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| Original Article |

A Comparison of Three Methods for Postoperative Pain Control in Patients Undergoing Arthroscopic Shoulder Surgery

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Background: Arthroscopic shoulder operations (ASS) are often associated with severe postoperative pain. Nerve blocks have been studied for pain in shoulder surgeries. Interscalene brachial plexus blocks (ISB) and an intra-articular injection (IA) have been reported in many studies. The aim of the present study is to evaluate the effect of ISB, a continuous cervical epidural block (CCE) and IA as a means of postoperative pain control and to study the influence of these procedures on postoperative analgesic consumption and after ASS.

Methods: Fifty seven patients who underwent ASS under general anesthesia were randomly assigned to one of three groups: the ISB group (n = 19), the CCE group (n = 19), and the IA group (n = 19). Patients in each group were evaluated on a postoperative numerical rating scale (NRS), their rescue opioid dosage (ROD), and side effects.

Results: Postoperative NRSs were found to be higher in the IA group than in the ISB and CCE groups both at rest and on movement. The ROD were 1.6 ± 2.3, 3.0 ± 4.9 and 7.1 ± 7.9 mg morphine equivalent dose in groups CCE, ISB, and IA groups ($P = 0.001$), respectively, and statistically significant differences were noted between the CCE and IA groups ($P = 0.01$) but not in between the ISB and CCE groups.

Conclusions: This prospective, randomized study demonstrated that ISB is as effective analgesic technique as a CCE for postoperative pain control in patients undergoing ASS. (Korean J Pain 2015; 28: 45-51)

Key Words: Analgesia; Arthroscopy; Epidural anesthesia; Interscalene block; Intraarticular injection; Pain.

INTRODUCTION

Although minimally invasive ASS is commonly performed, the procedure is associated with severe postoperative pain [1,2]. Therefore, appropriate pain control methods in the early postoperative period can improve rehabilitation and recovery [2]. The opioid requirements for this pain are known to be similar to those following gastrectomy or thoracotomy [3]. While the administration of parental opioids is considered for severe postoperative pain control, the use of opioids can lead to complications including nausea, vomiting, pruritus, ileus, confusion, urinary retention, hypotension, and respiratory depression [4].

Therefore, nerve block procedures for shoulder surgeries have been studied. The ISB is regarded as an effective analgesic method for ASS. Previous studies have reported that ISB is excellent due to both its pain control and morphine-sparing effects in the first 24 hours following surgery, compared to either a suprascapular nerve block or a single injection of a local anesthetic especially in shoulder surgeries. In addition, more effective postoperative pain control is achieved through a combination of ISB and local analgesic injection [2,3,5]. An intra-articular injection (IA) is performed by the surgeon at the end of surgery just before wound closure. With the use of IA, additional procedures for pain control are not needed by patients and the procedure is as effective as an ISB [3]. Also, a continuous cervical epidural block (CCE) is known to provide excellent pain relief for patients undergoing upper extremity surgery. Epidural analgesia with a local anesthetic, an opioid or both is regarded as the treatment of choice for postoperative pain control in various surgeries (e.g., total knee arthroplasty, thoracotomy). However, a cervical epidural catheter is not commonly used and is in fact rarely utilized in shoulder operations [6]. Despite the severe pain associated with arthroscopic shoulder surgery, comparisons between a neuraxial block such as CCE and other analgesic methods such as ISB and IA are very rare. Therefore, the aim of this study is to compare postoperative pain control in an ISB group compared to that in CCE and IA groups.

MATERIALS AND METHODS

1. Patients

The study protocol was approved by the ethics committee of the Jeju National University Hospital and was registered as a clinical trial (2012-04-002-004). The study was carried out according to the principle of the Declaration of Helsinki 2000, and written informed consent was obtained from all participants before their inclusion in the trial. Between May of 2012 and April of 2013, a total of 57 consecutive patients undergoing elective ASS under general anesthesia at our hospital were enrolled. The exclusion criteria were allergy to any medication in this study, a history of hypertensive disease, a grade of an American Society of Anesthesiologists (ASA) class exceeding II, and an inability to understand the instructions concerning the study. All operations were performed by a single surgeon who used an arthroscopic repair technique. All patients were recruited into this prospective randomized study and randomized into one of three groups using a simple randomization technique : 1) ISB group; n = 19; 2) CCE group; n = 19; and 3) IA group; n = 19

