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Original Article

Costoclavicular versus Lateral Sagittal Approach of Infraclavicular Brachial Plexus Block for Upper Limb Surgeries: A Prospective Comparative Study

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Abstract

Background and Aim: The infraclavicular brachial plexus blocks are an alternative to axillary block for anaesthetizing elbow, forearm, and hand surgeries. Furthermore, they are associated with lesser complication rates as compared to supraclavicular blocks. Hence, this study is undertaken to compare two approaches of infraclavicular brachial plexus block with respect to block hemodynamics.

Methodology: This prospective and comparative study was done in 40 patients posted for the upper limb surgeries for a duration of 2 months under American Society of Anesthesiologists I, II, III. Here patients will be divided into two groups randomly. First group will receive lateral sagittal approach infraclavicular brachial plexus block with 20 mL of 0.5% Bupivacaine and second group will receive costoclavicular approach of infraclavicular brachial plexus block with 20 mL of 0.5% Bupivacaine. Block performance time and dynamics are compared between two groups.

Outcome Measures: To assess Imaging time, needling time, block performance time, number of needle redirections, onset of sensory and motor block**,** duration of block, duration of surgery, surgeon and patient satisfaction score, number of patients who require a rescue block, and complications associated with block.

Results: Imaging time, Needling time, block performance time, and number of needle redirections are lesser in costoclavicular approach as compared to lateral sagittal approach. None of the patients required any rescue blocks in both the groups. No complications were noted in both the groups.

Conclusion: Costoclavicular approach is easy to perform in terms of block performance as cords are clustered at a single anatomical location as compared to lateral sagittal approach.

Key words: Brachial plexus block, Costoclavicular, Lateral sagittal, Upper limb surgeries

INTRODUCTION

Peripheral nerve blocks are a type of locoregional anesthesia that provides a targeted and localized anesthesia of extremities both for surgical anesthesia and post-operative analgesia. It has more advantages in that anesthesia is provided to a particular area of interest and general systemic side effects of polypharmacy are avoided. Furthermore, it is a part of multimodal analgesia in this upcoming era of opioid free anesthesia. Brachial plexus block is used to anaesthetize upper limb for surgeries involving from shoulder to fingertips. Various approaches are available to block brachial plexus which include – interscalene block, superior trunk block, supraclavicular brachial plexus block, infraclavicular brachial plexus block, and axillary block. The brachial plexus is formed by the nerve roots from C8 to T1. The nerve roots split to form superior, middle, and inferior trunks above the clavicle. As the trunks pass under the clavicle, it is found in close proximity with each other and it is easier to block at this level. Below the clavicle, the brachial plexus splits to form

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the lateral, medial, and posterior cords around the axillary artery. The infraclavicular brachial plexus block provides anesthesia and analgesia from mid-humerus to finger tips.[1] The infraclavicular brachial plexus blocks are an alternative to axillary block for anaesthetizing the elbow, forearm, and hand surgeries. Infraclavicular brachial plexus block was developed to overcome the limitations of axillary block which includes musculocutaneous nerve sparing. Furthermore, infraclavicular block has several advantages that make it a preferable approach to brachial plexus blockade: Comprehensive upper extremity anesthesia, lower incidence of tourniquet pain, and preferable site for catheter insertion. Our main objective was to compare the block performance and block dynamics in terms of imaging time, needling time, block performance time, number of needle redirections, onset of sensory, and motor blockade. Hence, this study is undertaken to compare two approaches of infraclavicular brachial plexus block with respect to block hemodynamics.

