methods of selecting the proper size, shape, and volume of tissue expanders.[1-7] Using both in vitro and in vivo models, the increase in surface area obtained with tissue expansion has been calculated by many techniques.[1,2,7] Unfortunately, the exact location of the cuts used to create flaps to cover a certain defect is rarely discussed,[8,9] and flaps are probably quite frequently suboptimally designed in clinical practice. Several authors[1,2] have shown that the calculated increase in surface area with tissue expansion is significantly overestimated when compared with the actual gain. The senior author (Zide) noted this and embarked on the development of procedures to significantly increase the mobility and use of the flaps. Three methods of flap design, after rectangular tissue expansion, have been employed for the last 5 years in more than 50 patients with excellent results.

Methods

Double Back-Cut Flap

A rectangular expander slightly larger than the lesion is inserted adjacent to the longest side of the lesion (Fig. 1, *A*). After the expander is

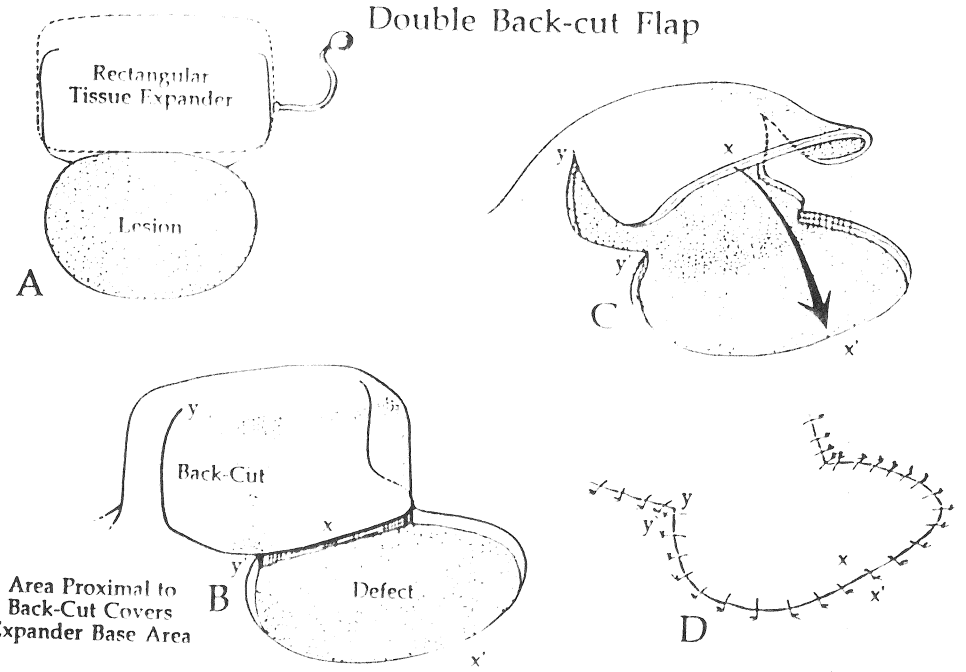

Fig. 1. Schematic diagram demonstrating the design of the double back-cut flap.