1) ISB group: Patients in the ISB group received the block before the induction of general anesthesia in the operating room. After supine positioning with head rotation to the other side, ISB was performed with ultrasound and nerve stimulation. The brachial plexus was identified using a nerve stimulator (Stimuplex-S, B. Braun Melsungen AG, Melsungen, Germany) connected to the proximal end of the metal inner needle of a plastic cannula (Stimuplex-A, 25-G B. Braun Melsungen). The initial current output of the nerve stimulator was 0.7 mA. A linear high frequency 6-13 MHz ultrasound probe (Sonosite M-turbo, SonoSite, Inc., Bothell, WA, USA) was used. Upon contraction of the triceps muscle, the C5-6 nerve root or superior trunk was found, and 10 ml of 0.25% ropivacaine with 200 mcg of epinephrine was injected. Twelve hours after the operation, a fentanyl patch (12 mcg/hr) was applied to the patients.

2) CCE group: The procedure was performed one day prior to the surgery. After prone positioning of patients and sterile preparation, local anesthetics were injected at the insertion site. A 17 gauge Tuohy needle was inserted under fluoroscopic guidance at the C7-T1 interspace. After identification of the epidural space using the loss of resistance technique, an epidural catheter (Epidural Catheterization Set, 19-G, Arrow International, Inc., Asheboro, NC, USA) was inserted. The catheter reached the C4 or C5 epidural space on the ipsilateral side of the affected limb. Following confirmation of the catheter position with contrast medium, the catheter was sutured in place with naylon 3.0.

After the patients were transferred to the operating room, a 10 ml bolus of 0.25% ropivacaine was injected through the epidural catheter, after which an epidural PCA (patient controlled analgesia) infusion pump (ropivacaine 0.25%, total 250 ml, basal 3 ml, bolus 3 ml, lockout time 30 min) was connected to the epidural catheter prior to the induction of general anesthesia. The catheter was removed 48 hours after the completion of the surgery.

3) IA group: After the completion of the arthroscopic procedure, the surgeon inserted a catheter into the joint via an arthroscopy portal. The catheter was attached to a disposable PCA infusion pump (Accufuser®, Wooyoung Medical Co., Ltd., Chungcheongbuk-Do, Korea) containing 100 ml of 0.25% ropivacaine, with a continuous basal infusion of 2 ml/hour with patient-controlled boluses available at 4 ml/hour. The catheter was removed 48 hours after the completion of the surgery.

2. General anesthesia technique

General anesthesia was induced by the IV administration of thiopental (5 mg/kg) after manual ventilation with O_2 at 6 L/min. Orotracheal intubation was facilitated with rocuronium (1 mg/kg). Anesthesia was maintained with O_2 and N_2O each at 1 L/min, and sevoflurane was maintained at a minimum of 1.0 vol%. A non-invasive blood pressure, electrocardiography, pulse oximetry and BIS values were monitored continuously. No additional intravenous analgesics including opioids were injected. After the completion of the surgery, glycopyrrolate and neostigmine were intravenously administered and the patients were extubated. The procedures were performed by one of the two co-authors of the study.

3. The studied variables

The primary outcome measure was the numerical rating scale (NRS) and rescue opioid dosages (ROD) during the first 48 hours postoperative. The severity of postoperative pain was evaluated by pain at rest and on movement and was assessed 30 minutes, 4 hours, 24 hours, and 48 hours after the operation with the NRS, with scores ranging from 0 = no pain to 10 = worst pain imaginable. If the NRS was higher than 7, patients were administered with rescue opioids such as fentanyl 25 mcg or pethidine 50 mg. The ROD was converted to the total morphine equivalent dose with an opioid converter. The rescue opiod analgesia dose and time of administration were recorded. All measure-

ments were made and recorded by another investigator who was also blind to the procedure.

