

OPINION

The ShangRing device for simplified adult circumcision

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Abstract | Adult male circumcision reduces HIV transmission through vaginal intercourse and is being promoted in areas where HIV is widespread. Conventional surgical circumcision involves suturing and thus requires practitioners with surgical skills. It is also associated with complications, including bleeding and infection, especially in resource-poor settings. The ShangRing (Wuhu Snnda Medical Treatment Appliance Technology Co. Ltd, Wuhu City, China) has been used to perform thousands of circumcisions in adult men, principally in China. It consists of two concentric plastic rings that sandwich the foreskin of the penis, allowing circumcision without stitches or notable bleeding. As well as substantially reduced operative times, ShangRing adult male circumcision is associated with a low complication rate, and the technique can easily be taught to both physician and nonphysician personnel. The simple technique and successful outcomes associated with the ShangRing procedure mean that the device could enable standardization of adult male circumcision, helping HIV prevention efforts throughout the developing world.

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Introduction

Male circumcision represents one of the most common surgical procedures, with a prevalence of 70% in the USA and 30% worldwide.^{1–3} In the USA, the vast majority of circumcisions are performed on newborn babies; however, adult circumcision is currently on the rise in other populations, especially in parts of Africa where clinical trials have demonstrated that circumcised men have a reduced risk of acquiring sexually transmitted infections, such as those caused by human papillomavirus, herpes simplex virus, and HIV.^{4–6} Three randomized controlled trials in Kenya, Uganda, and South Africa have reported that adult male circumcision is associated with a substantially reduced risk of acquiring HIV infection via vaginal intercourse.^{7–9} Consequently, the WHO, the Joint United Nations Programme on HIV/AIDS (UNAIDS), and the US President's Emergency Plan for AIDS Relief (PEPFAR) have identified male circumcision to be an essential part of HIV prevention efforts in regions with high rates of heterosexual transmission.³

Competing interests

The authors declare no competing interests.

Two major obstacles to the implementation of large-scale programs for adult male circumcision merit consideration: the technical difficulty of the surgery, and the associated high complication rate when providers are not properly trained.¹⁰ These factors have led to the development of various devices for adult male circumcision, over 20 of which are commercially available worldwide. In general, the mechanism of action of these devices involves crushing, clamping, or ligation of the foreskin. However, these devices tend to be large and complex to use, and they also create a closed environment under the foreskin, increasing the risk of infection. Furthermore, discouraging results have been reported in randomized controlled trials of several of these devices in adults. Use of the Tara KLamp (Tarmedic Corp. SdN. BHD., Kuala Lumpur, Malaysia), for example, which is used to circumcise children safely and successfully in Asia and Europe, was associated with a high rate of adverse events when evaluated among young adults in South Africa.¹¹ The ideal device for adult male circumcision is one that is safe and effective, does not require suturing or electrocautery, and is simple enough to enable the

procedure to be performed by nonphysician health-care providers.

One device that might potentially meet these criteria is the ShangRing (Wuhu Snnda Medical Treatment Appliance Technology Co. Ltd, Wuhu City, China), which has been used to circumcise tens of thousands of men in China since 2005.¹² The ShangRing consists of two concentric plastic rings, the inner of which is lined with a soft silicone pad, leaving a smooth, nonbioreactive surface against the surgical wound. The outer ring consists of two halves that are hinged together at one end and contain a locking clasp on the other (Figure 1). These rings are positioned to sandwich the foreskin of the penis—allowing it to be excised without stitches or significant bleeding—and are then left in place for 7–10 days before being removed. While the conventional adult male circumcision procedure takes 20–40 min to perform, ShangRing circumcision can be carried out in around 5 min, enabling high numbers of procedures to be performed daily. The speed and simplicity of the technique could make ShangRing circumcision an option for use in resource-poor settings—especially in environments, such as sub-Saharan Africa, where doctors are in short supply and nonphysician personnel are the main providers of adult male circumcision.

In this Perspectives, we describe the ShangRing surgical technique and review the data and clinical experience of its use. Currently, all published data regarding the ShangRing are from China, where the device was developed and is in commercial use.

