Lipectomy as a new approach to secondary procedure superficialization of direct autogenous forearm radial-cephalic arteriovenous accesses for hemodialysis

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Background: **The depth of veins can discourage surgeons from creating radial-cephalic arteriovenous accesses for hemodialysis in obese patients. Elevation and tunneled transposition are the two techniques that have been described to superficialize these veins and make them accessible for cannulation. Unfortunately, such manipulation of veins has potential drawbacks. We report lipectomy, a new technique that removes subcutaneous fat and does not mobilize the vein.**
Methods: **This single-center prospective study included 49 consecutive patients (17 men, 32 women) who underwent second-stage lipectomy after creation of a radial-cephalic fistula. Mean patient age was 54 years, 36% had diabetes, and the mean body mass index was 31 ± 5.6 kg/m^2. Subcutaneous fatty tissues were removed after two transverse skin incisions under regional anesthesia and preventive hemostasis. Cannulation was first allowed 1 month later, after clinical and color duplex ultrasound evaluation. Technical success was defined as the ability to remove the fat and to palpate the patent vein immediately under the skin at the end of the operation. Clinical success was defined as the ability to perform at least three consecutive dialysis sessions with two needles. All patients were checked systematically every 6 months by the surgeon.**
Results: **Technical and clinical success rates were 96% (47 of 49) and 94% (46 of 49), respectively. Mean vein depth decreased from 8 ± 2 to 3 ± 1 mm according to duplex ultrasound imaging. The mean vein diameter increased from 6 ± 1 to 8 ± 2 mm. In one patient, vein tortuosity that was overlooked required conventional repeat tunneling. One extensive hematoma resulted in loss of the fistula. One patient died before the fistula could be used. Primary patency rates were 71% ± 7% and 63% ± 8% at 1 and 3 years, respectively, and secondary patency rates were 98% ± 2% and 88% ± 7%. Delayed complications were treated by surgery (n = 7) or by endovascular procedures (n = 10).**
Conclusion: **Lipectomy is a safe, effective, and durable approach to make deep arterialized forearm veins accessible for routine cannulation for hemodialysis in obese patients. It might even be hypothesized that incident obese dialysis patients will eventually have the highest proportion of radial-cephalic fistulas because they often have distal veins that have been preserved by their fat from previous attempts at cannulation for blood sampling or infusion. (J Vasc Surg 2009;50: 369-74.)**

Autogenous arteriovenous fistulas (AVF) for hemodialysis have been shown to be superior to prosthetic grafts or central catheters in terms of patient morbidity and mortality. In addition, arteriovenous accesses should be placed as far distally in the upper limb as possible to preserve proximal sites for future accesses.[1] Studies from the United States have reported that the prevalence of fistulas was lower in obese patients.[2,3] Preoperative imaging by color Doppler ultrasound (CDUS) or venography often confirms perfectly preserved forearm veins in obese patients because the thickness of the subcutaneous tissues makes the veins inaccessible to blood drawing. This protective fat barrier, however, may also discourage surgeons from using these veins for AVF creation. Similarly, successful and well-functioning radial-cephalic fistulas (RCF) may eventually prove to be difficult to cannulate because of the deep location of the vein.

Elevated transposition and tunneled transposition are the two techniques that have been reported to superficialize these veins beneath the skin to make routine cannulation for dialysis easier. However, our experience with both techniques was not as favorable as other published reported because we found evidence that such surgical manipulation of the vein was at risk of immediate and delayed complications, including damage to the vein wall leading to progressive aneurysmal degeneration and also twists and kinks creating stenoses, especially near the elbow. Finally, difficulties in cannulation after elevation can result from the superimposition of the scar and the vein, especially in cases of hypertrophic scarring.

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These adverse outcomes might explain why these techniques of superficialization are not mentioned in official guidelines and recommendations. We therefore conceived an alternative technique that would not mobilize the vein. Instead of transposing the vein beneath the skin, we decided to remove the subcutaneous tissue between the vein and the skin. This approach was called "lipectomy" because the major component of these tissues was fat. We report here our preliminary experience with this relatively simple and rewarding technique that made it possible to increase the proportion of RCFs constructed in obese dialysis patients.