METHODOLOGY

This was a prospective and comparative study conducted in a tertiary care hospital of South India in the setting of operation theater complex and post-anesthesia care unit for a study duration of 2 months among patients posted for upper limb surgeries. This study is done after getting Institutional Ethical Committee clearance in accordance with declaration of Helsinki. Each patient was given informed consent form explaining the procedure, drugs used, risks, and benefits. Patients between age group of 18 years to 80 years, those scheduled for elective forearm and hand surgeries, and patients with American Society of anesthesiologists (ASA) 1–3 are included in this study. Patients not consenting/unwilling to participate, age <18 years or >80 years. Patients with ASA 4, obesity (BMI >30 kg/m^2), those with contraindications to regional anesthesia (thrombocytopenia and infection at injection site), history of hypersensitivity or allergy to local anesthetics, and those patients requiring conversion to general anesthesia are excluded from this study. Group size of 20 was calculated using power analysis from a previous study report. The upper limb surgeries included are forearm fractures, hand surgeries, and AV fistula creation in end stage renal disease patients requiring hemodialysis. Continuous sampling was done and our study included 40 patients, out of which 20 patients were given lateral sagittal approach of infraclavicular brachial plexus block (Group LS) and rest were given costoclavicular approach of infraclavicular brachial plexus block (Group CC). Our primary objectives are to assess imaging time (time from placement of USG probe to proper visualisation of cord along with axillary artery), to assess needling time (time from needle insertion to needle out time after deposition of local anesthetic), to assess block performance time

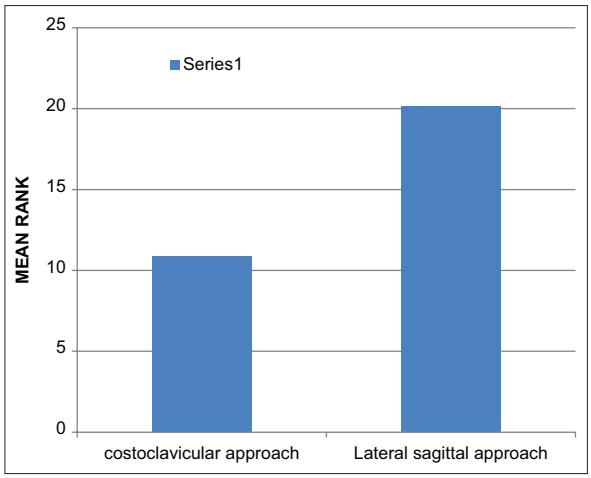

Figure 1: Bar graph showing comparison of imaging time among both the groups

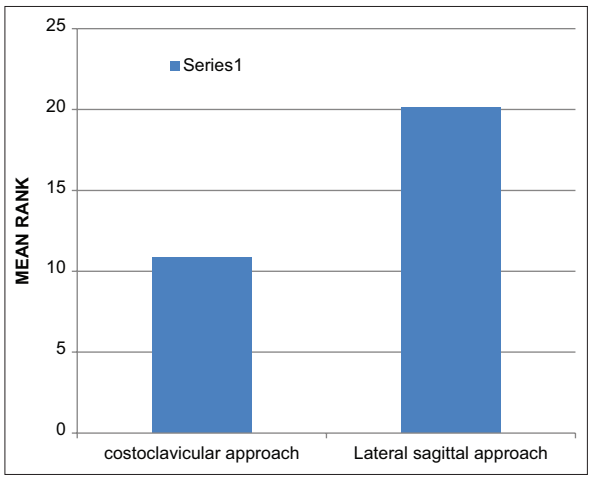

Figure 2: Bar grouph showing needling time comparison among both the groups

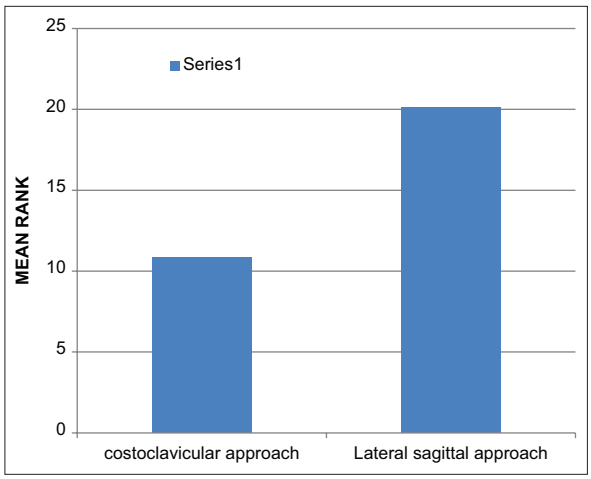

Figure 3: Bar graph showing block performance time comparison among both the groups