ShangRing surgical technique Preparation and anesthesia

Any visible penile lesions secondary to sexually transmitted disease, neoplasia, or inflammation must be evaluated and treated before the circumcision. The correct ShangRing size is ascertained using a measuring tape (provided in the ShangRing package) to determine the penile circumference (Figure 2). Appropriate sizing of the device minimizes the risk of its displacement and of discomfort to the patient from erections. In the event that a patient falls between two sizes, the larger



Figure 1 | The ShangRing is comprised of two concentric plastic rings: an inner ring and an outer ring. The inner ring is lined with a soft silicone pad, leaving a smooth, nonbioreactive surface against the surgical wound. The outer ring consists of two halves that are hinged together at one end and contain a locking clasp on the other.

size should be chosen. No cases of penile necrosis or gangrene due to a tight ring have been reported.

ShangRing circumcision is carried out using sterile technique and with appropriate local anesthesia (lidocaine 2%). If required, pubic hair is shaved before the procedure. Standard anesthesia involves a dorsal penile nerve block with or without a ring block, although ‘no-needle anesthesia’ has also been successfully used in ShangRing circumcision. An explanation of the no-needle anesthesia technique is provided in Supplementary Box 1 online.

Circumcision technique

After confirming adequate anesthesia, the inner part of the ShangRing is placed around the penis to the level of the coronal sulcus (Figure 3a). Clamps are placed on the foreskin at the 3, 6, 9 and 12 o'clock positions and it is then carefully everted over the inner ring (Figure 3b). In patients with phimosis, a 1 cm slit is made in the dorsal part of the foreskin before it is everted over the inner ring. Next, the outer ring is placed over the inner ring and is closed to the first stop of the clasp, thus sandwiching the foreskin between both rings (Figure 3c). The outer ring is only tightened after ensuring that the frenulum is retracted away from the outer ring, and that a symmetrical margin of foreskin approximately 1.5 cm wide is visible between the corona of the glans and the ring. The outer ring is then tightened by locking the clasp at the second stop.

The circumcision itself is carried out by excising the excess foreskin using curved scissors (Figure 3d). Afterwards, using a scalpel blade, four equidistant slits are

made in the foreskin on the underside of the proximal surface of the ring to allow the skin to spread as it heals and provide space for expansion of the scab (Figure 3e). The wound is cleaned with an antiseptic solution, dried and dressed with a dry piece of gauze. The ShangRing is left in place for 7–10 days (Figure 3f).

Removal of the ShangRing

Although the ShangRing takes less than 3 min to remove, patients may experience some discomfort during this procedure. For this reason, it is recommended that patients take a single dose of an NSAID 30 min before ShangRing removal. Additionally, many practitioners in China apply 1% lidocaine to the area around the wound 1–2 min before the device is removed.

The outer ring is unlocked and removed using the specific ShangRing removal tool provided in the kit (Figure 4a). The inner ring is then gently separated from the wound margin, using scissors that have a blunt tip and recessed cutting edges (Figure 4b). The wound site is cleaned with an antiseptic solution and wrapped in a sterile bandage, which is left in place for 1–7 days, according to the preference of the surgeon.

Postoperative considerations

The healing period after ShangRing circumcision is approximately 4 weeks, during which abstinence from sexual activity is advisable. Patients may bathe and return to all work responsibilities within 24 h of the procedure. Postoperative pain is usually managed with oral NSAIDs, although a small subset of patients may require 1–2 days of oral opioid analgesics, as is



Figure 2 | Correct sizing of the ShangRing is done using a penile circumference measuring tape. In the event that a patient falls between two sizes, the larger size should be used.

often the case with standard circumcisions. The patient is discharged with a bandage around his penis, which he changes as needed. Follow-up visits to evaluate wound healing demonstrate excellent cosmetic results (Figure 5b).