4. Statistical analysis

The sample size was determined from a previous study of ISB and IA groups. On the basis of previous studies [7,8], we hypothesized that we could observe a 50% reduction in the NRS immediately after anesthesia between the ISB and IA groups because there have not been reports on comparisons between ISB and CCE. A power analysis estimated that 15 patients would be needed in each group to provide a 90% chance of detecting such a reduction at the 0.05 level of significance. To compensate for possible dropouts, we recruited 19 patients per group. The normally distributed data were presented as the mean ± standard deviation, and the groups were compared using a one-way analysis of variance (one-way ANOVA) and a post-hoc Scheffe test along with Dunnett's T3 test for height, weight, and age and for the ROD. A P value of < 0.05 was considered to be statistically significant. All statistical analyses were performed using Stata, version 11.0 (StataCorp, College Station, TX, USA).

RESULTS

There were no statistically significant differences in the demographic data among the three groups (Table 1).

The NRS showed significant statistical differences among all three groups ($P < 0.001$). Postoperative NRSs were reduced in the ISB and CCE groups as compared to the IA group at rest and on movement at 30 min, 4, 24, 48 h. The ISB group showed reduced NRSs at rest and on movement compared to the scores of CCE and IA groups at 30 minutes postoperatively (Fig. 1) (vs. the CCE group, and vs. the IA group, $P < 0.001$). ROD were 1.6 ± 2.3, 3.0 ± 4.9 and 7.1 ± 7.9 mg morphine equivalent dose in groups CCE, ISB, and IA groups ($P = 0.001$), respectively, and statistically significant differences were noted between the CCE and IA groups ($P = 0.01$) but not between the ISB and CCE groups.

DISCUSSION

We confirmed that an ISB is as effective an analgesic technique as CCE for postoperative pain control in patients undergoing ASS.

Table 1. Dermographic Data in the Three Groups

Variable	Group ISB (n = 19)	Group CCE (n = 19)	Group IA (n = 19)	P value
Age (yr)	52 (13)	53 (9)	54 (7)	n.s.
Height (cm)	164 (8)	163 (10)	159 (9)	n.s.
Weight (kg)	64 (10)	67 (12)	63 (9)	n.s.
Duration of anesthesia (min)	113 (21)	117 (31)	113 (26)	n.s.
Duration of operation (min)	59 (22)	68 (27)	61 (20)	n.s.

Result are expressed as mean (SD). No statistical difference isfound among groups. Statistical significance istested by one way ANOVA among groups. NRS_R: numerical rating scale at rest, NRS_M: numerical rating scale on movement, ISB: interscalene brachial plexus block, CCE: continuous cervical epidural block, IA: intraarticular injection, n.s.: nonsignificant ($P > 0.05$).
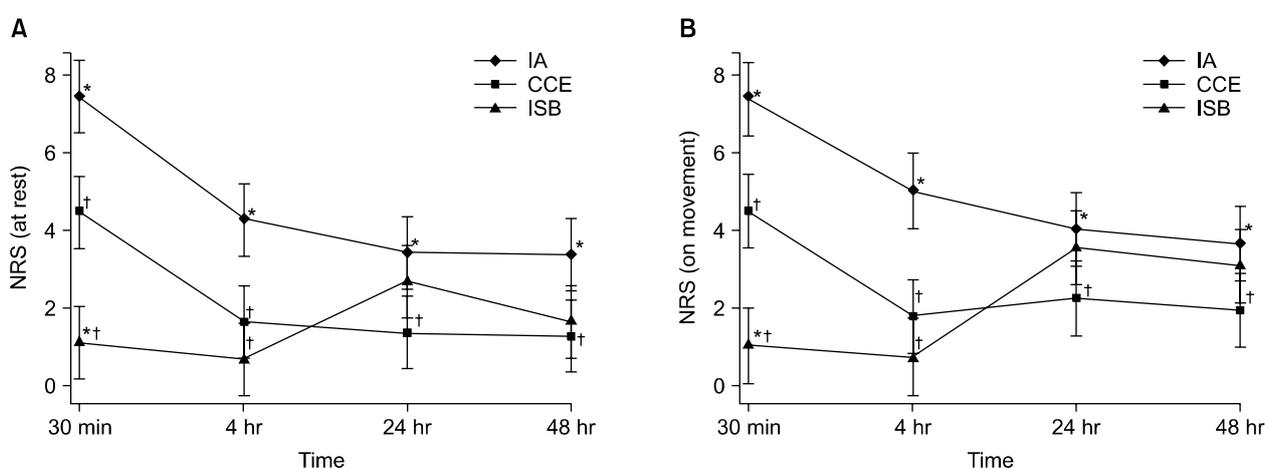

Fig. 1. Changes in NRS pain score at rest (A), on movement (B), NRS scores (mean ± SD) were measured at 30 minutes, 4 hours, 24 hours, 48 hours after surgery. ISB: interscalene brachial plexus block, CCE: continuous cervical epidural block, IA: intraarticular injection, *$P < 0.05$ compared with the CCE group; †$P < 0.05$ when compared with the IA group.

