A New Approach to Closure of Myelomeningocele Defect

Z Advancement-Rotation Flap

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Abstract: Because myelomeningocele defects vary in size, shape, and location, no single procedure applies to all. A large number of techniques have been described for closing the back defects occurring after excision of the meningocele sac, but new studies focus more on simple, reliable, and versatile alternatives because large defect is a challenging problem for reconstruction. This study presented a new fasciocutaneous flap, called z advancement-rotation flap for the coverage of meningomyelocele defects with the successful outcomes of 11 patients. Meningocele defect is imagined as a rhombus shape placed vertically over the midline and accepted to have corners and angles of a rhombus, but any skin excision from the margins of the wound is not made for creating a defect, which will be completely similar to a rhombus so that its angles are obtuse and real appearance is elliptic or round. Flaps are elevated from both sides of the wound and can easily be advanced, then rotated to the midline, and the donor area can be primarily sutured with no complications. Defect sizes ranged from 7.5 × 6 to 12 × 9.5 cm, and mean operation time for flap elevation and closure was 29 minutes. Presented technique is not only simple, safe, and stable but also has got some more advantages such as short operation time because of easy dissection, minimal blood loss, and primary closure of the whole wound as well. It seems to be an alternative for safe, rapid, less bleeding, and easy surgery resulting in a solution for the closure of large meningomyelocele defects.

Key Words: meningocele, defect, z flap, advancement, rotation, fasciocutaneous flap

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Although a large number of techniques have been described for closing the back defects occurring after excision of the meningocele sac, new studies focus on more simple, reliable, and versatile alternatives. Larger meningocele defects have a difficulty for the coverage over the repaired cord and meninges because this area has had limited donor tissue available for providing large composite flaps. Small meningocele defects, especially lower than 5 cm in diameter, may be closed easily without needing any additional soft tissue procedures such as flaps or skin grafts.[1] Primary closure can be accomplished by undermining the wound edges in these patients. The surgical options available for closing the larger ones include skin grafting, local skin flaps, musculocutaneous flaps, and fasciocutaneous flaps.

Most of meningoceles are now repaired in a few hours or days after birth, to preserve the function of the neural tissues and to prevent meningitis. As operative stress, postoperative infection, wound dehiscence, or flap necrosis may have devastative results, short operation time, less bleeding, safe flap perfusion, and good coverage of the wound are important to obtain satisfactory results and avoid any possible complications. In this study, a new method for the coverage of meningocele defects, permitting fasciocutaneous flap closure was presented.

PATIENTS AND SURGICAL TECHNIQUE

This study included 10 newborns and a 2-month-old baby with meningomyelocele sac treated in our clinic with defects that were too large to be repaired by direct suture (Table 1). The meningomyelocele was placed in lumbar region in 2 patients, thoracolumbar area in 5 patients, and lumbosacral area in 4 patients. Six of the children were girl and 5 were boy. All the patients were paraplegic. Ten patients were operated in first week of their life, but for 1 case, operation time was at 2 months of age. Operative procedures were started by a neurosurgical team to excise the meningocele mass and to repair the neural tube. Initially, 20 mL of saline composed of lidocaine in 0.05% of dilution with 1:1,000,000 of epinephrine was given subcutaneously around the sac and previously marked incision lines of the flaps to reduce bleeding and pain. Although neural parts were freed from cutaneous elements, meningocele sac was removed, and later a subarachnoid space was created with meningeal membranes. Additionally, a watertight dural closure was obtained for completing the construction of a neural tube. After the dorsally displaced neural tissue has been reduced in the vertebral canal, in all cases, a large defect, more than 5 cm in diameter, took place on the back. Defect sizes ranged from 7.5 × 6 to 12 × 9.5 cm^2 with an average of 8.7 × 7.2 cm^2.