Absorbable suture materials are used for wound approximation in conventional adult circumcision procedures. Although they facilitate effective wound healing, a major disadvantage of these sutures is that they leave stitch marks along the suture line. Circumcision results in penile mucosal edema, which can be exacerbated if absorbable sutures are placed in the mucocutaneous junction, leading to visible suture marks circumferentially around the glans penis (Figure 5a). Furthermore, sutures can break or be disrupted, resulting in wound dehiscence and further complications. Postoperative healing of the ShangRing procedure has a different appearance to that of conventional circumcision, because the wound is subjected to sustained circumferential pressure and the skin edges are juxtaposed underside to underside rather than edge to edge. During the 7–10 days that the device is left in place, a circumferential scab forms along the wound surface. When the ShangRing is removed, this scab and pink granulation tissue is seen around the penis (Figure 6)—this is the usual appearance of wound healing following ShangRing circumcision and does not represent dehiscence, although it can seem abnormal to those familiar only with suture-based circumcision. No patient in all the studies reviewed required additional sutures. In addition, according to the Chinese studies, the immune response of the healing area seemed to be robust without any evidence of increased risk of wound infections having been reported.

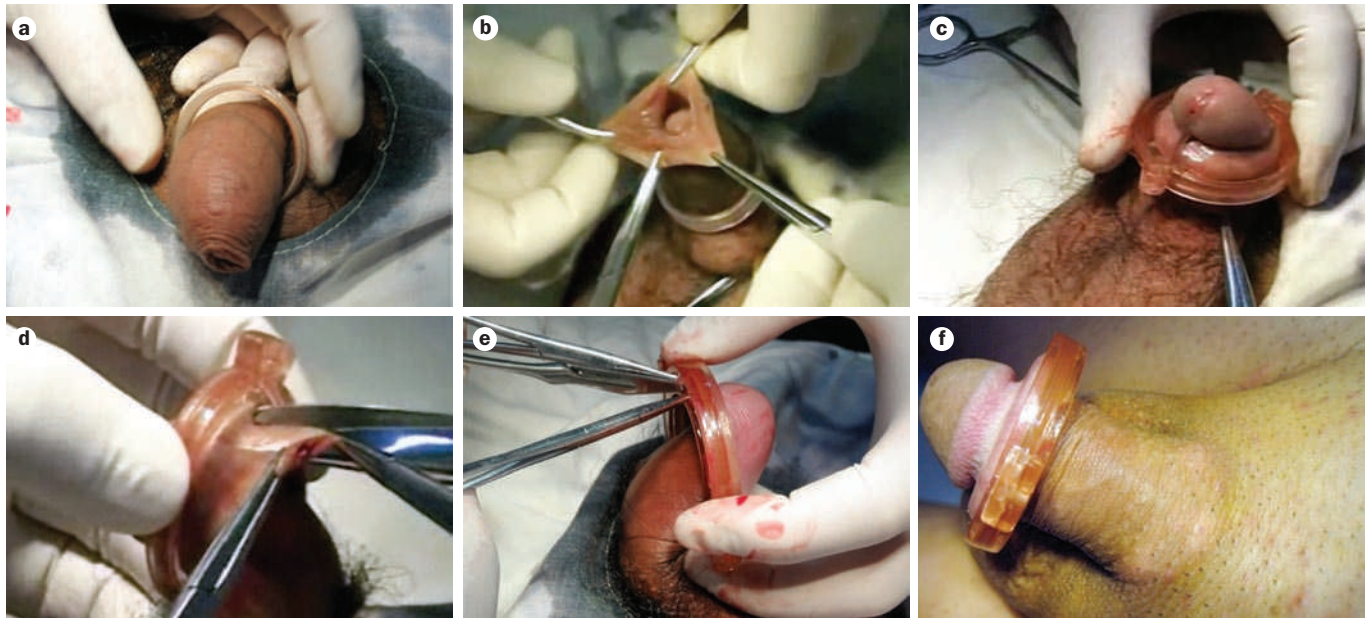


Figure 3 | The ShangRing procedure. **a** | The inner ring is placed around the penis to the level of the coronal sulcus. **b** | After placing clamps on the foreskin at the 3, 6, 9, and 12 o'clock positions, the foreskin is carefully everted over the inner ring. **c** | The outer ring is placed over the inner ring and closed to the first stop of the clasp, thus sandwiching the foreskin between both rings. **d** | The excess foreskin is excised using curved scissors. **e** | Afterwards, using a scalpel blade, 4 slits are made in the foreskin on the underside of the ring at the 2, 5, 8, and 11 o'clock positions; these slits are necessary to allow the skin to spread as healing occurs and to allow for expansion of the scab. **f** | The wound is subjected to sustained circumferential pressure and the skin edges are juxtaposed underside to underside rather than edge to edge. The ring is left in place for around 7 days.