ASS is associated with severe postoperative pain. Analgesia for shoulder surgery includes subacromial or the intraarticular infiltration of local anesthetics, a supra-scapular block with or without an axillary (circumflex) nerve block, a single-injection interscalene nerve block and a continuous interscalene nerve block [3].

ISB is one of the most common regional anesthesia techniques utilized, and many reports have described the effectiveness of and complications associated with ISB [2,4,9–16]. The recent use of ultrasound guidance for ISB has been shown to minimize adverse effects with an injection under the direct visualization of the target nerve and an injection of a lower dose of local anesthetics [16,17]. Improved postoperative pain control using the ISB method is linked to an earlier initiation of rehabilitation, as evident in other studies [18]. IA has been popular among surgeons because it is perceived as a simple and effective technique

associated with improved analgesia, the reduced use of analgesics, and improved patients' satisfaction [3,19,20]. Savoie et al. demonstrated improved analgesia and reduced analgesic requirements with a continuous IA of 0.25% bu-pivacaine (2 ml/h for 48 h) in patients undergoing sub-acromial decompression under general anesthesia. In addition, Stephen et al. demonstrated that a single ISB plus a continuous IA of 0.5% ropivacaine at 2 ml/h improved analgesia [21]. Therefore, we used a continuous IA of 0.25% ropivacaine at 2 ml/h. CCE was reported in a few studies to provide excellent postoperative analgesia for patients undergoing upper extremity surgery [6,22,23]. Narouze et al. [24] reported that CCE was effective in the rehabilitation phase after shoulder surgery for adhesive capsulitis. Therefore, we presumed that cervical epidural analgesia may be effective as a means of postoperative pain control and rehabilitation following ASS. However,

placement of a cervical epidural catheter is not a commonly used procedure. Rare but severe complications such as an epidural abscess and permanent spinal cord damage can be devastating, making CCE less attractive for general use [6]. Although lumbar and thoracic epidural analgesia has been studied in various surgical situations as an effective analgesic method in comparison with a peripheral nerve block in a number of reports [25−27], CCE has not been compared with other analgesic methods such as ISB and IA during ASS, as it is associated with severe postoperative pain as in open shoulder surgery. While there have been studies comparing ISB with IA with a focus on pain following ASS during surgery, there has been no research dealing with comparisons of these procedures with CCE. In our study, the severity of postoperative pain was compared among these three groups.

A few studies have reported that, IA was an effective alternative to ISB [3,19]. However, the results of the current study were identical to those of other studies, finding that ISB provided better pain control than IA [8]. Interestingly, NRSs at 30 minutes postoperatively were shown to be reduced significantly in the ISB group. It is well known that cervical epidural analgesia selectively blocks sympathetic fibers, then sensory fibers, and finally motor fibers with an increasing dose of local anesthetics. However, ISB may not achieve the effective separation of the motor and sensory block as sensory nerves are in the core bundle, surrounded by motor nerves [6,28]. Therefore, we anticipated that immediate postoperative pain control would be best achieved in the CCE group, but the NRSs of patients in this group were higher than those of the ISB group in the immediate postoperative period. This study showed, however, that the ROD was lowest in the CCE group. ISB was shown to be effective for 10−12 hours in controlling postoperative pain [12,14]. In order to control postoperative pain after 12 hours in the ISB group, a fentanyl patch was applied to the patients. Although an additional injection of analgesics after the 12−hour window of the ISB effect had statistically insignificant results, it appeared that the injected amount of analgesics was smaller in the CCE group.

Contrary to the IA, CCE and ISB were performed before surgical incision. Preemptive analgesia in procedures such as CCE and ISB could explain their superior analgesic efficiency compared to IA [5].