Meningocele defect was imagined as a rhombus shape placed vertically over the midline and accepted to have corners and angles of a rhombus (Fig. 1). However, any skin

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TABLE 1. Details of the Patients and Clinical Findings

Patient No.	Sex	Birth Week	Age at Operation	Size of Defect (cm)	Operating Time* (min)	Bleeding Volume (mL)	Region	Complications
1	F	Term	2 d	12 × 9.5	35	25	Thoracolumbar	None
2	M	Term	1 d	8 × 6	19	15	Lumbar	None
3	F	Term	5 d	7.5 × 7.5	28	17	Lumbosacral	None
4	F	Term	4 d	10 × 8	32	20	Thoracolumbar	None
5	M	Term	4 d	9 × 7	30	18	Lumbosacral	None
6	F	Term	3 d	8 × 7	30	16	Thoracolumbar	None
7	F	Term	1 d	7.5 × 7	25	15	Thoracolumbar	None
8	M	Term	2 d	7.5 × 6	25	13	Lumbosacral	None
9	M	Term	59 d	9 × 8	35	20	Lumbosacral	None
10	M	Term	3 d	9.5 × 7.5	35	18	Lumbar	None
11	F	Term	2 d	8 × 6	25	15	Thoracolumbar	None

*Excluding time for closure of the neural tube.

excision from the margins of the wound was not made for creating a defect, which would be completely similar to a rhombus, so its angles were obtuse and real appearance was elliptic or round (Figs. 2A, B; 3A, B; 4A). All corners were first marked in the beginning of the drawing in every patient, but margins of the rhombus were signed in some patients. As z advancement-rotation (ZAR) flap was planned to close the defects, at first flap marking was made with drawing a curve line from the proposed large angle of the defect that was accepted like a rhombus, to gluteal area in one side and to thoracal region in the other side (Figs. 1, 3A). Gently curving marking was approximately 25% longer than the rhomboid sides themselves, extending along the long axis of the rhomboid.

Skin incisions deepened to the latissimus dorsi muscle and a fasciocutaneous flap including the thoracolumbar or lumbosacral facia was dissected, taking care to avoid damage to the perforating vessels at the base. After elevating the flaps and making a meticulous hemostasis, rotation and advancement of them into the defect area were made easily. Two-layer closure was obtained without any tension and a suction drain was placed under the flaps (Figs. 2B, C; 3B, C; 4B). The patients received care postoperatively in the prone position until wound healing was completed, which lasted from 5 to 6 days.

RESULTS

In all patients, meningocele defects and flap donor sites were closed primarily. Neither skin graft nor another flap was used for the coverage of donor sites. Suction drain remained for 3 days and then was taken out. Hematoma, seroma, wound dehiscence, flap necrosis, or infection were not observed (Figs. 2D, 3D, 4C). After suturing the flaps, in most cases, some skin excess occurred at which the flaps joined; also in a patient, a "dog ear" formation took place in the side of the wound, at the flap base (Figs. 2C, 3C). Both skin redundancies and wrinkles relaxed spontaneously in a month and dog ear resolved in 3 months, so surgical intervention was not needed. Because of little bleeding due to the infiltration of adrenaline-contained solution, blood transfusion was not required in any case. The average blood loss was 17.4 (13–25) mL for flap elevation and closure. Bloodless surgical area made the neurosurgical procedures, flap elevation, and closure faster and easier so that mean operation time for flap elevation and closure was 29 (19–35) minutes. The patients had a follow-up of 2 to 28 months with a mean of 8 months, and no patient was observed with late breakthrough of the wound (Figs. 2E, 3E, 4C).

DISCUSSION

Fasciocutaneous flaps, elevated around the paraspinal area for repairing of the meningocele wounds, have been demonstrated to be safe in terms of vascular supply, which is supported by a rich vascular network with 3 main dominant vascular territories.[2] First, vascular pattern of the middle third of the area originates from the muscular perforators and lateral cutaneous branches of the costal groove segment of the lower intercostal arteries. Second, parascapular and scapular fascial branches of the circumflex scapular artery supply the upper lateral portion of it. Third, fascial vasculature of the lower, richly arborizing with the middle segmental intercostal extensions is from lateral extensions of the superficial circumflex iliac artery. As these vascular networks have been showed anatomically and clinically in a study that included 13 patients who had undergone reconstruction of large lumbosacral myelomeningoceles with bilateral paralumbar fasciocutaneous flaps, it was thought that performing an application of the ZAR flap for the meningocele defect would be possible. Using this anatomic base, various fasciocutaneous flaps for the closure of back defects have been described with successful clinical experience, but present study has been the first experience to repair a meningocele defect with ZAR flap in the literature. In our patients, like the mentioned study, flap necrosis neither totally nor partially was observed despite the administration of some adrenaline.