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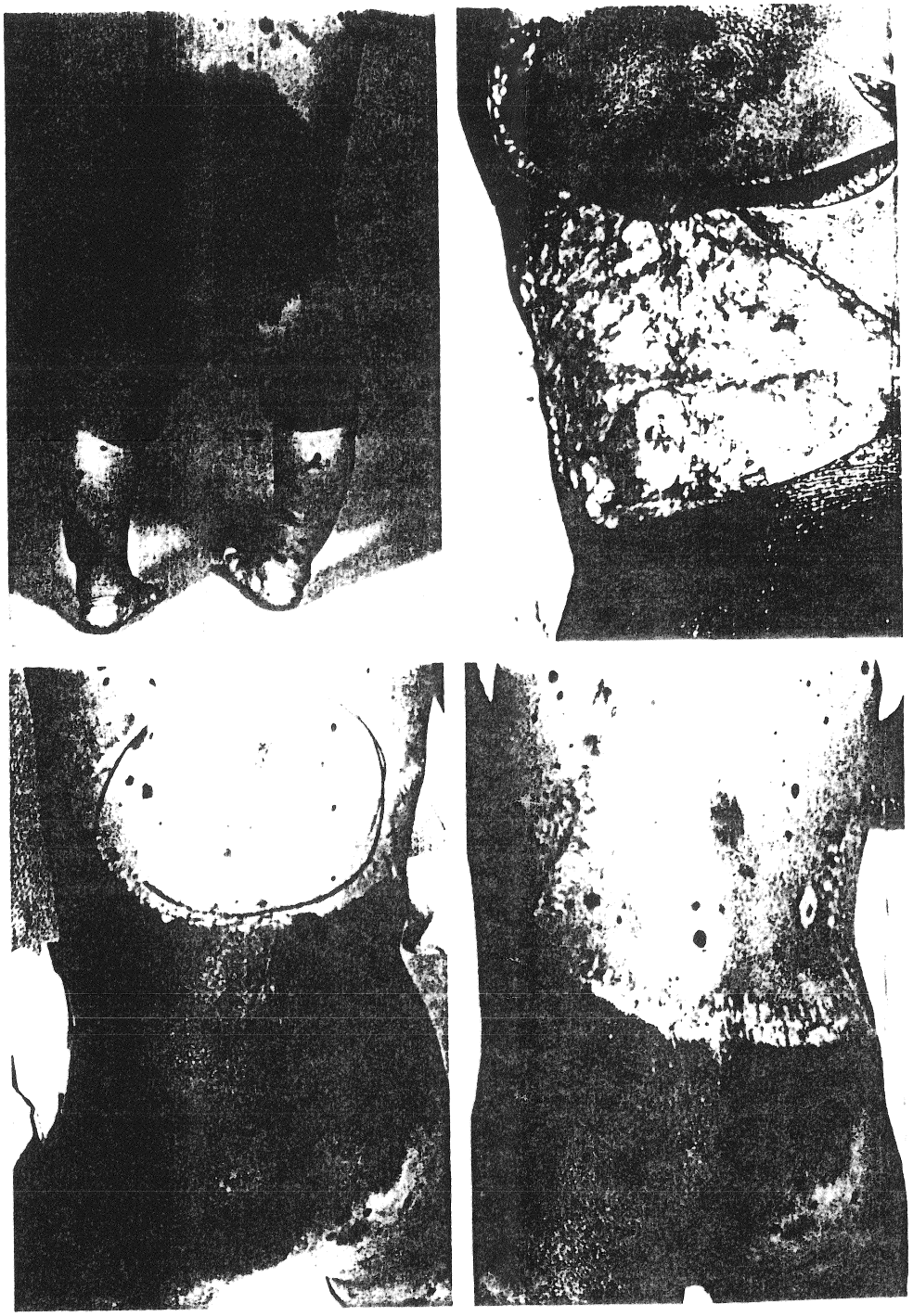

FIG. 2. (*Above, left*) Lesion prior to treatment. (*Above, right*) After resection of the lesion and creation of the first double back-cut flap. (*Below, left*) Lesion prior to insertion of the second tissue expander. (*Below, right*) Appearance 3 months after resection and inset of the second double back-cut flap.

inflated, a flap is designed with an incision placed along the advancing edge of the flap and then continued halfway along the sides of the expander. From this point, back-cuts are performed to the height of the expander on both sides (Fig. 1, *B*). After the lesion is excised and the flap is advanced, minimal resection of normal tissue is required to inset the flap (Fig. 1, *C* and *D*) properly. This technique provides the maximal gain of soft tissue and is best for round or rectangular lesions. It also provides for the maximal excision of giant nevi. The expanded tissue