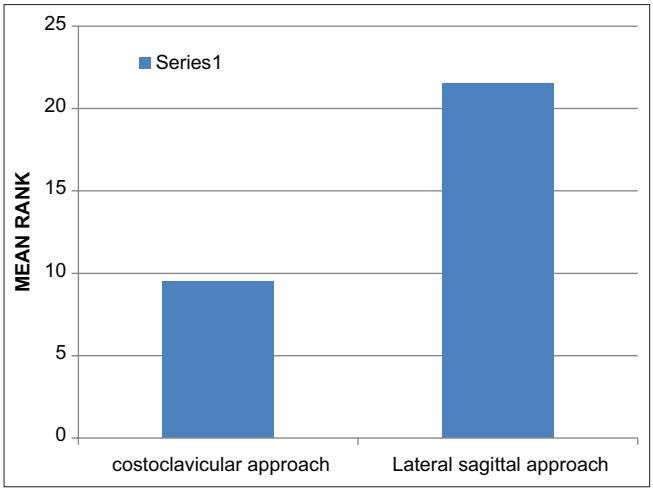

Figure 4: Bar graph showing Number of needle redirections comparison among both the groups

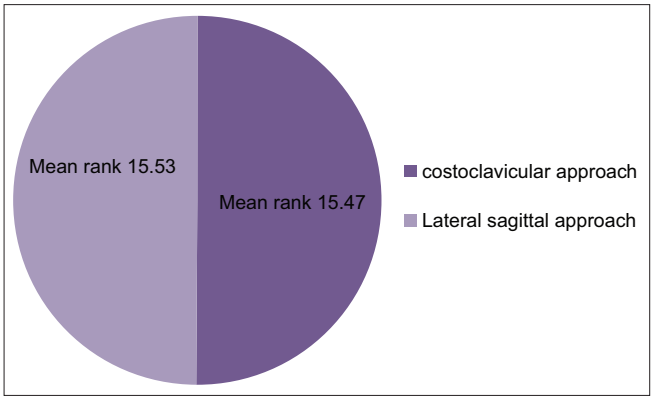

Figure 5: Pie chart showing comparison of onset of sensory block among both the groups

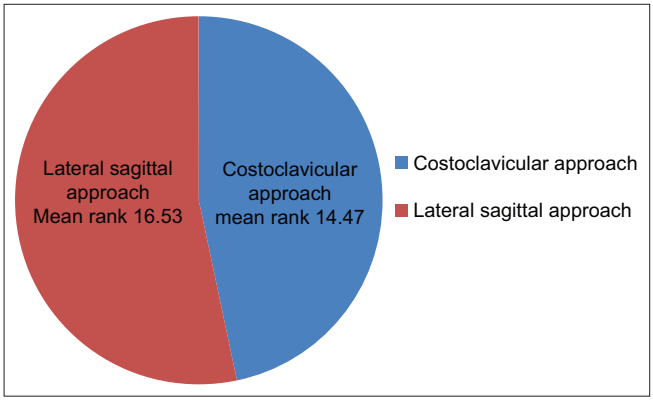

Figure 6: Pie chart showing onset of motor block comparison among both the groups

(imaging time + needling time), to assess number of needle redirections, and to assess the onset of sensory and motor block. Secondary objectives are to assess the duration of analgesia, number of patients who require a rescue block, and complications associated with block. All the patients in both the groups received the same treatment protocol.

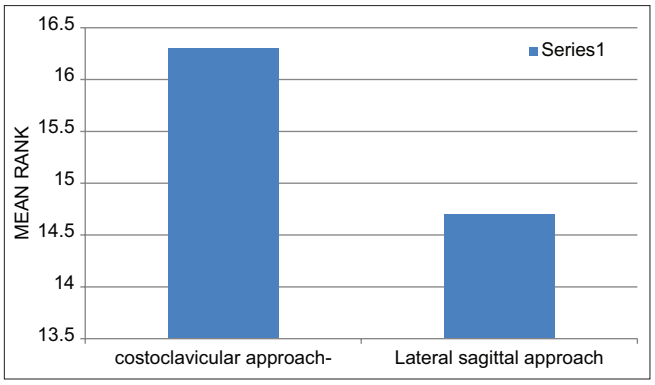

Figure 7: Bar graph showing comparison of duration of analgesia among both the groups

All patients were pre-medicated with 0.1 mg/kg midazolam intravenously. Routine monitoring includes electrocardiogram, pulse oximetry, and non-invasive blood pressure. Supplemental oxygen was administered through oxygen mask at a flow rate of 4 L/min.