The ZAR flap has been known since Pate[3] first described it in the fifth international symposium of plastic and reconstructive surgery of the head and neck. It was recommended for closing some facial defects ranging from 1 to 3.2 cm in diameter due to excision of skin carcinoma. Successful results in 265 cases with 5-years follow-up had been reported

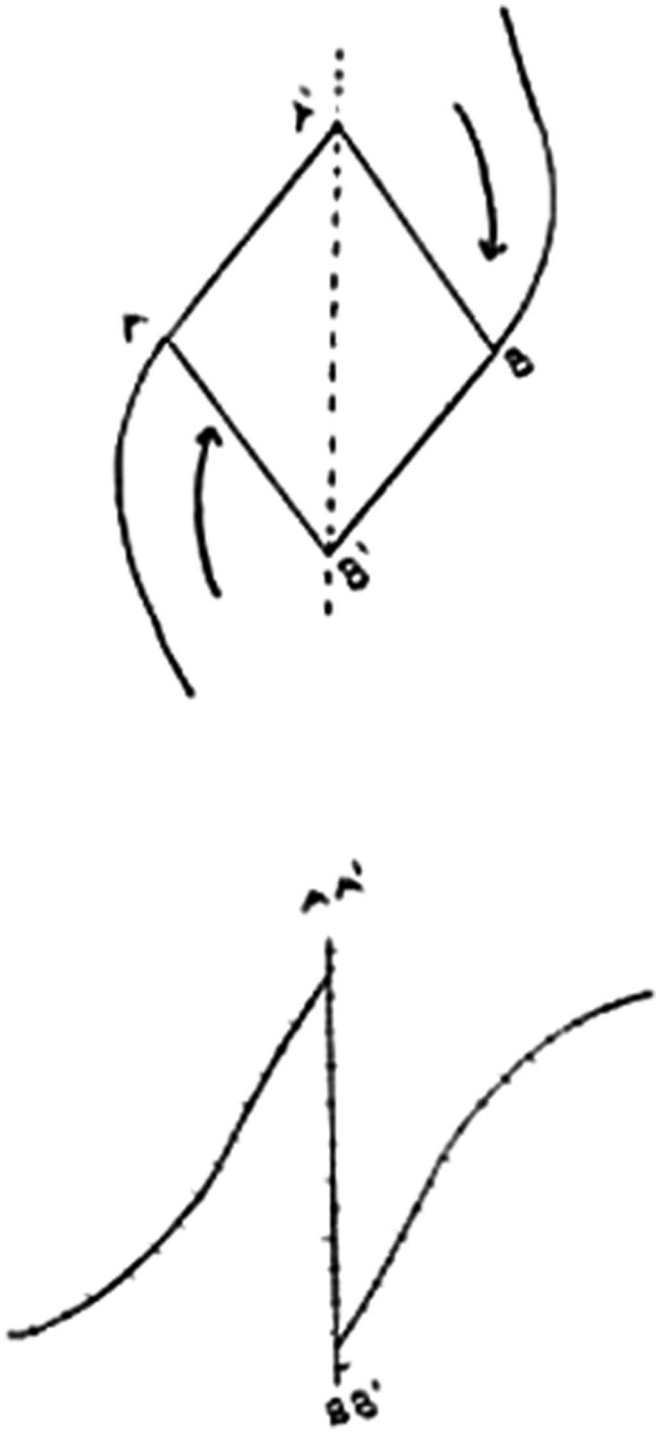

FIGURE 1. Schematic illustration showing a rhombus and ZAR flap. When A and B flaps are elevated, advanced, and rotated into the rhombus, they go to A′ and B′, respectively.

for full-thickness cutaneous defects. We made a modification of the flap to achieve more safe and stable closure of the meningocele defects, using 2-layer tissue, skin, and facia. Unlike skin flap, fasciocutaneous flap preparation also provided a rich vascular network.

