

MATURITY AND FAILURE OF MATURITY OF AVF IN HEMODIALYSIS PATIENTS : ROLE OF EXERCISE

Presenting by:

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Outlines

- **General information**
- **Definition of AVF maturity**
- **Glance at mechanism of AVF maturity and immaturity**
- **Causes of failure of AVF maturity**
- **Role of exercise**
- **Recent evidence and guidelines**
- **Recommendations**



General information

- Autologous arteriovenous fistula (**AVF**) is the **preferred choice** for vascular access in patients with chronic kidney disease undergoing a hemodialysis program.
- Compared to CVC and AVG, the **AVF** has been increasingly recognized for use in hemodialysis due to **lesser complications**, **lower risk of fatality**, and **longer patency rate**, consequently leading to maturation status.
- As a consequence, healthcare **costs are lowest** for patients with an **AVF**, compared to patients with an AVG or CVC



General information

- The vital importance of the process of AVF maturation is widely known.
- In order to have sufficient time for maturation, it is important to **construct the AVF early when renal failure is diagnosed**.
- KDOQI considers it reasonable that in non dialysis CKD patients with **progressive decline in kidney function**, referral for dialysis access assessment and subsequent creation should occur when eGFR is 15-20 mL/min/1.73 m².
- **Earlier referral** should occur in patients with unstable and/or rapid rates of eGFR decline (eg, >10 mL/min/year). (Expert Opinion)



Mature AVF

- A mature fistula can be defined as *physiologically mature* or *functionally mature*.
- In KDOQI guidelines, a **mature fistula** is one that can provide prescribed dialysis consistently with **2 needles** for **more than two thirds of dialysis sessions** within **4 consecutive weeks**.
- *Adequate* AVF maturation leads to its proper functioning, with *fewer complications* arising and *increased AVF survival*



Mature AVF

- Arteriovenous fistula maturation is defined as an *adequate size of vessel conduit*, together with a sufficient amount of blood flow of autogenous anastomosis between the artery and vein.
- The AVF maturation has typically been evaluated using an **ultrasonographic method** that can track changes in **vessel diameter, depth of vein** and **blood flow volume**.
- A **palpation method** is also used to determine the maturation, called clinical maturation.

Clinical AVF Maturity is found based on Inspection, palpation, and auscultation of the vascular access.

Four clinical signs that are:

- **Vein visible length during light tourniquet pressure**
- **Vein feel firm with light tourniquet pressure**
- **Vein engorgement**
- **Machinery thrill palpable on fistula**



Salimi F, Shahabi S, Talebzadeh H, Keshavarzian A, Pourfakharan M, Safaei M. Evaluation of Diagnostic Values of Clinical Assessment in Determining the Maturation of Arteriovenous Fistulas for Satisfactory Hemodialysis. *Adv Biomed Res* 2017;6:18.



In this regard, it is important to recall the proposal of Rayner *et al.*, which was incorporated in the K-DOQI guidelines as “**the rule of 6.**”

- It identifies the *ultrasound characteristics* that confirm that a fistula is mature and therefore, ready for use:
 - A flow volume of **600 ml/min**
 - An outflow vein diameter of **6 mm**
 - An outflow vein depth of **6 mm** below the skin surface.

In general, two variables are required for AVF maturation

- ✓ adequate blood flow
- ✓ enough size


- 
- Timing of Changes in **Blood Flow** and **Diameter** in a Newly Created AVF:

SOON AFTER AVF CONSTRUCTION

(only 10 min after completion of the anastomosis)

(interestingly, no significant changes in these two parameters were noted in the second, third, or fourth month after AVF creation)

- ✓ Successful maturation typically occurs within the first few weeks after creation.
- ✓ Failure to achieve maturation within 4–8 weeks should prompt a search for reversible etiologies.

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- Although an arteriovenous fistula is considered the preferred type of access, ,About 28–53% of AVFs fail to mature adequately.