METHODS

Patients. No Institutional Review Board approval was required for this prospective single-center study that started in 2004. The study included 49 consecutive patients (17 men, 32 women) who underwent lipectomy for their RCF from January 2004 to June 2008. The mean patient age was 54 years ± 16 (range, 3-83 years), 36% had diabetes, 90% had hypertension, and the mean body mass index (BMI) was 31 ± 5.6 kg/m^2 (range, 14-44 kg/m^2).

A RCF was the first access created in 37 of the 49 patients. Most had a recently created fistula: the median interval from RCF creation to lipectomy was 0.3 year (range, 0.1-16 years). Attempts to treat these nonmatured fistulas before lipectomy included surgical revision of juxta-anastomosis stenoses in seven, percutaneous transluminal angioplasty (PTA) of stenoses located far from the anastomosis in two, and one resection and anastomosis for stenosis of the perforating vein at the elbow.

At the time of lipectomy, the RCF was already being used for dialysis in nine patients but within a very short juxta-anastomosis cannulation area allowing for single needle access only. Nine additional patients were receiving dialysis, one through a different fistula, seven through a central venous catheter (CVC), and one by a peritoneal catheter. Two patients had a kidney transplantation that was failing. Finally, 29 patients were not yet receiving dialysis.

In our practice, before construction of the distal radial-cephalic direct anastomosis, the continuity and absence of fibrosis and stenosis of the forearm cephalic vein and of its outflow are assessed by clinical examination and duplex US imaging, combined with venography in cases of previous CVC. Calcified distal arteries are not considered as contraindications. We conclude from our experience that no minimum vessel diameter is required when anastomoses are created using preventive hemostasis and an operating microscope, which allows for good quality sutures, even in small-sized adults as well as in children.[4,5]

Patients were clinically checked by the surgeon 1 month after the fistula was constructed, before any attempt at cannulation. When the clinical examination showed evidence that the vein was not likely to be accessible to cannulation, the patient was checked again one month later by CDUS imaging. The decision to perform a lipectomy was then made when CDUS imaging (Fig 1) confirmed deep location (>5 mm from the skin) but normal dilation of the vein (diameter >6 mm), with a flow rate >600 mL/min and no significant stenosis (except juxta-anastomosis stenoses surgically treated concomitantly with lipectomy). In some cases, CDUS imaging showed a vein that was not too deep but trapped in a thick fascia superficialis (the connective tissue surrounding the superficial nerves and veins), which was believed to limit expansion of the vein and explains why we used the technique in a patient with a BMI of only 14 kg/m^2.

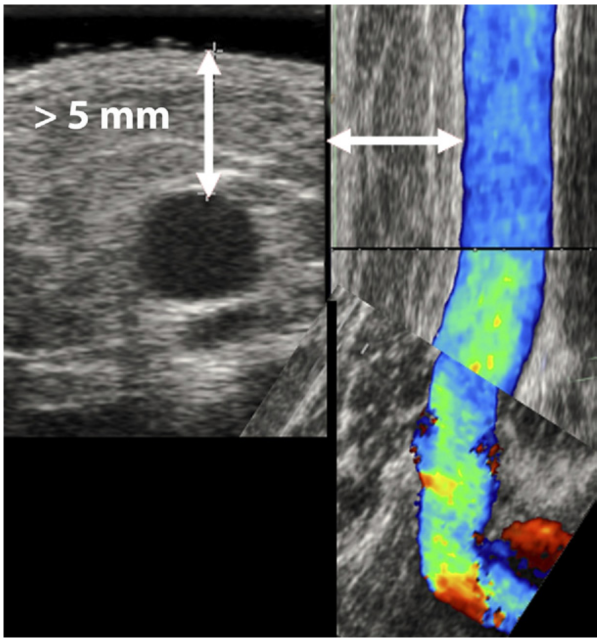

Fig 1. Preoperative color duplex ultrasonography: transversal (left panel) and wrist to elbow (from top to bottom) longitudinal (right panel) imaging of subcutaneous tissues and vein. The *double head arrows* indicate the skin-to-vein distance above 5 mm.