Z-plasty is a widely used method for the closure of various skin defects placed at different sites of the body. In some studies, it has been demonstrated that meningocele defect coverage with Z-plasty technique was available. Cruz et al[4] described a double z-rhomboid technique for closing of the large myelomeningocele defects with elevating equilateral Z-plasty flaps at the sides of the rhombus and transposing across it. Successful outcomes reported in 10 cases as a result of experiencing this approach. The main difference from our study was the lack of rotation and advancement of the flaps; they made only transposition of them. Moreover, cutaneous flap preparation, using double Z-plasty flaps, and excision of excess skin are another differences of their technique.

Most surgical techniques have been recommended for the closure of large meningocele wounds, but some complications occurring after surgery in infants may be devastating; so, choosing the surgical method has some difficulty.[1,5,6] As less bleeding, short operation time, and rapid closure are important to perform an intervention on newborns, local flap is one of the most preferred methods in plenty of different options because direct skin grafting onto the nervous system can result in subsequent skin ulceration. In using some local flaps, especially the larger ones such as rhomboid flaps, bipedicled flaps, rotation flaps, and transposition flaps, an additional soft tissue is necessary for closing the donor site, so lateral relaxing incisions or delays of the flaps, skin grafts, delayed repair of the sac, sac membrane using for the flap donor site or tissue expansion for primary skin closure have become severe procedures managing to close the donor sites to avoid extra surgical trauma and to facilitate all the surgery in some studies.[7–10] To repair a meningocele defect with a technique that permits primary closure of the whole wound is desired by most surgeons, then some methods providing primary closure are preferred more than another techniques, which require a skin graft or additional flap. A well-known method described by Ramirez et al[11] for the reconstruction of large thoracolumbar and lumbosacral meningomyelocele defects with latissimus dorsi and gluteus maximus myocutaneous units is probably one of the most effective alternatives. No lateral relaxing incisions, delays, or skin grafts are necessary. Flaps are advanced medially and reapproximated in the midline, permitting primary closure of the defect in 3 layers. Although successful outcomes were reported when closing a meningocele defect, such a musculocutaneous flap operation is quite invasive in a newborn and sacrifice of muscle tissue should be avoided, especially in a patient who may be confined to a wheelchair. Indeed, all muscle and musculocutaneous flaps described by different authors provide a good padding with a well-vascularized tissue over neural repair, but increased blood loss and longer operating time with sacrifice of the back muscles compromising the structural integrity of the spine and adversely affecting crutch walking have been reported to be major drawbacks.[12–15]

Recently, a technique described as an available alternative for the closure of large meningomyelocele defects, Mutaf triangular closure seems to be useful but difficult for marking of the flaps with Doppler assessment to confirm the existence of major perforators at the base of the flaps, exten-