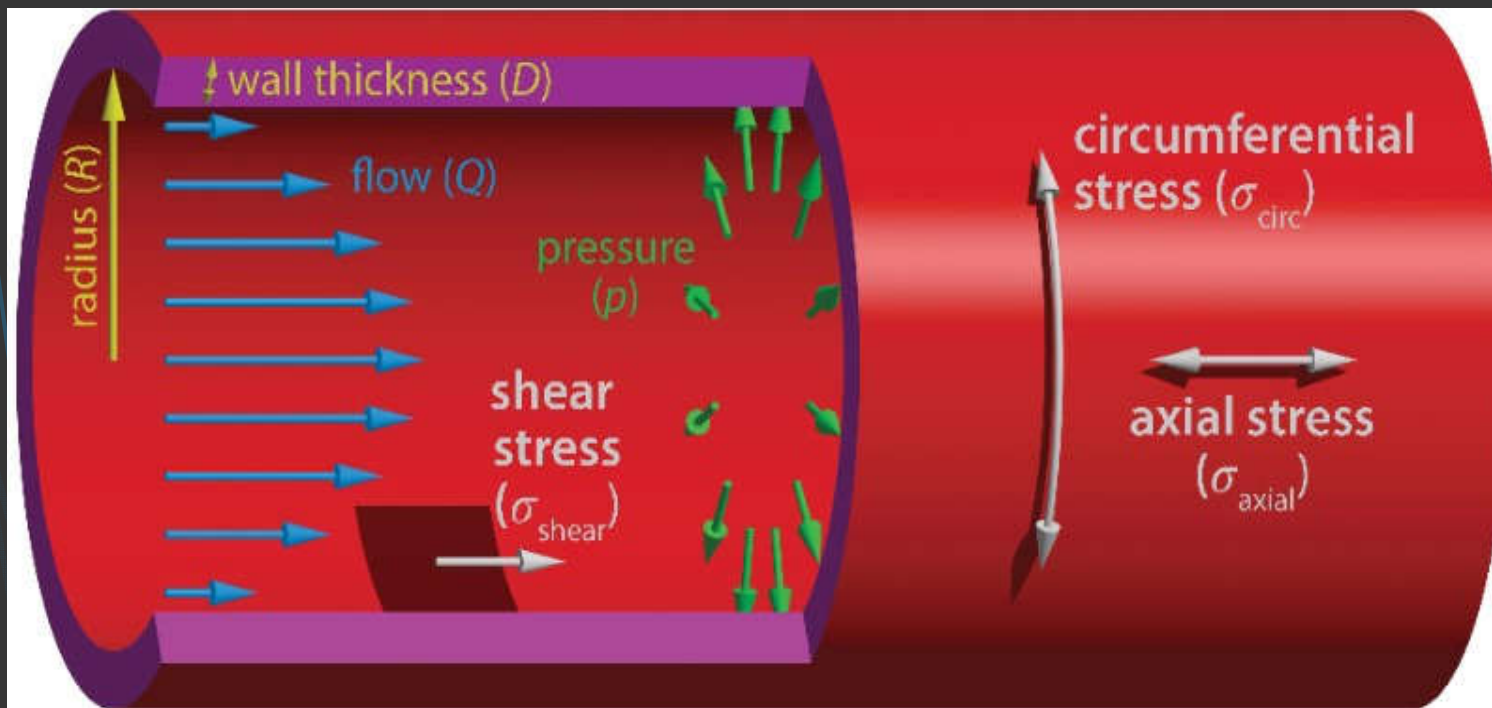


Mechanisms of AVF Maturation

- During AVF creation, there is many changes in **hemodynamic**, **anatomic**, **molecular**, and **functional** level of feeding artery and draining vein constructing AVF.