It is of paramount importance to intervene on the vein before any attempt at cannulation, which could "weld" the vein to the overlying skin and the overlying subcutaneous tissues. In such cases, it is not uncommon to enter the vein inadvertently, resulting in significant bleeding.

Technique. Regional anesthesia was used for all interventions. Preventive hemostasis was achieved by application of an elastic Esmarch bandage, followed by inflation of a proximal pneumatic tourniquet.[5]

Two transverse skin incisions were made at right angles over the cephalic vein, 8 cm apart. The fat can be removed over a length of approximately 4 cm on each side of each incision. One incision was therefore sufficient when the lipectomy was limited to a short segment of the vein. Dissection was facilitated by elevation of the skin with hooks. The periadventitial plane (plane of Leriche) was opened and dissected between the fascia superficialis and the anterior surface of the vein (Fig 2). The tourniquet allows for easy bloodless separation of the vein and the fascia.

The posterior part of the subcutaneous fatty tissue was thus dissected medially from the anterior surface of the vein

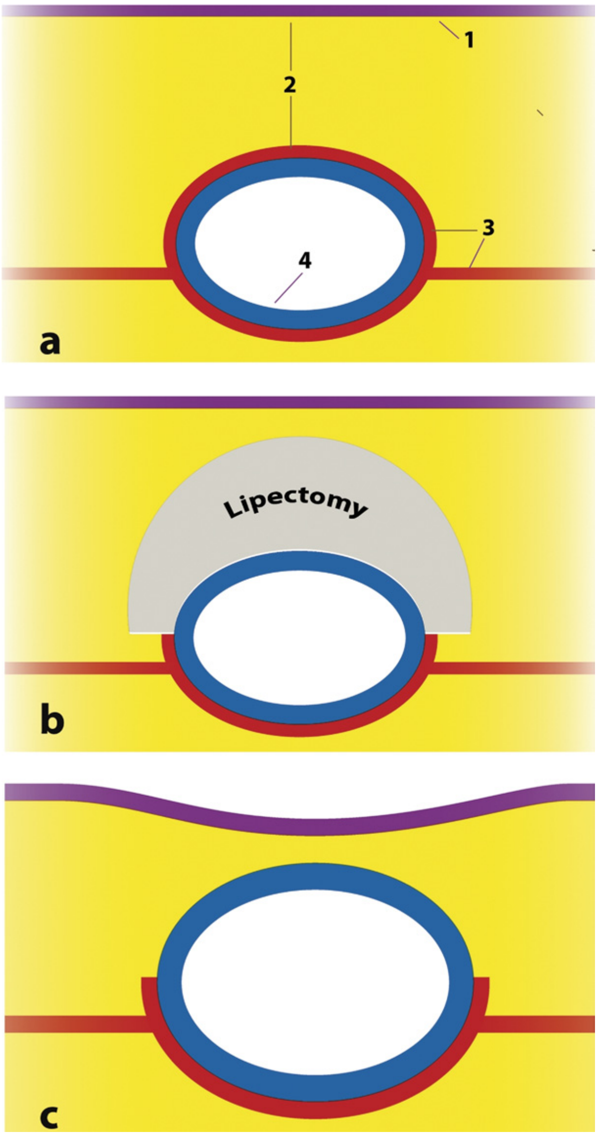

Fig 2. Operating diagram shows the arm **(a)** before, **(b)** during, and **(c)** after lipectomy. *1,* skin; *2,* fat; *3,* fascia superficialis; *4,* vein.

and cut laterally. The anterior part of the subcutaneous fatty tissue was bluntly separated from the skin, with the exception of the most superficial part (1 mm deep). This approximately 4-cm-long dissection was performed distally and proximally from each incision site. The tissues were cut medially and laterally 2 cm from the vein. The fat pad and the underlying fascia were then excised (Fig 3).