Site of intervention was painted and drained under sterile aseptic precautions. All blocks were performed under ultrasound guidance ("Sonosite") using high frequency linear probe with the patient in supine position and head turned toward opposite side. In lateral sagittal approach, the sterile ultrasound probe was placed medial to the coracoid process in the sagittal plane in the infraclavicular region, and then three cords of the brachial plexus were visualized [Figure 8]. Furthermore, the major vascular bundles axillary artery and axillary vein are visualized. Using 23G spinal needle and by the in-plane technique needle is directed in a craniocaudal direction and 20 mL of bupivacaine 0.5% will be administered around the posterior cord (7 mL), lateral cord (7 mL), and medial cord (6 mL) [Figure 11].

In costoclavicular approach, patient was positioned in supine position with head rotated toward opposite side away from site of surgery with arms abducted at an angle of 90°. The sterile ultrasound probe was placed parallel to the clavicle in the midclavicular area and tilted toward the cephalad and the axillary artery, and three cords were visualized [Figure 9]. A 23G spinal needle was forwarded from lateral to medial using the in-plane technique, and 20 mL of bupivacaine 0.5% was administered at the center of the three cords in the costoclavicular space [Figure 10].

Adequacy of blocks was checked using pinprick sensation along the dermatomal distribution of ulnar nerve, median nerve, and radial nerve after about 15 to 20 min of local anesthetic injection and before the commencement of surgery. Furthermore, any dermatomal sparing requiring rescue blocks were assessed.

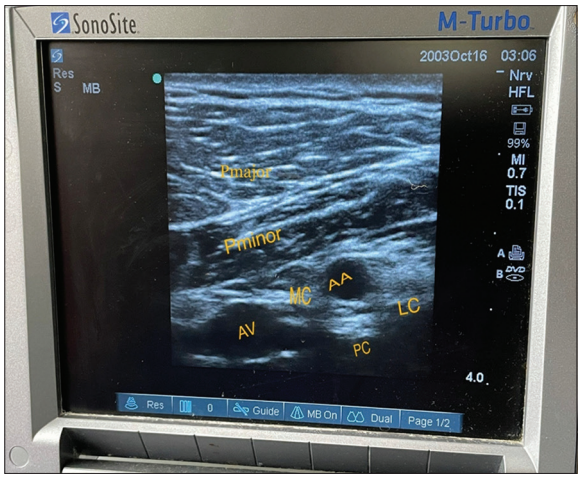

Figure 8: Image showing sonoanatomy of lateral sagittal approach of infraclavicular brachial plexus block
Pmajor: Pectoralis major, Pminor: Pectoralis minor, AV: Axillary vein, AA: Axillary artery, PC: Posterior cord, MC: Medial cord, LC: Lateral cord

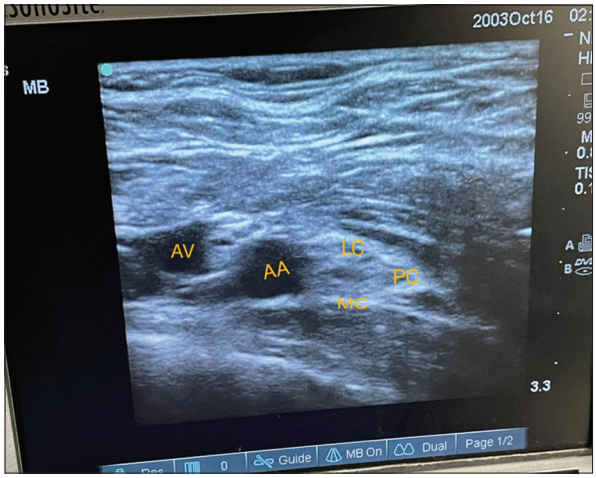

Figure 9: Image showing sonoanatomy of costoclavicular approach of infraclavicular brachial plexus block
AV: Axillary vein, AA: Axillary artery, PC: Posterior cord, MC: Medial cord, LC: Lateral cord