In our study, side effects were not evident in the ISB and CCE groups using ultrasonography and a C−arm device. Due to their requirement of highly skilled techniques, cervical epidural procedures are not commonly recommended. A cervical epidural block has always been viewed as a relatively safe procedure, with complication rates ranging from 0−16.8% [3]. Although CCE demands a high degree of skill, it should also be considered as an effective means of controlling pain after ASS due to its comparatively low incidence rates of complications and its pain−relieving effects.

The study has several limitations. First, the number of participants in each group is relatively small if seeking to claim strong statistical power. Second, due to the difficulties in evaluating actual blood concentrations of local anesthetics, it is difficult to conclude that equal anesthetic effects were achieved in the three groups despite the fact that identical anesthetic agents and dosages were administered. Third, evaluations of experimental factors such as pain scores were not performed blindly after the assignment of patients into the three groups. Since it is known that factors associated with incisions such as fibrosis and joint inflammation influence the operation time and types of anesthetics [29], future research will be required to study those factors.

In conclusion, ISB is as effective an analgesic technique as CCE for postoperative pain control in patients undergoing ASS.

ACKNOWLEDGEMENTS

REFERENCES

1. Boss AP, Maurer T, Seiler S, Aeschbach A, Hintermann B, Strebel S. Continuous subacromial bupivacaine infusion for postoperative analgesia after open acromioplasty and rotator cuff repair: preliminary results. J Shoulder Elbow Surg 2004; 13: 630−4.
2. Cho CH, Song KS, Min BW, Jung GH, Lee YK, Shin HK. Efficacy of interscalene block combined with multimodal pain control for postoperative analgesia after rotator cuff repair. Knee Surg Sports Traumatol Arthrosc 2012 [in press].
3. Fredrickson MJ, Krishnan S, Chen CY. Postoperative analgesia for shoulder surgery: a critical appraisal and review

of current techniques. Anaesthesia 2010; 65: 608-24.

4. Ilfeld BM, Morey TE, Wright TW, Chidgey LK, Enneking FK. Continuous interscalene brachial plexus block for post-operative pain control at home: a randomized, double-blinded, placebo-controlled study. Anesth Analg 2003; 96: 1089-95.

5. Singelyn FJ, Lhotel L, Fabre B. Pain relief after arthroscopic shoulder surgery: a comparison of intraarticular analgesia, suprascapular nerve block, and interscalene brachial plexus block. Anesth Analg 2004; 99: 589-92.

6. Tsui BC, Bury J, Bouliane M, Ganapathy S. Cervical epidural analgesia via a thoracic approach using nerve-stimulation guidance in adult patients undergoing total shoulder replace-ment surgery. Acta Anaesthesiol Scand 2007; 51: 255-60.

7. Klein SM, Nielsen KC, Martin A, White W, Warner DS, Steele SM, et al. Interscalene brachial plexus block with continuous intraarticular infusion of ropivacaine. Anesth Analg 2001; 93: 601-5.

8. Beaudet V, Williams SR, Tétreault P, Perrault MA. Peri-operative interscalene block versus intra-articular injection of local anesthetics for postoperative analgesia in shoulder surgery. Reg Anesth Pain Med 2008; 33: 134-8.

9. Hughes MS, Matava MJ, Wright RW, Brophy RH, Smith MV. Interscalene brachial plexus block for arthroscopic shoulder surgery: a systematic review. J Bone Joint Surg Am 2013; 95: 1318-24.

10. Al-Kaisy A, McGuire G, Chan VW, Bruin G, Peng P, Miniaci A, et al. Analgesic effect of interscalene block using low-dose bupivacaine for outpatient arthroscopic shoulder surgery. Reg Anesth Pain Med 1998; 23: 469-73.

11. Simeoforidou M, Vretzakis G, Chantzi E, Bareka M, Tsiaka K, Iatrou C, et al. Effect of interscalene brachial plexus block on heart rate variability. Korean J Anesthesiol 2013; 64: 432-8.

12. Lee HY, Kim SH, So KY, Kim DJ. Effects of interscalene brachial plexus block to intra-operative hemodynamics and postoperative pain for arthroscopic shoulder surgery. Korean J Anesthesiol 2012; 62: 30-4.

13. Song SY, Roh WS. Hypotensive bradycardic events during shoulder arthroscopic surgery under interscalene brachial plexus blocks. Korean J Anesthesiol 2012; 62: 209-19.

