

# Expanded Pedicle Scalp Flaps for Baldness: Is a Delay Necessary?

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The use of skin expanders in the treatment of male pattern baldness and cicatricial alopecia after ablative surgery or trauma has been a major advance in aesthetic and reconstructive surgery.<sup>1-9</sup> It has also led to major improvements in reconstructive techniques for the breasts, extremities, and head and neck area in general.<sup>2,10-12</sup>

The principles of tissue expansion are demonstrated in the natural process of the enlarging uterus in pregnancy, resulting in postpartum-redundant skin. These same principles can be applied to create additional skin for reconstructive or aesthetic surgery.

Although numerous examples of the expansile properties of skin were evident in everyday life, actual application of skin expansion as a reconstructive tool was first reported by Neumann in 1957.<sup>13</sup> Radovan<sup>14,15</sup> developed an implantable, inflatable prosthesis with a self-sealing remote injection port. Austad and Rose<sup>16</sup> created a self-inflating tissue expander, which was osmotically powered, by including a high-solute content within a semipermeable membrane.

The use of anteriorly based temporoparietaloccipital (TPO) pedicle flaps (described by Juri) has been well described for the treatment of male pattern baldness (Figs. 1 and 2).<sup>17-22</sup> In this article, the terms Juri flap and TPO flap are used interchangeably. It is not

surprising that, in selected cases, combining the benefits of both the Juri flap and skin expanders would be useful and advantageous.<sup>3,7</sup>

Candidates for a Juri flap, who possess a particularly inflexible scalp, or patients having a second Juri flap, may be considered for use of a skin expander (Figs. 3 and 4). In such cases, the major difficulty lies in closure of the donor defect. Too much tension in the donor area can result in widening of the scar, possible scalp necrosis, and/or hair loss in the donor site, all offsetting much of the benefit gained by the Juri flap. The skin expander is eminently suited in such cases to alleviate many of these potential difficulties.

The question that arises in cases where a TPO flap will be expanded, before rotation, is whether staged delays are necessary, as is generally recommended.<sup>17-22</sup>

In order to answer this question, a review of the literature and the experience of the senior author will be given. Emphasis will be placed on the vascular changes that occur in expanded tissue.

## PHYSIOLOGY OF EXPANDED TISSUE

The ability of human tissues to adapt to gradual physiologic stretching is well documented. The cal-

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**Figure 1.** The Juri flap: A delayed TPO flap for the treatment of male pattern baldness.



**Figure 2.** Diagrammatic example of completed Juri (TPO) flap procedure.

varium expands at the suture lines in response to the enlarging brain. The pelvic bones open to allow for parturition. The expansion of abdominal skin in the pregnant female or breast skin in response to hormonal changes are all examples of this adaptation by human tissue.

The ability of skin to stretch in response to mechanical tension (i.e., skin hooks or skin expanders) is based on its viscoelastic properties. These properties originate from two phenomena known as mechanical creep and stress relaxation. Creep occurs



**Figure 3.** An example of a loose, flexible scalp that lends itself well to pedicle flap procedures and scalp reduction.



**Figure 4.** Example of an inflexible scalp, having previously undergone flap reconstruction of the anterior hairline. Further flap surgery in this patient requires tissue expansion.

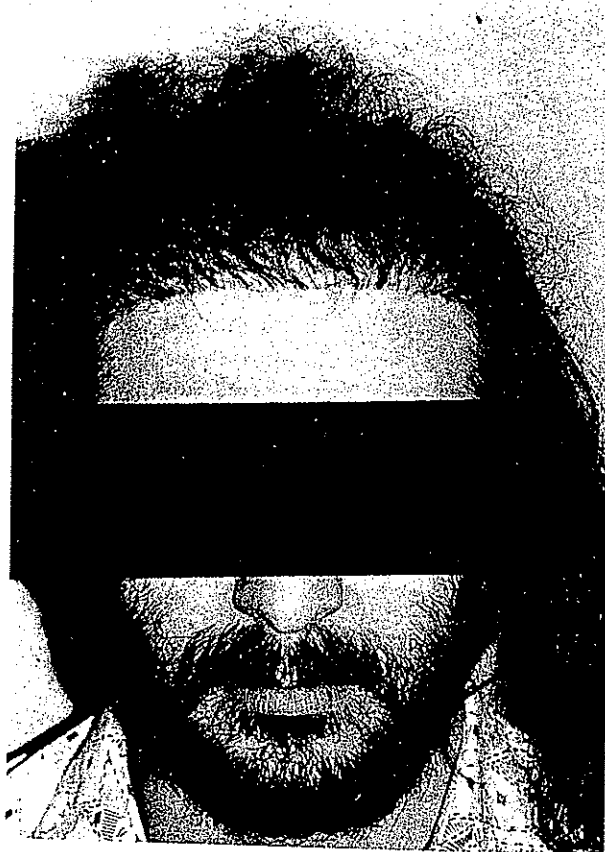


Figure 5. Unsatisfactorily punch-grafted hairline before revision by the Juri flap procedure.