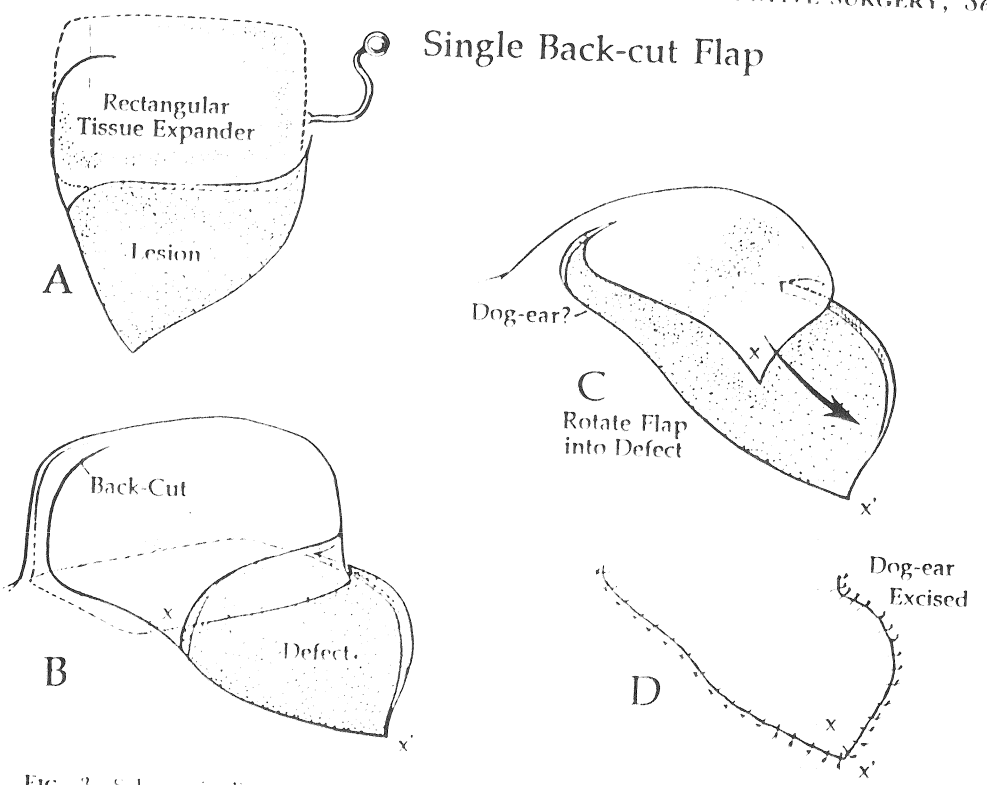

FIG. 3. Schematic diagram demonstrating the design of the single back-cut flap.

proximal to the back-cuts covers the area where the expander base rested. When multiple serial expansions will be required, the same flap may be used repeatedly.

CASE REPORT

This patient is an 11-month old boy with a large truncal giant hairy nevus (Fig. 2, *above, left*). After a paravertebral excision of 12 × 5 cm of the nevus, a 12 × 7 cm (450 cc) rectangular tissue expander was placed under the normal skin, superior to the lesion, using the same incision. The expander was inflated to approximately 600 cc over 3 months, and a double back-cut flap was designed that allowed excision, without dog-ears, of a 9 × 10 cm area of the lesion (Fig. 2, *above, right*). Five months later (Fig. 2, *below, left*), the patient had a similar-sized expander placed directly under the previously advanced flap. After 3 months of inflation, to approximately 680 cc, another double back-cut flap, using the same incisions, was raised, and a 15 × 6 cm section of the nevus was resected (Fig. 2, *below, right*). Similarly, no dog-ears were created.

Single Back-Cut Flap

In cases of triangular lesions or when transposition is required, an expander is placed parallel to the longest side of the lesion (Fig. 3, *A*). After expander inflation, a triangular type of flap may be designed to the exact size of the lesion to be resected by using a back-cut on one side (Fig. 3, *B*). The tissue proximal to the back-cut covers the area where the expander was, and a small dog-ear usually needs to be excised (Fig. 3, *C* and *D*).

CASE REPORT

This patient is a 1-year-old girl with a large involuting hemangioma of the left scalp and forehead resulting in a gross deformity (Fig. 4, *above*). A small partial excision of the hemangioma was performed through an incision in the posterior portion of the lesion, and an 8 × 6 cm rectangular expander was placed through the same incision. The expander was inflated to approximately 300 cc over 3 months. A triangular flap was designed the exact size of the lesion, and a back-cut was placed to allow easier rotation and inset of the flap (Fig. 4, *center*). The entire lesion was resected (Fig. 4, *below*).