AND

- **Shear stress** is the **determinant factor** in making the above changes and related to **blood viscosity**, **blood flow**, and **vessel radius**
- The shear stress rate is an indicator of the difference in velocity between the center of the vessel and the boundary layer, where, by definition, the blood velocity is zero.



dominated
by:

flow rate (Q)

blood pressure (p)

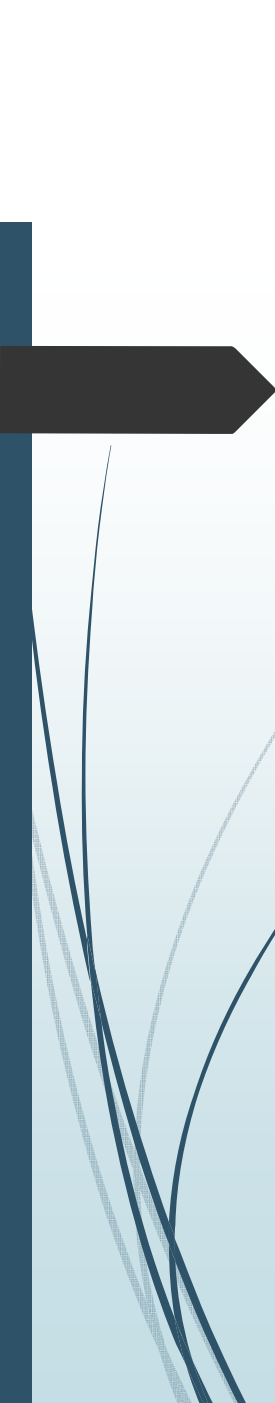
influence geometry:


- calibre (diameter)
- wall thickness
- length

$$\sigma_{\text{shear}} = \frac{4\eta Q}{\pi R^3}$$

$$\sigma_{\text{circ}} = \frac{pR}{D}$$

$$\sigma_{\text{axial}} = \frac{pR}{2D}$$

- 
- At a mechanical level, vessels try to maintain their original level of shear stress.
 - An increase in blood flow and consequently shear stress , after the creation of an AVF, will result *in attempts to decrease the shear stress applied to the vessel wall.*
 - Because blood viscosity is difficult to alter, an increase in shear stress invariably results in **vascular dilation** .
 - This flow-mediated (shear stress) dilation increases vessel diameter and consequently brings the shear stress back to the pre-arteriovenous anastomosis level (**Vascular remodeling**)

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- At a **biologic level**, vascular response to changes in **shear stress** is mediated **through the endothelium**, and the **secretion** of substances such as **nitric oxide** and **prostacyclin** that promote **vasodilation** and **inhibit thrombosis** and **platelet aggregation**.

JVA

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REVIEW

Is shear stress the key factor for AVF maturation?

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Why does Failure Of Maturity happen for an AVF?

Failure of arterial dilation:

- The linkage between high shear stress rates and vascular dilation through AVF creation in patients with **severe vascular disease** and **diabetes** may not always hold true.
- The endothelium of a calcified vessel in an **elderly uremic patient with diabetes** may not have the ability to secrete the mediators that are required for **flow mediated vasodilation**.

Why does Failure Of Maturity happen for an AVF?

Failure of venous dilation:

- Similar reasons may also result failure of venous dilation
- **Previous Venipuncture** and loss the ability to vasodilate

Accelerated venous neointimal hyperplasia:

- There are many different configurations for the creation of an AVF, may result in differing levels of shear stress at different points in the venous segment.
- Regions of **low shear stress** could **result focal areas of neointimal hyperplasia** and **vasoconstriction** as occurs clinically in the context of the common juxta-anastomotic stenosis.

Why does Failure Of Maturity happen for an AVF?

Vascular injury:

- The segment that is most frequently affected with venous stenosis and is associated with **early AVF failure** is the segment that has been **mobilized and manipulated by the surgeon** during the procedure.
- This process often involves **stretching, torsion, and skeletonization** of the vessel.
- Skeletonization of the vessel may **disrupt the vasa vasorum** for that segment of vein. These factors adversely affect the AVF and result in the lesions that are observed in this region is not clear



Why does Failure Of Maturity happen for an AVF?