Patients are informed about potential complications of the procedure before, and after, the ShangRing has been removed, such as excessive bleeding, pain (especially during erections with the ring in place), edema, ring displacement, and infection. Additionally, patients should be given instructions on proper hygiene while the device is in place and encouraged to shower regularly. They should also be asked to return to the clinic if they experience excessive pain on erection. The postinflammatory exudate and healing scab may resemble an infection or wound dehiscence during the initial period after the ring has been removed. The health-care provider must be made aware of this fact and trained to differentiate between the two. After the ShangRing is removed, patients are followed up in the clinic, usually 2–4 weeks postprocedure.

Experience with the ShangRing

The ShangRing has been used in China to circumcise both children and adults, although the vast majority of ShangRing circumcisions (including those in the published studies, which were all conducted in China) have been performed in adults aged 18–58 years. All study participants either had phimosis or desired elective circumcision.

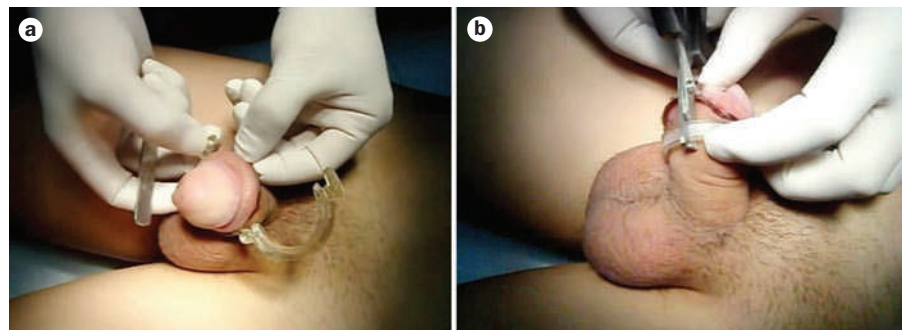


Figure 4 | Removal of the ShangRing. **a** | The outer ring is unlocked and removed using the ShangRing removal tool. **b** | The inner ring is gently separated from the wound margin and cut at the 3 and 9 o'clock positions using special scissors that possess a blunt tip and recessed cutting edges.

In the first Chinese study of 1,200 patients, the average procedure time was 3 min (excluding anesthesia). This duration is substantially less than that needed for standard WHO-recommended circumcision methods.¹³ Complication rates associated with the ShangRing procedure were low and included no reports of device dislocation or damage to the frenulum. Mild to moderate edema occurred in 10% of patients undergoing elective circumcision and in 3% of those with phimosis. Edema of the frenulum was seen in 2% of patients, and the incision became infected in <1%. After removal of

the device, wound dehiscence was observed in 2% of patients, and <1% reported bleeding around the incision, which was treated conservatively with bandaging and observation. Another study of ShangRing circumcision, which included 328 adult men aged 18–58 years, showed that the mean operative time was 4.7 ± 1.31 min, with ring removal at 7–8 days. On a scale of 0–10, mean pain scores were 0.2 during the circumcision procedure, 1.6 24 h postprocedure, 1.7 before ring removal, and 2.7 during ring removal. Complications were mild and included bleeding (2 men), infection (2 men), wound

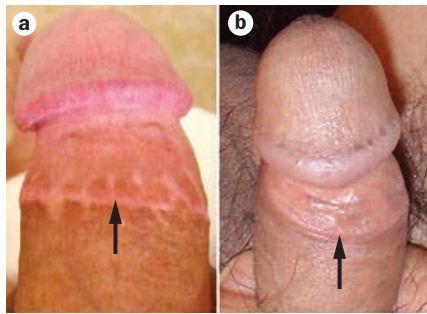


Figure 5 | Penile appearance following circumcision. **a** | Cosmetic result following conventional circumcision (with sutures). **b** | Cosmetic result following ShangRing circumcision. The use of the ShangRing does not result in the scars often seen with conventional circumcision technique.