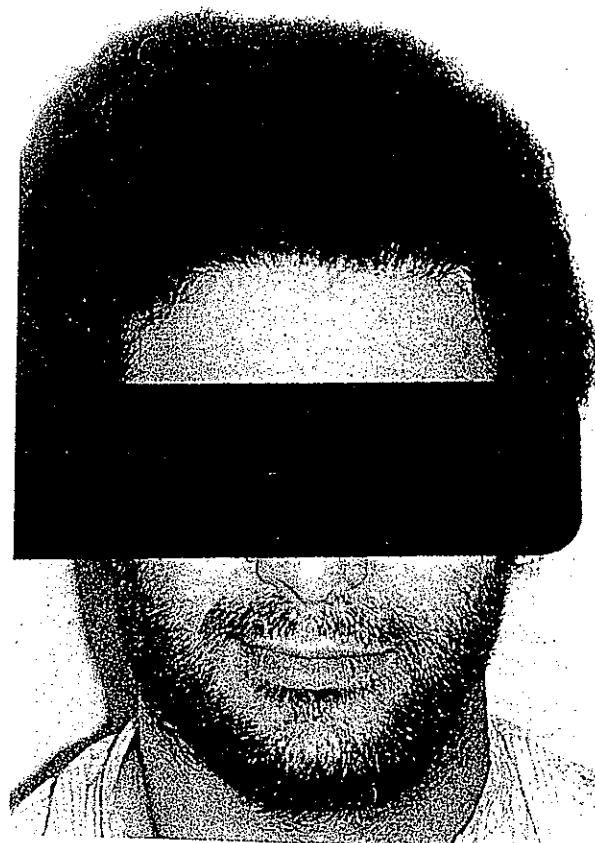


Figure 6. Same patient as on Figure 5; 6-month post-operative Juri flap reconstruction of the hairline.

before performing a Juri flap procedure. Situations in which expansion before transferring a Juri flap may be recommended occur when: (1) the scalp is unusually inflexible, (2) a second Juri flap is being considered on a given patient, and the previous surgery has rendered the scalp significantly less mobile, and (3) in cicatricial alopecia where prior trauma or ablative surgery have caused significant scarring. The major problem in such cases is not the transfer of the Juri flap, but the closure of the donor site defect without tension.

### Is a Delay Necessary After Expansion?

Insertion of a skin expander with gradual expansion has been shown in studies to serve the same purpose as a delay, perhaps even more effectively in terms of increased flap length survival. As described previously, an increase in vascularity occurs in expanded tissue.<sup>3,28,29</sup> However, whether the increase in vascularity is of a sufficient caliber and in the proper axis to perform a Juri flap without delay has not been established. The vessels actually being "delayed" in an expanded Juri flap may not be the appro-

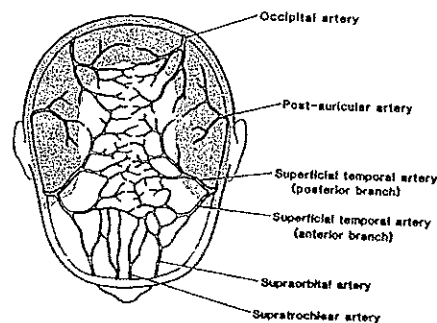


Figure 7. Anastomoses of the scalp arterial supply is greatest in the vertex above the hair-bearing fringe. A non-delayed flap should do very well if it contains the arcades between the posterior branch of the superficial temporal artery and the occipital artery. The Juri flap for baldness is usually too low to contain these arcades.

priate vessels that allow for improved survival of a flap.

The blood supply of the scalp is generally provided by vessels running in an inferior-to-superior direction, with a significant anastomosing of the vessels as they approach the vertex.<sup>32</sup> The three major vessels involved in the region of a prospective Juri

when a load applied to the skin is kept constant. The amount of extension increases with the passage of time. The benefits of creep are attributed to: (1) the extrusion of fluid and mucopolysaccharide-ground substance from the undersurface of the extended skin; (2) the parallel realignment and compacting of the collagen fibers from a random pattern in the dermis; (3) microfragmentation of elastic fibers in the dermis; and (4) migration of tissue from adjacent skin into the area where tension is being applied.<sup>23</sup> The corollary to creep is stress relaxation. This occurs when a constant load applied to the skin causes it to stretch. With time, the load required to maintain the skin in a stretched position decreases. Stress relaxation and creep are the viscoelastic properties of skin. Knowledge of these phenomena is important in understanding skin expansion.