Inadequate vessel size before surgery :

(ATTENTION TO PREOPERATIVE AVF MAPPING)



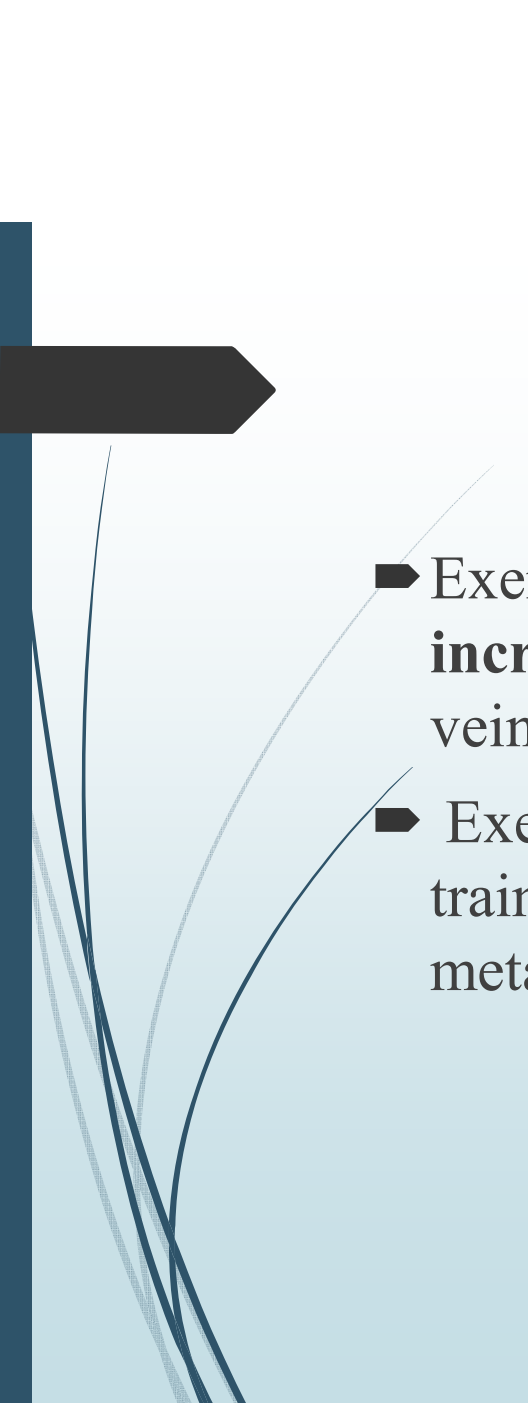
Why does Failure Of Maturity happen for an AVF?


Adding to given previous immaturity causes:

- Majority of **patients are referred late**, often when already undergoing MHD.
- To reduce the complications that are associated with alternate HD accesses, it is necessary to find ways to increase the AVF maturation rates for repetitive hemodialysis.

Role of exercise



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- Exercise is thought to improve maturation of AVF by **increasing the blood flow** and **the diameter** of the outflow vein.
 - Exercise blood flow restriction in association with physical training is used to stimulate a rapid increase of specific metabolic enzymes for muscle mass and strength.