Over-the-Top Advancement Flap

A rectangular expander, slightly wider than the lesion to be excised, is placed next to the lesion (Fig. 5, *A*). After completion of inflation, a flap is designed directly over the top of the expander (Fig. 5, *B*). The amount of tissue available in the flap is easily calculated, and as much of the lesion as possible is removed. Normal tissue is discarded from the sides of the flap to allow inset of the flap and elimination of dog-ears (Fig. 5, *C* and *D*).

CASE REPORT

This patient is a 7-year-old girl with a large giant hairy nevus of the left cheek, forehead, and scalp. The left cheek

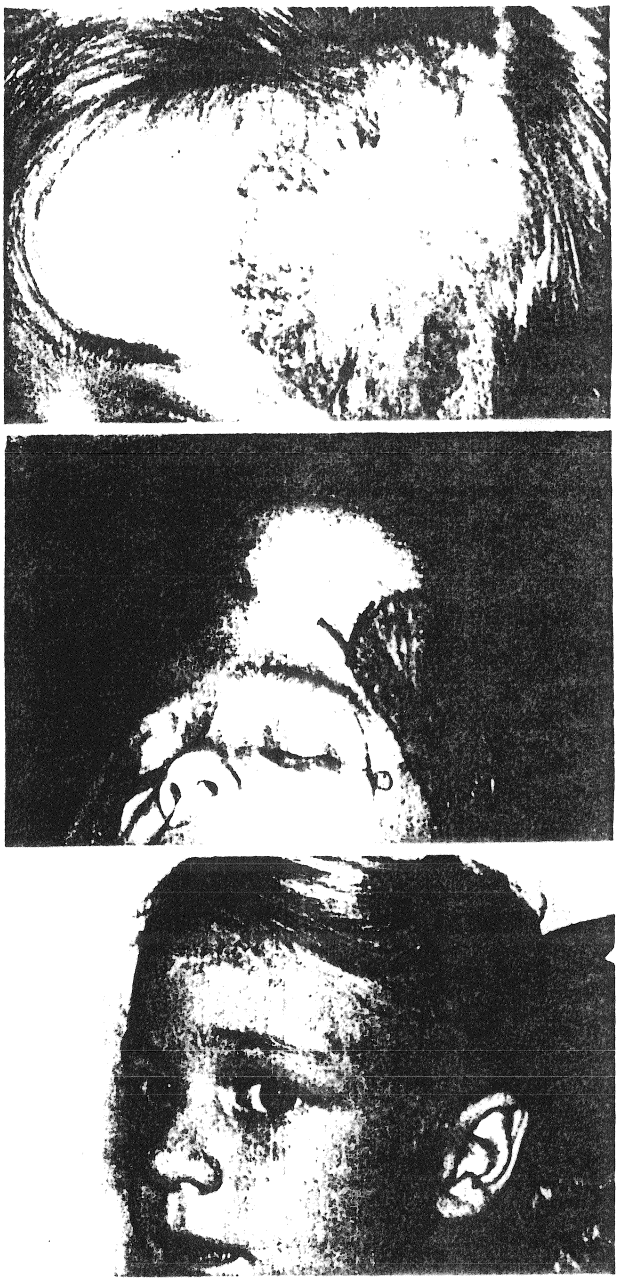

FIG. 4. (*Above*) Involuting hemangioma prior to resection. (*Center*) Design of the single back-cut flap. (*Below*) Appearance 9 months postoperatively.

lesion was treated with a 6 × 5 cm rectangular tissue expander placed adjacent to the lesion through a preauricular incision. The expander was inflated to approximately 160 cc over 3 months (Fig. 6, *left*), and then an over-the-top advancement flap was designed and the lesion was resected (Fig. 6, *right*). The forehead nevus also was treated with an expanded flap, using a single back-cut transposition flap.