The changes occurring in expanded tissue have been studied microscopically as well. These observations shed additional light on the phenomena of creep and stress relaxation. Histologic specimens taken from expanded skin have shown that the epidermis actually thickens.<sup>24</sup> This is due to an increase in mitotic activity in the basal layer of the epidermis in an attempt to maintain epidermal thickness.<sup>25,26</sup> There is an actual net gain in tissue. Stretching skin appears to stimulate epidermal proliferation.

Dermis, however, thins during expansion, although this is probably of no clinical significance. There is an increase in collagen production, with compacting of the collagen fibers in the papillary and reticular dermis, and reconstitution of the original thickness upon removal of the implant.<sup>9</sup> There are also increased numbers of active fibroblasts and myofibroblasts in the expanded dermis. The subcutaneous adipose tissue thins with expansion, although this was shown to resolve at the end of 2 years.<sup>27</sup> No change in hair follicle morphology was noted. Follicles will become separated from each other, but the number of follicles remains the same.

A capsule forms around the implant composed of compacted, elongated collagen fibers running parallel to the surface of the implant. Also present are active, flattened fibroblasts and myofibroblasts.<sup>9</sup>

Cherry et al<sup>28</sup> demonstrated that expanded skin flaps had 117% greater survival length than acutely raised, random pattern flaps. The surviving length of expanded skin flaps was greater than delayed random pattern flaps by 44%, but this was not statistically significant. Angiograms, performed in the random pattern flaps without delay, showed this tissue to be predominantly supplied by nonspecific underlying arterial and venous musculocutaneous perforators. An increase in vascularity, as well as vasodilation, was demonstrated in expanded tissue in angiograms performed at 5 weeks postexpansion, although the vascularity remained nonspecific. The

capsule in the expanded tissue was found to have a blood supply. The presence of the capsule probably added to the overall increase in vascularity seen in expanded tissue, and resulted in the greater survival length observed.

Elongation of vessel length in response to expansion has been documented, ranging from 30% to 140%.<sup>29</sup> Patency of vessels was also maintained with gradual expansion. Repeat stretching of a vessel by tissue expanders can result in ischemic damage to the vessel wall, which may be a stimulus for smooth muscle cells to multiply. Tension on endothelial cells is known to stimulate angiogenesis, and may be a factor in the neovascularization found in expanded tissue.<sup>30</sup>

The increase in the amount of transferable tissue and its vascularity makes skin expansion a valuable technique, particularly in the treatment of alopecia.

### Juri Flaps and Skin Expansion

The Juri flap, which is a TPO flap for the treatment of baldness, is twice delayed before transfer (Figs. 5 and 6).<sup>17-22</sup> We must note that there are reports of TPO flaps that were successfully performed without staged delays.<sup>31</sup> Generally, this is accomplished by designing the flap so that the occipital artery lies in the center of the distal end of the flap. A flap designed in this way may often be too short to create a complete hairline. Many of our flaps have the distal end terminating over the contralateral occipital protuberance.

The Juri flap is a large flap with an approximately 7:1 length-to-width ratio. The distal third of the flap will probably have a random pattern blood supply. Most scalps will not have the favorable arterial anatomy that can assure an axial pattern of vascularity throughout the entire length of the flap. Also, the pedicle of the flap is sewn in place with some torsion on it. This may further compromise the blood supply to the flap. All of these reasons strongly suggest the need for delay of the Juri flap.

There is an arcade of vessels connecting the superficial temporal and occipital arteries that generally lie above the design of the flap in a usual patient with significant male pattern baldness. A very high fringe in some individuals allows for a more superiorly placed Juri flap. Such a design would likely incorporate these anastomosing vessels into the flap. We feel that a highly arched flap would contain enough anastomotic branches between the superficial temporal and occipital arteries to survive consistently without delays. However, the hair-bearing fringe in most cases of male pattern baldness is too low to allow this phenomenon (Fig. 7).

It is generally unnecessary to use a skin expander

flap are the posterior branch of the superficial temporal artery, the postauricular artery, and the occipital artery. If an expander is placed beneath the lateral/posterior scalp in preparation for a Juri flap, through a superior incision, and no delay is performed as described in previous studies, there is no interruption of the postauricular or occipital arteries.<sup>17-22</sup> As the postauricular and occipital arteries generally lie directly over or adjacent to the expander, it is probably these vessels—even more than the posterior branch of the superficial temporal artery—that receive the benefit of the “delay” phenomenon of expansion. This assumes that direct mechanical force upon the vessel is at least, in part, the mechanism by which angiogenesis is induced.