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- Through simple or blood flow restriction exercise ,there is evidence of a **significant increase in laminar and turbulent blood flow that increase shear stress ,secretion of nitric oxide and prostacyclins,** leading to vasodilation, inhibition of the proliferation and migration of smooth muscle cells and platelet aggregation.
 - Exercise promotes **vascular remodeling.**



Role of exercise

Thus,

- Repetitive exercise results in dilatation of the vein **increase in AVF function and reduction in AVF-related morbidity and mortality** in adults on HD.
- The current vascular access guidelines recommend **post-operative handgrip exercise after creation of AVF**

Assessment of effects of upper extremity exercise with arm tourniquet on maturity of arteriovenous fistula in hemodialysis patients

J Vasc Access 2013; 14 (3): 239-244

Fereshteh Salimi¹, Gilda Majd Nassiri¹, Maryam Moradi², Amir Keshavarzian³, Ziba Farajzadegan⁴, Mohammad Saleki⁵, Azimeh Nikpoor⁶, Massoomeh Ghane⁶

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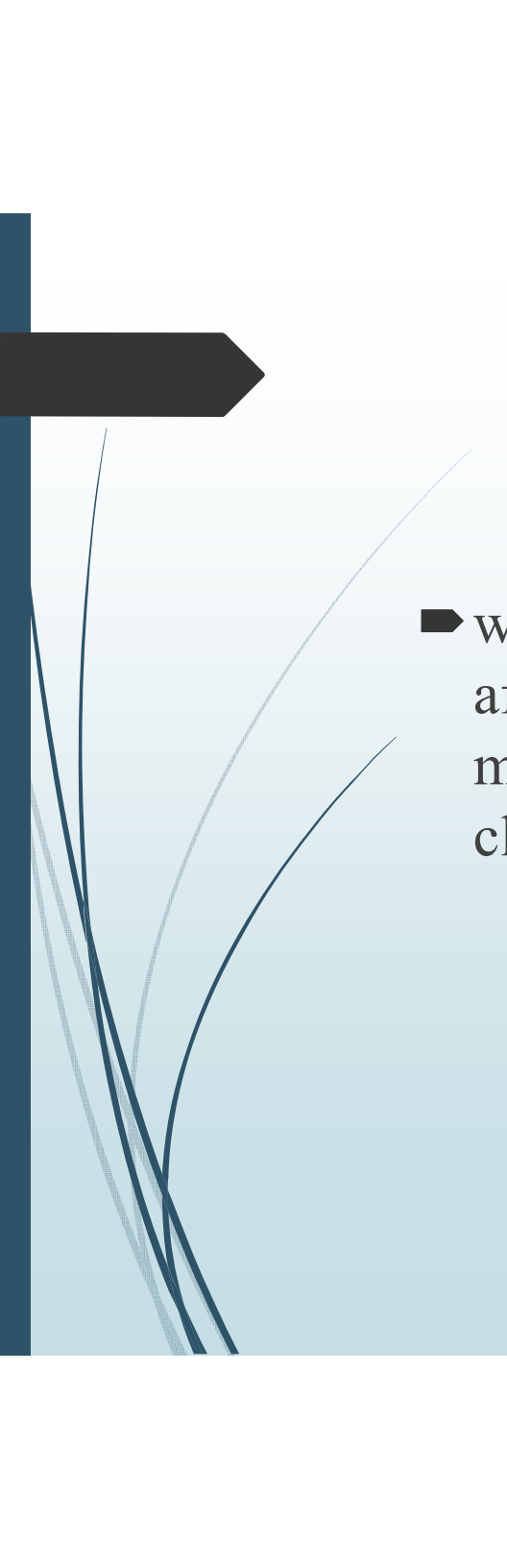
⁵Department of Sport Medicine, Isfahan University of Medical Sciences, Isfahan - Iran

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- we conclude that hand exercise using arm tourniquet affects most sonographic parameters associated with AVF maturity, and could be beneficial for acceleration of AVF clinical maturation.



Effect of a postoperative exercise program on arteriovenous fistula maturation: A randomized controlled trial

Néstor FONTSERÉ,¹ Gaspar MESTRES,² Xavier YUGUEROS,² Teresa LÓPEZ,¹
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Hemodialysis International 2016; 20:306–314

1. Elbow Flexion-Extension



2 sets of 10
repetitions
every day

2. Wrist Flexion-Extension




2 sets of 10
repetitions
every day

3. Hand Open-Close



2 sets of 25
repetitions
every day

- 
- This study suggests that, in adult patients with chronic renal disease, a postoperative controlled exercise program after AVF creation may increase 1-month clinical maturation, especially in distal accesses.