After deflation of the tourniquet, hemostasis was completed with utmost care. A suction drain was placed for 24 hours in every case. Wound closures were performed using absorbable 3-0 Monocryl suture (Ethicon Inc, Somerville, NJ).

In four patients, a juxta-anastomosis vein stenosis was treated simultaneously by creation of a more proximal anastomosis through an elective incision at the wrist. Partial

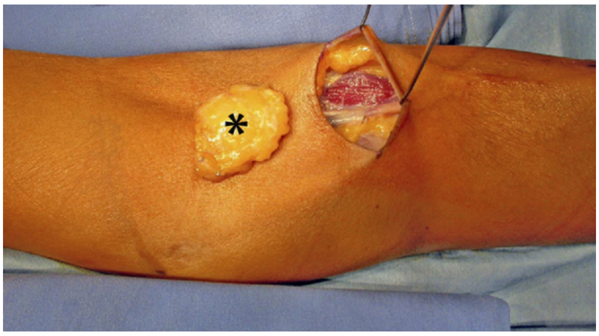

Fig 3. Operative view shows one incision and the freshly removed fat pad (*).

lipectomy only was performed in the nine patients who had a fistula that was already being used for single-needle dialysis within a short juxta-anastomosis area.

Success. Technical success was defined as the ability to remove the fat and to palpate the patent vein immediately under the skin at the end of the operation. Clinical success was defined as the ability to perform at least three consecutive dialysis sessions with two needles.

Follow-up. The fistula was systematically checked by clinical examination and CDUS imaging 1 month after the lipectomy. The normal healing of the incisions and the accessibility of the vein were evaluated, and initiation of routine cannulation for dialysis was eventually possible. Early cannulation ≤1 month should not be performed because of the risk of subcutaneous hematoma due to insufficient integration of the vein in the surrounding tissues. Clinical examination by the surgeon and CDUS imaging were repeated every 6 months. Incidental stenoses or thromboses were treated by surgical revision or endovascular procedures.

Patency rates after lipectomy were evaluated in agreement with the recommended reporting standards of the Society for Vascular Surgery.[6,7] Primary patency was defined as the interval from the time of lipectomy until any intervention designed to maintain or re-establish patency or function, access thrombosis, or the time of measurement of patency. Secondary patency was the interval from the time of lipectomy until access abandonment, or the time of patency measurement including surgical or endovascular interventions designed to re-establish function in stenosed or thrombosed accesses (Appendix, online only).

Statistical analysis. The Kaplan-Meier method was used to estimate survival probabilities. All statistical analyses were performed using SPSS Statistics 3 17.0 software (SPSS Inc, Chicago, Ill).

RESULTS

Immediate technical success was achieved in 47 of 49 patients (96%). The first failure was due to a large subcutaneous hematoma that resulted in irreversible thrombosis of the vein. Three other postoperative hematomas were treated, with no detrimental outcome for the vein or the skin. The second failure was due to overlooked tortuousities of the vein, which were treated successfully by third-stage conventional repeat tunneling. We concluded that such sinuous veins should be now considered as a contraindication for lipectomy. No significant sensory deficit was noted. One patient died ≤1 month after surgery before any puncture of the fistula, but death was not related to the operation.

According to CDUS examinations performed at 1 month, the mean vein depth decreased from 8 ± 2 mm before lipectomy to 3 ± 1 mm after lipectomy. The mean vein diameter increased from 6 ± 1 to 8 ± 2 mm. This moderate increase in diameter was due to the liberation of the vein from the fascia superficialis or to the disappearance of extrinsic compression by the fatty tissues. The mean flow rate changed from 755 ± 150 to 794 ± 215 mL/min, which was not significant.