DISCUSSION

Three techniques are presented that demonstrate methods of designing flaps to be elevated following rectangular tissue expander placement. We can now state several facts:

1. Creation of flaps by cutting around the advancing edge of expanded tissue does not take full advantage of the expansion.
2. The expanded tissue also must cover the area where the expander was sitting. Thus the width of the expander base helps determine the position of the back-cut (usually the middle of the expander).
3. Single and double back-cut flaps dispose of little normal tissue.
4. Over-the-top advancement flaps result in considerable mobility, more tissue sacrifice than single or double back-cut flaps, but the greatest ease in flap design. This method works best in the scalp and face.
5. A single back-cut technique will allow the flap to be advanced or transposed. The other two techniques only provide advancement. This is the workhorse technique.
6. Multiple rectangular expanded double back-cut flaps may actually interdigitate with each other and be reexpanded with ease.
7. The single back-cut flap is especially useful for lesions that are triangular in shape or can be resected in a triangular manner. The back-cut side easily advances to cover the base of the triangular defect with the advantage of easy inset and primary closure of the donor site. The inset of this flap may require resection of a small dog-ear opposite the back-cut or where the back-cut closes on itself.
8. The over-the-top advancement flap is an old standard with much more tissue gain. This flap is useful for resection of round or rectangular lesions (similar to the double back-cut flap). When excising dog-ears and insetting the flap, resection of normal tissue is almost always required, and as expected, the flap narrows when advanced.

SUMMARY

Three different options are proposed to cut the flap after expansion of rectangular tissue expanders. Each method, when used effectively, allows the expander to deliver the full punch of the expansion process.

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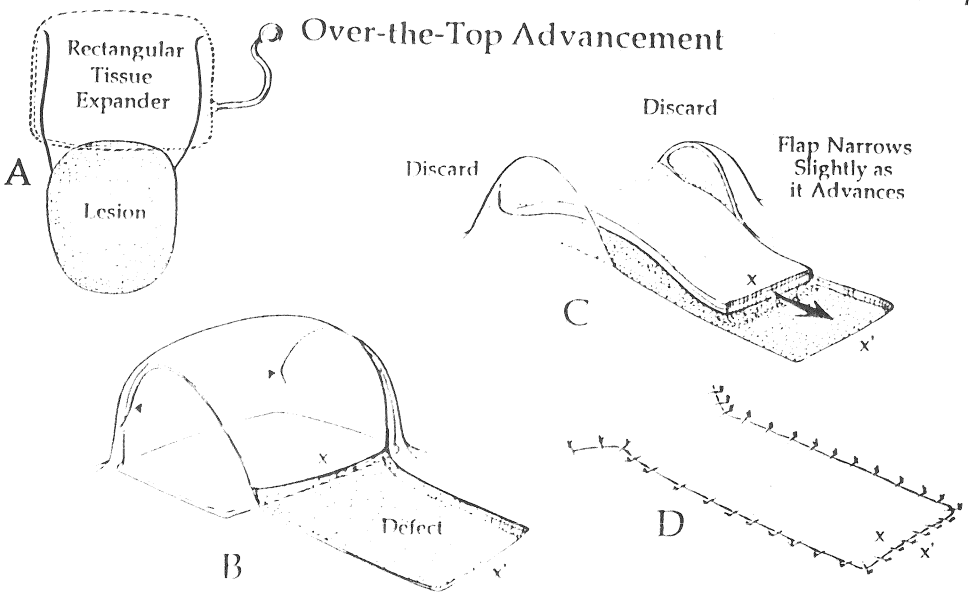

FIG. 5. Schematic diagram demonstrating the design of the over-the-top advancement flap.

FIG. 6. (*Left*) Design of the over-the-top advancement flap. (*Right*) Appearance 1 year postoperatively.

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Discussion

Maximizing Gain from Rectangular Tissue Expanders

by Barry M. Zide, D.M.D., M.D., and Nolan S. Karp, M.D.

Discussion by Ernest K. Manders, M.D.