Clinical Kidney Journal, 2021, vol. 14, no. 2, 688–695

doi: [10.1093/ckj/sfz194](https://doi.org/10.1093/ckj/sfz194)

Advance Access Publication Date: 5 February 2020

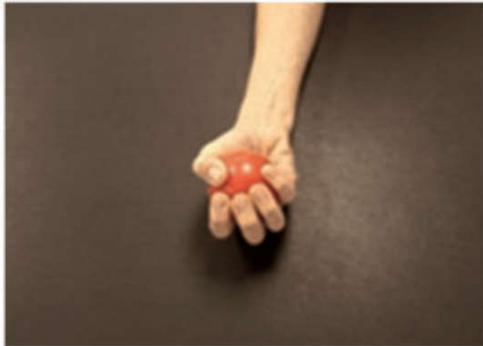
Original Article

ORIGINAL ARTICLE

Upper limb isometric exercise protocolled programme and arteriovenous fistula maturation process

Irati Tapia González^{1,2,3}, Vicent Esteve Simó^{1,2}, Sara Ibañez Pallares^{1,4}, Fátima Moreno Guzman², Miquel Fulquet Nicolás², Verónica Duarte Gallego², Anna Saurina Solé², Mónica Pou Potau², Montserrat Yeste Campos⁴ and Manel Ramírez de Arellano Serna²

(a)



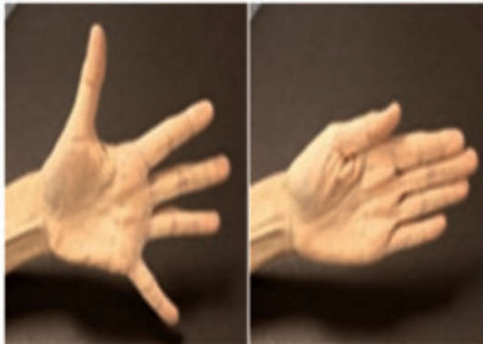
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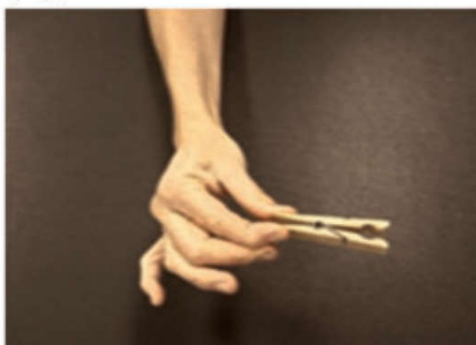
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(g)