Clinical success was 94% (46 of 49), because in addition to the two technical failures, one patient died before fistula cannulation. In seven patients who previously underwent dialysis through a CVC, first and successful cannulation in the lipectomy area was achieved after complete healing at a mean interval of 53 days (range, 31-64 days). Earlier cannulations were avoided to minimize the risk of subcutaneous bleeding after puncture. In the two patients whose dialysis was through a failing fistula or by peritoneal dialysis, the first cannulation was performed after 41 days. In nine patients, who required partial lipectomy, the fistula had already been in use for a mean interval of 820 days, allowing continued cannulation. In the remaining 28 patients, who had not undergone a previous dialysis, dialysis was started by cannulation of the fistula after 148 days (range, 33-450 days). We emphasize that this long interval reflects early referral to surgeons by general practitioners and nephrologists, which is a key point for creation of a distal fistula that is well matured in due time for the initiation of hemodialysis.

During the observation period, three patients died from unrelated causes, two were lost to follow-up, and seven underwent successful transplantation. Delayed complications were treated by surgery in seven patients or endovascular procedures in 10. Surgical treatments included 3 revisions of the anastomosis, 1 distal radial artery ligation for hand ischemia, 1 vein transposition for treatment of elbow vein stenosis, and 2 skin flaps for focal late in cannulation areas (all techniques of superficialization weaken the skin and can favor late occurrence of local necrosis) associated with outflow stenoses that were treated by PTA rapidly after surgery. Endovascular procedures included PTA in nine patients and thrombectomy in one. The buttonhole technique is not currently used in our dialysis centers. In some cases, mild aneurysmal degeneration (Fig 4) is usually due to chronic outflow stenoses.

Including initial failures, primary patency rates were 71% ± 7%, 67% ± 7% and 63% ± 8% at 1, 2, and 3 years, respectively. Secondary patency rates were 98% ± 2%, 94% ± 4%, and 88% ± 7% at 1, 2, and 3 years, respectively.

Fig 4. Postoperative view at 3 years shows the access creation incision *(1)*, and the lipectomy incisions *(2* and *3)*.

Kaplan-Meier primary and secondary patency curves are shown in Fig 5.

DISCUSSION

The RCF, which once matured has by far the best long-term patency rates, is the vascular access of choice that should be created whenever possible. The forearm cephalic vein may be deeply located in obese patients due to thick subcutaneous tissues interposed between the skin and the vein, although obesity may sometimes predominate in the upper arm and spare the forearm. Deep location easily explains why the vein is preserved from prior cannulation by nurses, but this advantage becomes a drawback when it comes to fistula construction. Consequently in our experience, many obese patients are eventual candidates for RCF creation, followed by second-stage superficialization whenever necessary. The feasibility of lipectomy has been mentioned in *Nephrology Nursing Journal*, where it was clearly explained that, "lipectomy can remove barriers such as vein depth and limb obesity, creating an opportunity to have a functioning fistula."[8]

Mobilization of a deep vein beneath the skin has been performed to date by tunneled transposition or elevated transposition. The principles of both techniques were established for creation of brachial-basilic fistulas, but there are few reports about forearm fistulas.[9,10] The possibility of superficializing forearm veins is obviously overlooked or ignored in most publications referring to construction of dialysis accesses.[11,12]

The tunneled transposition procedure includes skin incisions, total dissection of the vein with suture-ligation of all branches, division of the vein at its lower extremity, flushing with heparinized saline solution, placement of the vein in a straight subcutaneous tunnel away from the incision, and creation of a new anastomosis. Silva et al[13] reported a series of 89 transpositions of forearm veins that did not specifically address the problem of deep location. Most cases involved forearm basilic veins that were transposed from their initial dorsal to a volar location. They reported an excellent 91% success rate, with an 84% primary patency rate at 1 year and 69% at 2 years. Unfortunately, we experienced much less favorable results with this technique