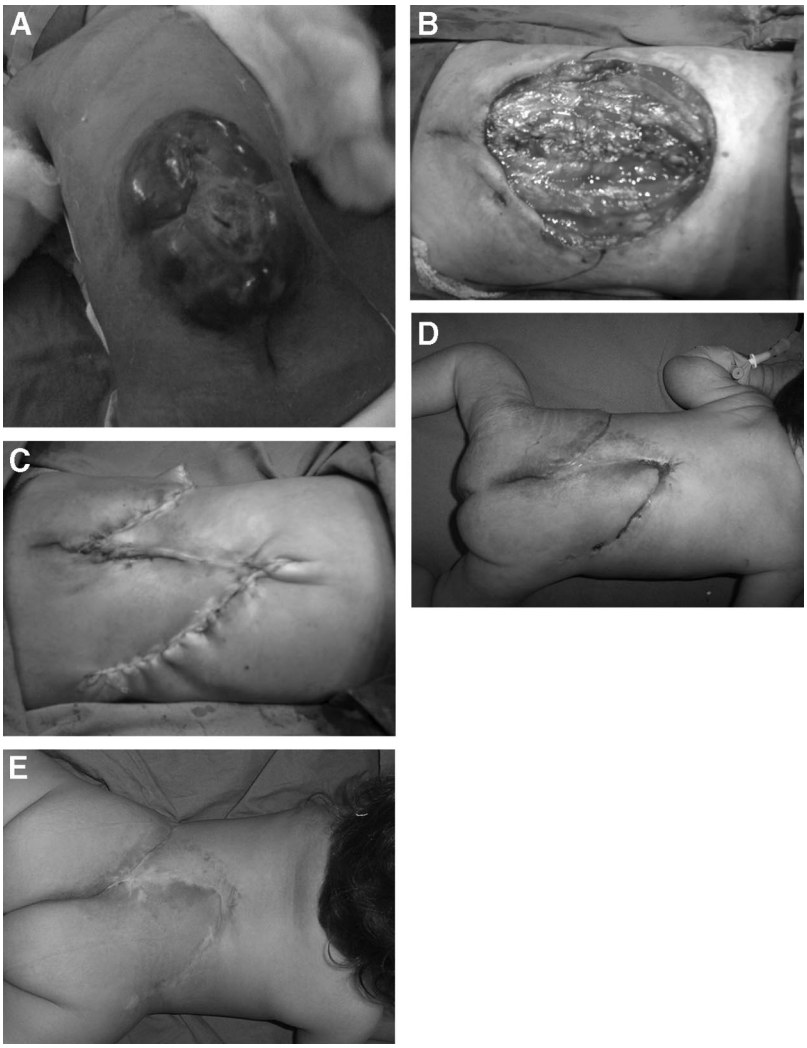

FIGURE 2. A, A 2-day-old female newborn with a large thoracolumbar meningocele. B, Intraoperative view of the defect and repaired neural tube with the marking of the flaps on the lateral sides, observing less bleeding, and significant palor around the defect because of the effect of local anesthetic infiltration. C, Immediate postoperative view after suturing of the flaps, showing skin wrinkles, and a dog ear at the base of 1 flap. D, One month postoperatively. E, Appearance of the repair at 28 months. Note that dog ear formation and skin wrinkles are lost.

sive dissection extending to the throchanteric area in some cases, and longer operation time may be disadvantages to our technique.[12] In the flap elevation, a meticulous dissection is performed at the base of the ZAR flaps to protect the perforating vessels, especially if encountered, leading to support the flap perfusion, but a special effort to find a perforator vessel in the surgery or previously with Doppler probing is not made, as fasciocutaneous flaps have been already demonstrated to be safe and well vascularized in most studies without any severe discussion. Therefore, to search a perforating vessel is unnecessary, and whether there is a vessel or not at the base of the flap will not alter its direction, elevation, rotation, or advancement, or other surgical approach. Finally, results supported our consideration about flap elevation. Neither partial nor complete flap loss developed.

Duffy et al[16] reported the use of the superior gluteal artery perforator flap for the closure of lumbosacral meningomyelocele defects with the average defect size of 4.8×6.8 cm^2, whereas it was 8.7×7.2 cm^2 in our series. It seems to have several promising features such as well-vascularized healthy soft tissue padding; the flap is limited for the small and medium meningomyelocele defects.

Bilateral modified v-y advancement flaps for closing meningomyelocele defects have been used in the successful repair of 11 meningomyelocele defects, the size of which ranged from 35×20 mm^2 to 80×50 mm^2.[13] In this study, meningocele defects are smaller than ours, and it seems to require more meticulous dissection not to compromise flap perfusion.

In some cases presenting a paucity of dural tissue to be created in the "neural-tube," many neurosurgeons may need to harvest the thoracolumbar fascia to seal the closure; although in the present series, it has not encountered such a case. Theoretically, the technique permits to be able to harvest the thoracolumbar fascia from either paraspinal area that is not involved by the flaps or the remaining facia in place after elevating the flaps.

At the end of the review of the experiences of meningocele surgery including various techniques, it can be emphasized that in the repair of large meningocele defects, advancement of the lateral tissues only into the defect area does not provide a safe closure every time and is not enough to cover the entire wound without any suture tension, so additional tissue coming from either thoracal or gluteal area