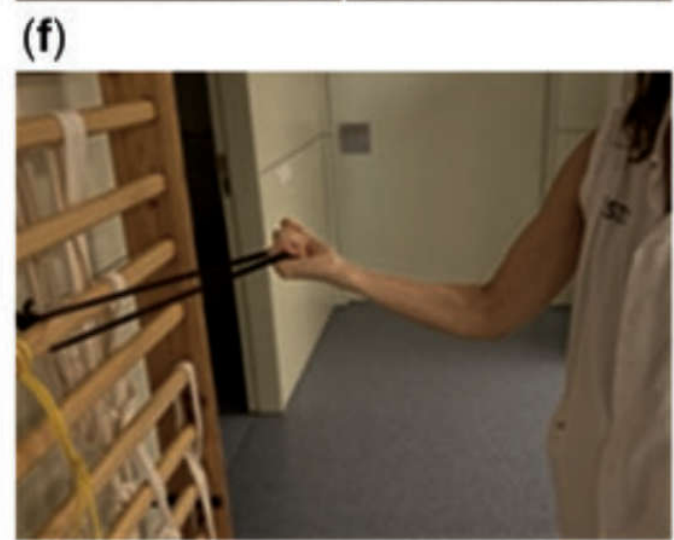
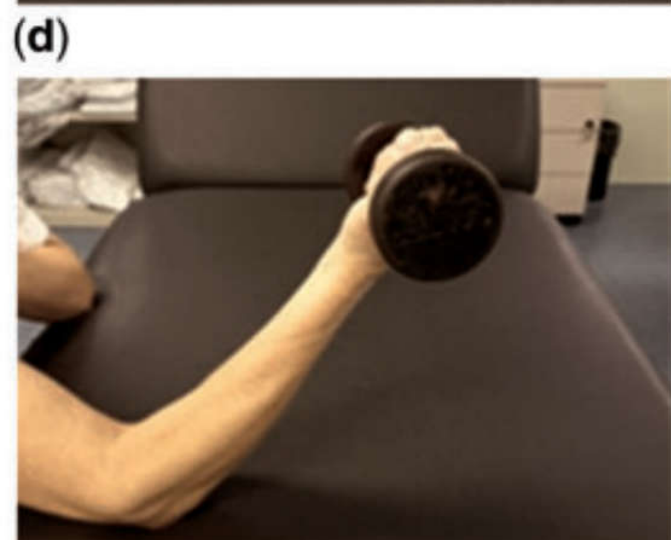
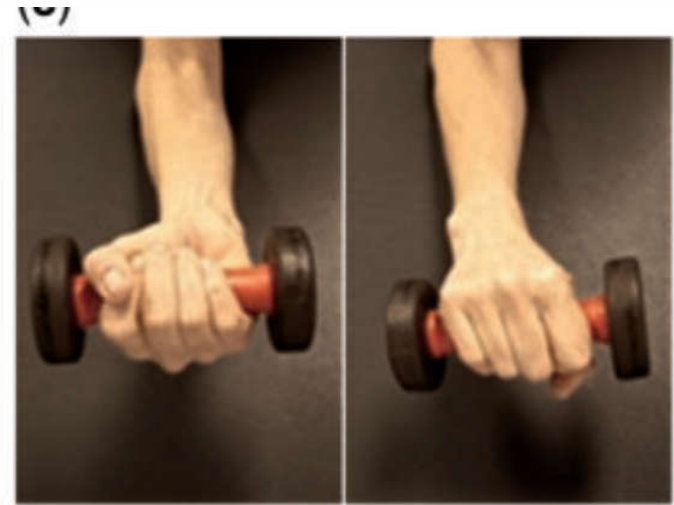
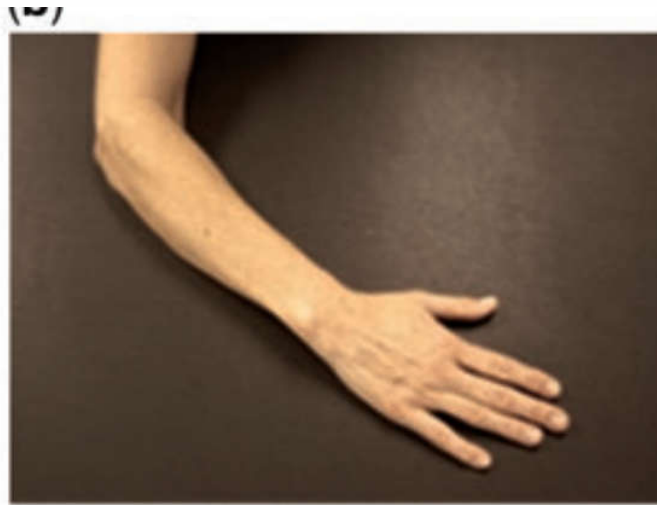
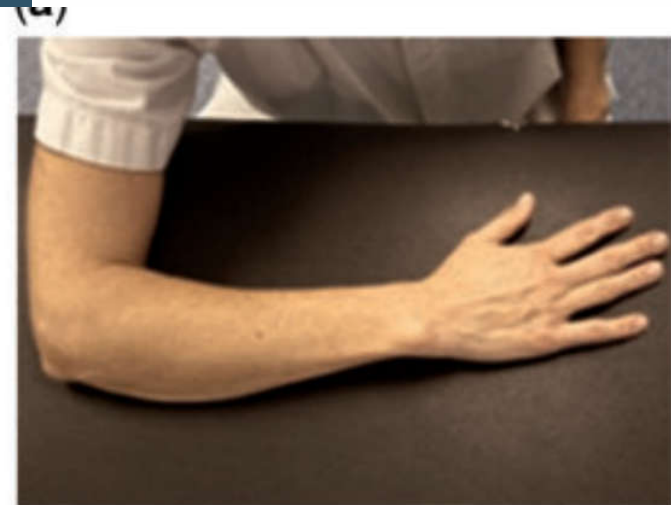