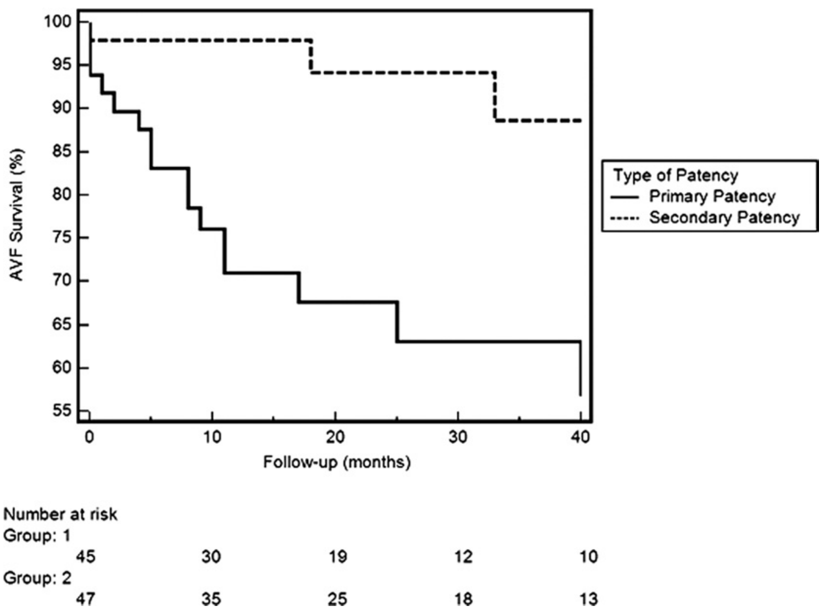

Fig 5. Kaplan-Meier curves of primary *(solid line)* and secondary patency *(dashed line)* rates of all fistulas after lipectomy, with numbers of patients at risk (standard errors < 10%).

of transposition in the forearm, especially in obese patients, because as for basilic veins in the upper arm, the development of a stenosis in the final part of the transposition was almost inevitable. In addition, compared with lipectomy, tunneled transposition is a much more time-consuming operation and the longitudinal scar is resented by patients for esthetic reasons.

Elevation of the vein is performed through a longitudinal forearm incision. The procedure includes superficial mobilization of the vein, suturing of the subcutaneous tissues beneath the vein, and skin closure over the vein. Our experience, however, reveals that the vein eventually lies immediately under the longitudinal incision, which makes it difficult to cannulate the vein, especially in cases of keloid or hypertrophic scars, which are common in black patients. In addition, healing of cannulation sites through the scar is often delayed.

In a series of 24 patients published in 2002, Weyde et al[14] used elevation of forearm veins as a second-stage technique in 22 patients and reported an immediate success rate of 95%, with a 1-year primary patency rate close to 90%. This very low incidence of secondary stenosis was somewhat surprising in veins that had been extensively dissected and mobilized. We were therefore less surprised by their updated results published in 2008 showing evidence of lower primary patency rates of 59% at 1 year.[15] Bronder et al[16] also recently published results after elevation in 46 RCFs. Primary and secondary patency rates were in agreement with the updated results of Weyde et al, with 60% and 71% at 1 year, respectively. Our personal results appear slightly better, but our patients were younger, less obese, and fewer had diabetes.

From an esthetic point of view, which cannot be ignored at the forearm level, the transverse scars after lipectomy (Fig 4) have a much better outcome compared with the possible hypertrophic scar formation after the longitudinal incisions required for elevation and frequently used for tunneled transposition.

Our study addresses a problem mainly encountered in obese patients. However, some nonobese patients can also be candidates for lipectomy when the cephalic vein runs relatively deep when approaching the elbow or when the expected dilation of the vein seems to be hampered by a thick fascia superficialis entrapping the vein. On the other hand, some patients with thick subcutaneous tissues can develop a well-matured and easy to puncture fistula if the vein enlargement is sufficient to flatten the subcutaneous tissues and decrease the actual depth of the vein.

For all of these reasons, the indications for lipectomy are not straightforwardly predictable at the time of fistula creation, and lipectomy is always a second-stage intervention, performed only if clinical and imaging follow-up shows evidence of the need for superficialization. In addition, we know from our experience with brachial-basilic fistulas that a secondary stage of superficialization is much easier to perform when the vein diameter has increased and the vein wall has been rendered thicker by some weeks of arterialization.