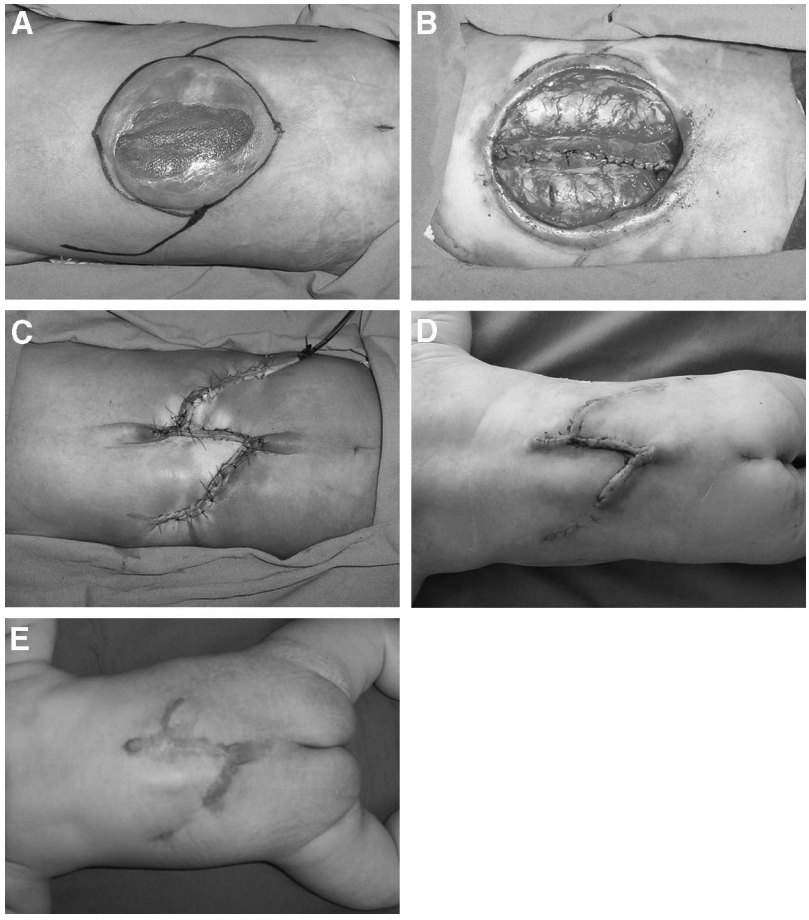

FIGURE 3. A, An appearance of 4-day-old female newborn with the marked ZAR flap and sac. B, Intraoperative view of the large defect. C, Suturing completed. The flaps turned pale with the injection of the local anesthetic, but blood perfusion was not disturbed in any cases. D, Postoperative appearance on 14th day after repair. E, Final view shows a good coverage 6 months after surgery.

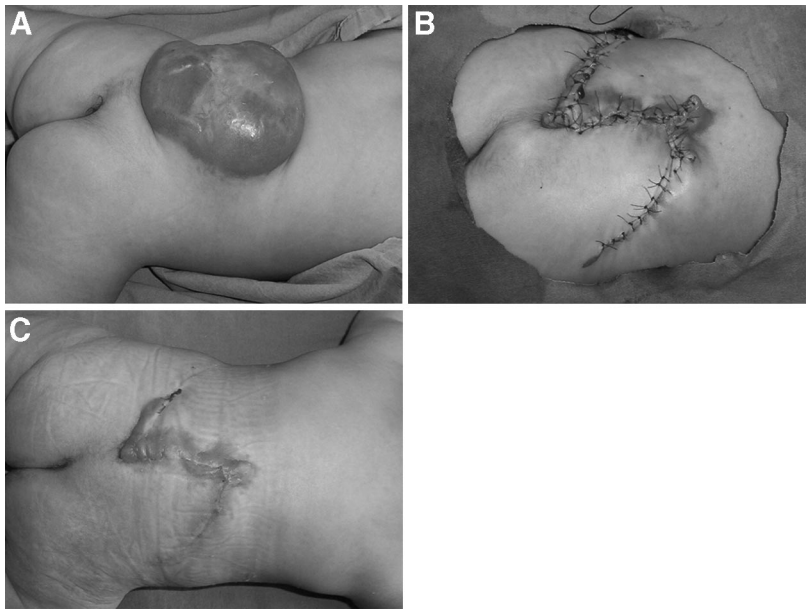

FIGURE 4. A, Preoperative view of the 9th patient presenting a lumbosacral meningomyelocele. B, Appearance of the flaps after suturing at the end of the operation. C, One month postoperatively.

into the defect is necessary. ZAR flap presents an extra tissue from both areas to allow primary closure without suture tension and the necessity of any skin graft or flap for the donor site.

Presented technique is simple, safe, and stable; moreover, it has got some more advantages such as short operation time because of easy dissection, minimal blood loss, and primary closure of the whole wound. It seems to be an

effective option for rapid, easy, and safe closure of the meningocele defects.

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