(h)



(i)





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- The study suggests that a post-operative program of isometric exercises for AVF offers, at both 4 and 8 weeks, greater clinical and ultrasound maturation in the distal and proximal regions of the arms.

Indian Journal of Surgery

<https://doi.org/10.1007/s12262-020-02553-9>

ORIGINAL ARTICLE



The Effect of Post-Operative Handgrip Exercise on the Maturation of Arteriovenous Fistula: a Randomized Controlled Trial

Pol Maruti Manjunath¹ • Singh Gurpremjit¹ • Singh Devender¹ • Vyas Surabhi¹ •
Arumugaswamy Prasanna Ramana¹ • V. Sreenivas² • S. K. Aggarwal³

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Spanish Clinical Guidelines on Vascular Access

Recommendation

R 3.2.1) We suggest that the patient do exercises before and after the creation of native arteriovenous fistulae to promote maturation

The study by Leaf et al.¹⁹⁵ showed that the performance of Order et al.¹⁹⁶ analysed the impact of physical exercise

The prospective randomised study by Salimi et al.¹⁹⁸
Fontseré et al.¹⁹⁹ carried out a prospective randomised

KDOQI CLINICAL PRACTICE GUIDELINE FOR VASCULAR ACCESS: 2019 UPDATE

10.2 There is inadequate evidence for KDOQI to make a recommendation on the use of upper extremity exercise to facilitate postoperative AVF maturation.

10.3 KDOQI recommends the use of whole arm rather than finger exercise, if exercise is used to facilitate AVF maturation. (Conditional Recommendation, Moderate-High Quality of Evidence)

Fontsere et al²⁷⁴ (N = 72) compared isometric exercises along the whole arm postoperatively to usual routine

In a single-center study, Salimi et al²⁷⁵ compared isometric exercises of the whole arm (n = 25) to limited finger

Vascular Access: 2018 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS)

Recommendation 38

Structured post-operative hand exercise training should be considered, to increase arteriovenous fistula maturation.

Class

Ila

Level

B

Refs.

157,294

157 Salimi F, Majd Nassiri G, Moradi M, Keshavarzian A, Farajzadegan Z, Saleki M, et al. Assessment of effects of upper extremity exercise with arm tourniquet on maturity of arteriovenous fistula in hemodialysis patients. *J Vasc Access* 2013;**14**:239–44.

Fontserè N, Mestres G, Yugueros X, Lopez T, Yuguero A, Bermudez P, et al. Effect of a postoperative exercise program on arteriovenous fistula maturation: A randomized controlled trial. *Hemodial Int* 2016;**20**:306–14.



Recommendations

Take home messages

- Proper case selection
 - Careful clinical examination
 - Preoperative AVF mapping
- Preoperative hand and arm exercise
- Appropriate & correct surgical technique
- Postoperative hand and arm exercise
- Regular post op follow up
- On time intervention





THANKS FOR YOUR PATIENCE

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