In patients who have already undergone dialysis through their RCF but within a very short juxta-anastomosis cannulation area that allows for single-needle dialysis only, puncture will remain possible at the former site immediately after partial lipectomy. This partial lipectomy operation is much easier to perform if the segment of deep vein has not previously been damaged by attempts at cannulation. In such partial superficialization, the lipectomy technique offers another major advantage over the previously used partial tunneled transposition technique, which includes the construction of a vein-to-vein anastomosis prone to subsequent stenosis.

This lipectomy technique seems also to be usable in brachial-cephalic fistulas. We have achieved favorable results in a preliminary series of 10 patients.

Very few articles in the literature have dealt with the creation of forearm AVFs in obese patients, and forearm and upper arm AVSs are combined in the nearly all reports. In 2000 two large-scale studies[2,3] reported a significantly lower likelihood of having an AVF for patients with a BMI > 27 kg/m^2. On the other hand, Kats et al[17] compared obese with nonobese patients in a series of 388 patients. Autogenous fistulas (47%) and grafts were equal in both groups. The primary failure rates, including technical failure, early thrombosis, failure to mature, and steal, were similar at 46% vs 41%. In contrast, secondary fistula patency rates in obese and nonobese patients were 68% and 92%, respectively. Surprisingly, although numerous hypotheses were raised to explain this poorer outcome, the likely role of deep location of the vein and needle infiltration during cannulation in these obese patients was not discussed, and the authors did not mention whether any forearm fistula had eventually been superficialized. Other conflicting results can be found; for example, Miller et al[18] reported that the "adequacy" of newly created autogenous fistulas was lower in patients with a BMI $>$27 kg/m^2, although Chan et al[19] mentioned that "using body mass index (BMI) $<$30 kg/m^2 as reference, obesity did not emerge as a factor in predicting the necessity for vascular access revision."

CONCLUSION

The positive outcome after lipectomy confirms that deep location of the vein should not be a contraindication for the creation of distal RCFs. It might even be hypothesized that incident obese dialysis patients will eventually have the highest proportion of RCFs because their forearm veins are more likely to have been preserved from previous attempts at cannulation for blood sampling or infusion.

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AUTHOR CONTRIBUTIONS

Conception and design: PB, JT, JG, LT
Analysis and interpretation: PB, JT, JG, LT
Data collection: PB, JT, JG, GF, OV, AR
Writing the article: PB, JT, LT, GF
Critical revision of the article: PB, JT, LT-R, AN
Final approval of the article: PB, JT, LT, GF, OV, AR, AN
Statistical analysis: PB, LT, AN, JT
Obtained funding: PB
Overall responsibility: PB, JT, LT

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Additional material for this article may be found online at www.jvascsurg.org.

Appendix (online only). Life tables

Sample size	*Primary patency*		*Secondary patency*	
	49		*49*	
Survival time (months)	*Survival proportion*	*SE*	*Survival proportion*	*SE*
0	0.939	0.0342	0.980	0.0202
1	0.918	0.0393	...	...
2	0.897	0.0436	...	...
4	0.876	0.0475	...	...
5	0.831	0.0547	...	...
3	0.785	0.0606	...	...
9	0.761	0.0633	...	...
10	...	...	...	...
11	0.710	0.0685	...	...
12	...	...	...	...
14	...	...	...	...
16	...	...	...	...
17	0.676	0.0731	...	...
18	...	...	0.942	0.0417
21	...	...	...	...
22	...	...	...	...
23	...	...	...	...
24	...	...	...	...
25	0.631	0.0809	...	
30	...	...	...	
31	...	.	...	...
33	...	...	0.887	0.0666
35	...	...	...	...
37	...	...	...	...
40	0.568	0.0943	...	...

	Comparison of survival curves (log-rank test)	
	Primary patency	*Secondary patency*
End point observed, No.	16.0	3.0
Expected, No.	8.9	10.1
χ^2	10.9062	
DF	1	
Significance	$P = .0010$	
Hazard ratio		4.6155
95% CI		1.8621-11.4401

CI, Confidence interval; *SE,* standard error.