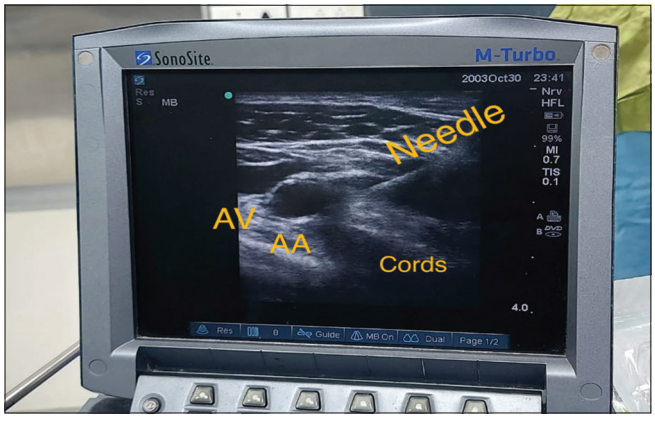

Figure 10: Image showing needle position in costoclavicular approach of infraclavicular brachial plexus block

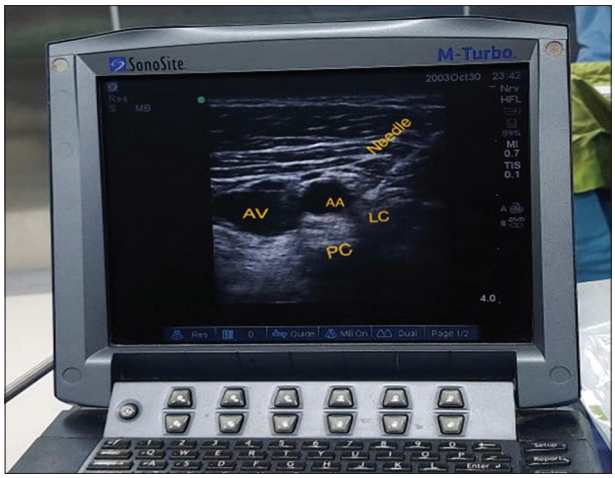

Figure 11: Image showing needle position in lateral sagittal approach of infraclavicular brachial plexus block

Block performance time and block dynamics were assessed and compared with both the groups in terms of imaging time, needling time, block performance time, number of needle directions, onset of sensory, and motor blockade. None of the patients were sedated intraoperatively. Hemodynamic monitoring was done intraoperatively for both the groups. Need for rescue analgesia was also assessed and recorded. Both the groups were monitored for block complications such as pneumothorax, accidental vascular puncture, local anesthetic toxicity, Horner's syndrome, and local site hematoma. Postoperatively patient was monitored in the recovery room and shifted to ward with an Aldrete score >9.

Statistical analysis of continuous variables such as imaging time, needling time, block performance time, no. of needle redirections, onset of sensory, and motor block was done using Mann–Whitney U test. A confidence interval of 95% was used in all statistical tests and $P < 0.05$ is considered to be statistically significant.

RESULTS

The imaging time was higher in the lateral sagittal approach infraclavicular brachial plexus group with a mean rank of 20.13 versus 10.87 (s) in the costoclavicular approach infraclavicular brachial plexus group and was statistically significant with $P = 0.004$ [Table 1 and Figure 1]. Furthermore, the needling time was higher in the Group LS mean rank of 19.47 versus 11.53 in the Group CC (seconds) but was not statistically significant [Figure 2]. Moreover, the block performance time was statistically significantly longer in the Group LS as compared to Group CC 20.43 versus 10.57 (s) with $P = 0.002$ [Figure 3]. The number of needle directions that were higher in the Group LS