If anything, the prospective Juri flap will have been “trained” to rely even more extensively on the postauricular and occipital arteries by the use of the expander. The potential for distal flap necrosis upon elevation and transfer of the Juri flap without delay is significant. It would appear that the major increase in vascularity due to tissue expansion occurs in an axis perpendicular to both the long axis of the flap, and to the redirection of the posterior branch of the superficial temporal artery along that axis. Although there is probably some neovascularization of the posterior branch of the superficial temporal artery as a result of expansion, there is likely to be an equal or greater angiogenic response from the postauricular and occipital arteries. This will result in a flap that becomes more, rather than less, dependent on these posterior arteries unless proper “delay” procedures are performed, as previously described.

If expanders are used for extensive scalp reduction,<sup>3</sup> this is a different situation. In this case, the expanded scalp is advanced in the axis of the major vessels supplying it (inferior to superior). The increase in vascularity arises from the vessels that will continue to supply the advancing scalp, since they are not transected in scalp reduction. There is no rotation of a long flap on a relatively narrow pedicle, which is dependent primarily on a single vessel.

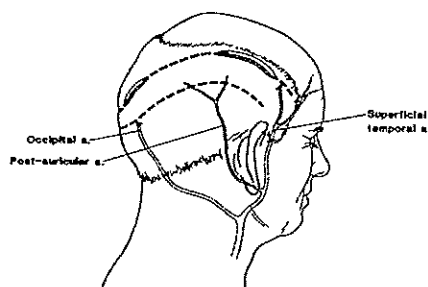
The senior author has observed two cases of distal flap necrosis in expanded Juri flap procedures performed without delays. In addition, in one of these cases, a significantly hypertrophied postauricular artery was identified that was of a very large caliber, and was not observed in over 200 cases of Juri flaps performed previously.

## Technique

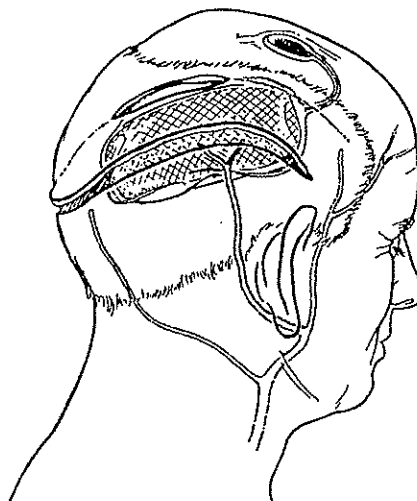
Rather than inserting an expander through an incision along the edge of the hair-bearing scalp fringe, we recommended that insertion of the skin expander be initially done through a 6- to 8-cm inci-

sion at the anterior superior border of a designed TPO flap. This incision transects the posterior branch of the superficial temporal artery, redirecting its flow posteriorly. An additional incision should be made posteriorly at this time to sever and ligate branches of the occipital artery (Fig. 8). This serves as the first delay. The expander is then inserted under a subgaleal dissection created between the two incisions. The incisions are closed with nondissolving 2-0 galeal sutures and staples for the skin. Expansion can begin within 10 to 14 days after initial healing of the incisions.

After obtaining the desired expansion, usually at 6 weeks, the second delay is performed by incising the entire flap except for areas incised with the insertion procedure (Fig. 9). The flap is generally elevated already by the expander. This effectively transects any remaining vascular contributions from the postauricular artery and other small arteries. The incisions are closed as described above. The expander



**Figure 8.** Incisions for insertion of expander for expanded Juri flap. Note the ligated vessels. Also shown is a pocket for the expander created by blunt subgaleal dissection from the two incisions.



**Figure 9.** At 7 to 12 days before the flap is turned, a delay procedure is done to further redirect blood flow. The expander is partially deflated for closure purposes.

can be refilled to 75% of capacity. This will not cause wound separation or widening of the scar, but will provide sufficient mechanical pressure to maintain the tissue expansion already gained. In 10 days, the flap can be transferred.

By delaying expanded TPO flaps before transfer, there have been no significant complications in subsequent cases. The additional surgery and time that the patient is required to endure—often a socially unacceptable appearance—is considered a reasonable concession for assuring a successful outcome for the procedure.

## SUMMARY AND CONCLUSION

The Juri flap is one of our preferred surgical treatments for male pattern baldness. We use tissue expansion via the Juri flap procedure when the scalp seems too tight for easy donor site closure. We have addressed the issue of whether these expanded flaps need delay procedures. Expanded flaps are known to have increased vascularity, which in studies has resulted in statistically significant improvement in survival lengths of flaps when compared with acutely raised random pattern flaps. It may even be superior, in some situations, to normal delay procedures in ensuring flap survival. Because of the specific arterial anatomy of the scalp—especially regarding the Juri flap—it is our belief that expanded Juri flaps still require delays before transfer.

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