Figure 6 | When the ShangRing is removed, healthy pink granulation tissue encircles the penis. Although the appearance of the wound is quite different from that seen after conventional circumcision, this appearance does not suggest infection or dehiscence.

edema (16 men), and wound dehiscence (2 men), all of whom were managed conservatively. The mean time for complete wound healing was 20.3 days. 99.7% of men were satisfied with the cosmetic result and 73.2% were sexually active 1 month after ShangRing circumcision.¹⁴

In a further study, 60 men underwent a ShangRing circumcision using the no-needle anesthesia technique (Supplementary Box 1 online).^{15,16} The mean age of patients in this study was 25.4 years. The median time to onset of the anesthetic effect was 42 s. Of the 60 men receiving anesthesia via jet injection, nine (15%) required supplemental needle anesthesia (a penile ring block using 3–5 ml of 1% lidocaine) before proceeding with the circumcision. Complications associated with use of no-needle anesthesia involved mild urethral bleeding in four patients, which resolved spontaneously with mild pressure at the jet injector site in all cases. Further discussion of jet injector anesthesia *per se* is outside

the scope of this Perspectives, however this method of anesthesia is a viable option to be used in resource-poor areas, as it can be used by nonphysician health-care providers, if they are properly trained.

A prospective, noncomparative study carried out in Kenya was designed to assess the safety, efficacy and acceptability of ShangRing circumcision in adult men.¹⁷ Three people (one obstetrician/gynecologist, one surgeon, and one nurse) underwent a standardized training program in the ShangRing circumcision technique. Following informed consent and a penile ring block, 40 HIV-negative Kenyan men underwent ShangRing circumcision, carried out by the newly trained physician or nurse. Follow-up included clinical examinations at 2, 7, 9, 14, 21, 28, 35 and 42 days after circumcision to assess device placement, occurrence of adverse events, and healing progress, as well as patient-reported problems and levels of satisfaction. The ShangRing was removed on day 7 in all patients.

The average procedure time for circumcision and device removal was 4–5 min and no intraoperative complications were reported. Six patients reported mild post-operative adverse events, including minor injuries to the penile skin (three men), moderate edema (two men), and infection (one man), all of which resolved with conservative management. Three partial detachments of the ShangRing device occurred at days 2–7, although they did not require treatment or early ring removal. Erections with the ShangRing in place were well tolerated, with a mean pain score of 3.5 ± 2.3 . Approximately 85% of men were back at work by day 7 after surgery. At 7 days, 90% of participants were very satisfied and the remaining 10% were somewhat satisfied with their circumcision. All participants said they would recommend the ShangRing procedure to others. The preliminary results of this study—the first to be conducted outside China—are encouraging, and indicate that the ShangRing is suitable for further study in African populations.¹⁷ Use of ShangRing circumcision could potentially increase take-up rates of adult male circumcision, especially in areas where HIV is endemic. The African study correlates well with results from China. All of the trials to date show that the ShangRing is a suitable device for adult male circumcision, although additional study is warranted in African populations. The studies also show that the device has some advantages over conventional circumcision approaches, such as being faster and having a reduced risk of bleeding.

Discussion

Surgical complications of circumcision include excessive bleeding, hematoma formation, infection, pain, injury to the glans or urethra, excessive or insufficient skin removal, and poor cosmetic results. Current complication rates for adult male circumcision are about 2–4% under optimal conditions,^{3,18,19} but are considerably higher in resource-poor settings and when circumcision is performed by inexperienced or poorly trained practitioners. A study conducted in Kenya has demonstrated that circumcision complication rates range from 17% in clinical settings to 35% in traditional settings.²⁰ Despite the potential benefits of circumcision in reducing transmission of HIV in areas where infection with this virus is endemic, the standardization of adult male circumcision is an ongoing issue. Extensive training and resources are, therefore, required in sub-Saharan Africa, where adult male circumcision is being aggressively promoted.