Soft-tissue expansion requires time. The process is somewhat inconvenient, and therefore, anything that will maximize the use of the tissue gained by expansion is attractive to surgeons and patients alike. In this paper, Drs. Zide and Karp present us with three strategies for doing just that. Their paper is a good one, deserving of our reading and study. Several points, however, are worthy of discussion.

The first thing to say is that Drs. Zide and Karp have analyzed the problem of unfurling the hemispheric flap, and they have shown us three ways to go about it. The title of the article refers specifically to rectangular tissue expanders, but in actual fact their method applies to hemispheric flaps generated by expanders with a round base as well.

The double back-cut flap of Figure 1 advances very nicely and opens the flap effectively. The single back-cut design appears, as they state, to be well suited to filling triangular defects. This analysis is an improvement over the original back-cut around the base of the expander advocated by Dr. Radovan years ago.

The over-the-top advancement flap has been published before.[1] It is well to remember it and, in particular, to design it as an axial-pattern flap wherever possible. It is well worth inclusion in this discussion.

There is a very important point to be made regarding these strategies. The point is this: *Each of these maneuvers requires the surgeon to create more scar.* Any patient who is reconstructed with one of these techniques will have a greater scar burden than if he or she were reconstructed with a simple advancement flap. This point must be emphasized. It recalls the two principal questions for planning soft-tissue expansion:

1. What is available to expand and cover the defect?
2. Where does one want the final scars to lie?

One can argue that some of the approaches used in this paper could actually have been designed better. In the case of the first patient, a large croissant flap across the whole upper back of the infant might well have provided a better advancement over a broader front. In this case we do not know exactly what the flanks and anterior thorax of this patient look like, but it may well have been possible to reconstruct this patient without the vertical scars evident in Figure 2 (*below, right*). A better strategy may have been to surround the defect and move the expanded tissue downward as a simple advancement flap. This scar could have been positioned low on the back, perhaps low enough to hide under shorts.

The patient in Figure 4 shows an excellent use of the single back-cut flap. It occurs to me, however, that a simple advancement of expanded forehead with simultaneous advancement of expanded scalp would have accomplished the closure without the transverse scar that is seen across the forehead of the patient in Figure 4 (*below*). If a second forehead expansion were necessary for a second advancement, would it have been worth it to avoid the transverse forehead scar? Perhaps yes.

The patient in Figure 6 did not, in my estimation, have an optimal expansion design. It is clear that a large amount of normal skin was discarded. I believe that one could have served this patient better by expanding across the cheek, staying

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within the aesthetic unit of the cheek. To be complete, I must add that my inclination would have been to pinch the skin to see just how much laxity there was in the face. Serial excision would probably have been my first choice. If expansion is required, there is an advantage to staying within the aesthetic unit if it is at all possible.

The defects of the reconstruction we see in Figure 6 (*left*) include parallel scars on the mid-cheek, which cross the aesthetic unit and which are very obvious. There is a discontinuity along the line of the mandible with a loss of normal cheek skin. In a male with an expected beard growth there, this could produce a discouraging result that might become obvious at puberty with growth of the beard. As a general rule, it is difficult to expand the neck and move it up into the cheek area. In particular, one often loses the concavity below the mandible, and the line of the mandible is obscured. Also, there is likely to be displacement of mobile features of the face.

Placement of a croissant or even a narrow rectangular expander adjacent to the nevus on this child's face would have allowed closure with a preauricular scar and a transverse scar at the level of the lateral canthus. I believe that this would be an aesthetically superior result to that obtained. There would be no scars on the cheek, and in particular, the line of the mandible would not be affected, nor would hair-bearing skin in a male be replaced.

Overall, this is a good paper with valuable material that is well presented. There will be times when the techniques demonstrated here fit the needs of a given patient. I certainly do not mean to sound hypercritical of excellent surgery. My comments are simply honest and well intended. Whenever possible, we should attempt to stay within aesthetic units, place our scars at the boundary of aesthetic units, and do simple things.

I am writing to provide perspective. In my judgment, it will seldom be necessary to use these techniques. They should be learned, however, because there will be a need to use them at times, and then they will be an excellent aid to assist a surgeon in fully using all the expanded tissue created in hemispheric flaps.

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