14. Conroy BP, Gray BC, Fischer RB, Del Campo LJ, Kenter K. Interscalene block for elective shoulder surgery. Orthopedics 2003; 26: 501-3.

15. Laurila PA, Löppönen A, Kanga-Saarela T, Flinkkilä T, Salomäki TE. Interscalene brachial plexus block is superior to subacromial bursa block after arthroscopic shoulder surgery. Acta Anaesthesiol Scand 2002; 46: 1031-6.

16. Lee JH, Cho SH, Kim SH, Chae WS, Jin HC, Lee JS, et al. Ropivacaine for ultrasound-guided interscalene block: 5 mL provides similar analgesia but less phrenic nerve paralysis than 10 mL. Can J Anaesth 2011; 58: 1001-6.

17. Renes SH, Rettig HC, Gielen MJ, Wilder-Smith OH, van Geffen GJ. Ultrasound-guided low-dose interscalene brachial plexus block reduces the incidence of hemidiaphragmatic paresis. Reg Anesth Pain Med 2009; 34: 498-502.

18. Capdevila X, Dadure C, Bringuier S, Bernard N, Biboulet P, Gaertner E, et al. Effect of patient-controlled perineural analgesia on rehabilitation and pain after ambulatory orthopedic surgery: a multicenter randomized trial. Anesthesiology 2006; 105: 566-73.

19. Axelsson K, Gupta A, Johanzon E, Berg E, Ekbäck G, Rawal N, et al. Intraarticular administration of ketorolac, morphine, and ropivacaine combined with intraarticular patient-con-trolled regional analgesia for pain relief after shoulder surgery: a randomized, double-blind study. Anesth Analg 2008; 106: 328-33.

20. Liu SS, Richman JM, Thirlby RC, Wu CL. Efficacy of continuous wound catheters delivering local anesthetic for postoperative analgesia: a quantitative and qualitative systematic review of randomized controlled trials. J Am Coll Surg 2006; 203: 914-32.

21. Savoie FH, Field LD, Jenkins RN, Mallon WJ, Phelps RA 2nd. The pain control infusion pump for postoperative pain control in shoulder surgery. Arthroscopy 2000; 16: 339-42.

22. Buchheit T, Crews JC. Lateral cervical epidural catheter placement for continuous unilateral upper extremity analgesia and sympathetic block. Reg Anesth Pain Med 2000; 25: 313-7.

23. Prusinkiewicz C, Lang S, Tsui BC. Lateral cervical epidural catheter placement using nerve stimulation for continuous unilateral upper extremity analgesia following a failed con-tinuous peripheral nerve block. Acta Anaesthesiol Scand 2005; 49: 579-82.

24. Narouze SN, Govil H, Guirguis M, Mekhail NA. Continuous cervical epidural analgesia for rehabilitation after shoulder surgery: a retrospective evaluation. Pain Physician 2009; 12: 189-94.

25. Davies RG, Myles PS, Graham JM. A comparison of the analgesic efficacy and side-effects of paravertebral vs epidural blockade for thoracotomy—a systematic review and meta-analysis of randomized trials. Br J Anaesth 2006; 96: 418-26.

26. Barrington MJ, Olive D, Low K, Scott DA, Brittain J, Choong P. Continuous femoral nerve blockade or epidural analgesia after total knee replacement: a prospective randomized controlled trial. Anesth Analg 2005; 101: 1824-9.

27. Davies AF, Segar EP, Murdoch J, Wright DE, Wilson IH. Epidural infusion or combined femoral and sciatic nerve blocks as perioperative analgesia for knee arthroplasty. Br J Anaesth 2004; 93: 368-74.

28. Casati A, Vinciguerra F, Scarioni M, Cappelleri G, Aldegheri G, Manzoni P, et al. Lidocaine versus ropivacaine for con-tinuous interscalene brachial plexus block after open shoulder surgery. Acta Anaesthesiol Scand 2003; 47: 355-60.

29. Tantry TP, Muralishankar B, Adappa KK, Bhandary S, Shetty P, Shenoy SP. Target-controlled infusion (Propofol) versus inhaled anaesthetic (Sevoflurane) in patients undergoing shoulder arthroscopic surgery. Indian J Anaesth 2013; 57: 35-40.

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