The existing evidence indicates that ShangRing circumcision is safe and effective in adult men. Advantages of the ShangRing procedure over the traditional suture technique include its simplicity and short duration (around 5 min compared to the 20–45 min required for conventional circumcision). The coronal sulcus is visible throughout the procedure, minimizing the risk of injury to the glans (Figure 3). The sterile device forms a tight seal along the wound, which maintains hemostasis without the need for sutures and allows patients to shower or bathe normally immediately after the procedure. The sutureless closure heals well with excellent cosmetic results. These characteristics mean that ShangRing circumcision has the potential to be used in high-volume, resource-poor settings, by health-care providers with minimal levels of training and experience.

Millions of adult male circumcisions have been estimated to be required over the next 5–10 years to effectively slow the spread of HIV.^{21,22} In Africa, adult male circumcision is usually performed using methods recommended by the WHO,²³ which include forceps-guided, dorsal-slit, or sleeve-resection methods. Adult male circumcision has suffered from a dearth of research comparing the different surgical techniques and devices available. The ShangRing is one of few adult male circumcision devices that has been studied in large populations.^{12,14}

A major disadvantage of the ShangRing is the necessity for men to wear the ring for

7 days. In addition, a second visit to the clinic is required for ring removal. However, this visit can be an advantage as it facilitates postsurgical evaluation of the patient and provides an opportunity to reinforce advice given in HIV risk-reduction counseling. Concerns have been raised that patients might not return for their postoperative device-removal visit and, therefore, might be subjected to adverse events as a consequence of device retention. To date, no studies have investigated this possibility, although proposals are in place to investigate various intervals for device removal in order to explore whether any additional benefit or harm is experienced by patients who retain the device for >7 days. Despite these concerns, few reports of adverse consequences regarding the length of time the ring is left in place were mentioned in either the Chinese or African studies, and patients were allowed to bathe and resume all normal activities (except for sexual activity) immediately after the ShangRing circumcision.

The unique ShangRing kits required to apply and remove the device, as well as the need to stock multiple sizes of the ShangRing, may also prove to be a limitation to their use, although experience with using the ShangRing in China has not suggested that these factors cause problems. Further trials could collect data on the most commonly used sizes to enable health services to predict the number of sizes required for future scaled-up efforts. Standard surgical circumcision does have the benefit of using instruments that can be used for other procedures, thus the equipment is already on hand and costs are reduced. The overall cost of ShangRing adult male circumcision in Africa is currently unknown, as the devices used in the Kenyan study were donated for research purposes. In China, the ShangRing sells for about RMB¥500–580 per kit, which equates to approximately US\$80–85. This price includes one ShangRing set, the measuring tape, and 10 bandages. However, the actual cost of production of the ring is much lower and negotiations are under way with the manufacturer to determine a significantly reduced price for the public sector in resource-poor settings such as sub-Saharan Africa. Once a demand for ShangRing circumcisions in Africa has been established, a cost-benefit analysis of the procedure's efficacy in terms of HIV prevention will need to be undertaken. Future planned studies of the ShangRing procedure include prospective, randomized, controlled trials to compare it to conventional surgical

techniques and to determine the ideal time for device removal. Additionally, studies comparing the use of the no-needle (jet injector) anesthesia technique to that of traditional needle anesthesia in ShangRing circumcision are planned.

Conclusions

The ShangRing is a simple and effective device for adult male circumcision. Its use results in substantially reduced operative times and complication rates versus suture-based circumcision, as demonstrated by studies in China and Kenya. Additionally, the simplicity of its application and removal mean that use of the device can be taught to nonphysician health-care providers, which suggests that ShangRing circumcision would be a valuable option for use in resource-poor settings. These characteristics could increase rates of adult male circumcision in HIV-endemic countries where circumcision prevalence is currently low.

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Author contributions

All authors researched data for the article and were involved in discussion of content, as well as writing and reviewing and editing the manuscript before submission.

Supplementary information

Supplementary information is linked to the online version of this paper at www.nature.com/nrurol