Table 1: Results showing statistical analysis of block performance and dynamics

Parameters	Costoclavicular approach (mean rank)	Lateral sagittal approach (mean rank)	*P*-value
Imaging time	10.87	20.13	0.004
Needling time	11.53	19.47	0.13
Block performance time	10.57	20.43	0.002
No. of needle redirections	9.50	21.50	0.001
Onset of sensory block	15.53	15.47	0.982
Onset of motor block	14.47	16.53	0.509
Duration of analgesia	16.30	14.70	0.614

with a mean rank of 21.50 and was statistically significant [Figure 4]. Furthermore, the block was successful in all patients and the onset of sensory block was similar in both the groups and was not statistically significant (P = 0.98) [Figure 5]. Furthermore, the onset of motor block was earlier in Group CC with a mean rank 14.47 (min) versus Group LS with a mean rank of 16.53 (min) but was not statistically significant [Figure 6]. Duration of analgesia was higher in Group CC but was not statistically significant (P = 0.61) [Figure 7]. Moreover, none of the patients required any rescue blocks or conversion to general anesthesia. No complications were encountered in both the groups such as vascular puncture, local site hematoma, pneumothorax, local anesthetic toxicity, horners syndrome, or any neurological complications.

DISCUSSION

Our present study shows that imaging and block performance time were longer in the lateral sagittal approach of infraclavicular brachial plexus block. However, there was no significant difference in the onset of sensory and motor block. One of the contemporary technological advances in the field of anesthesia is the introduction of anatomical evaluation by ultrasound imaging. Widespread use of ultrasound imaging depends on its proven clinical efficacy, cost effectiveness, and practicality as it provides anesthesiologist the visual treat to evaluate complex and varied anatomy of the local structures before needle insertion.

In costoclavicular approach, the cords are located at a more superficial level and clustered lateral to axillary artery at a depth of 3–4 cm whereas in lateral sagittal approach, the cords are in deeper level (4–5 cm) and are separated from one another around the artery.[2] This explains the greater imaging time and block performance time of lateral sagittal approach as compared to costoclavicular approach in our study. Furthermore, the greater number of needle redirections in the lateral sagittal approach can be explained by the anatomical arrangement of cords around the axillary artery along the 3, 6, and 9 o clock positions whereas in the costoclavicular approach, the cords are clustered lateral to the axillary artery.[3]

A randomized study by Yayik *et al.* in 60 pediatric patients undergoing forearm and hand surgeries found that needling time and block performance time was significantly longer in lateral sagittal group as compared to costoclavicular group. Moreover, there was no significant difference in the imaging time, number of needle passes, onset of sensory, and motor block.[4]

Few studies by Dingemans *et al.* and Gurkan *et al.* showed reduced block performance time and equal success rate with the use of ultrasound guidance alone rather than ultrasound with neurostimulation technique.[5,6]

A study by Monzó *et al.* on microanatomical considerations of brachial plexus block in the costoclavicular region found that there was interplexus fascial septum that separates the lateral cord from the posterior and medial cords in 94% of population which suggests that two separate injections are needed to block the cords to ensure adequate local anesthetic spread.[7]

Onset of sensory block showed no difference among both the groups in our study whereas costoclavicular approach showed a faster onset of motor block compared to lateral sagittal approach but was not statistically significant. Later onset of motor block in lateral sagittal approach may be due to the individual anatomical variations, depth of the cords, and the distance between them.

A RCT by Leurcharusmee *et al.* among 90 patients posted for upper limb surgeries using 35 mL mixture of 1% of lignocaine with 0.25% of bupivacaine and adrenaline 5 mcg/mL showed that there were no significant intergroup differences in terms of block performance time. However, the number the needle passes were marginally fewer in the lateral sagittal approach as compared to costoclavicular approach.[8]

A study by Li *et al.* in 40 patients undergoing elective upper extremity surgery using 25 mL of 0.5% of ropivacaine found that the onset of sensory block was faster in costoclavicular approach as compared to lateral sagittal approach (10 min vs. 20 min) and P = 0.004.[9]

Moreover, none of the patients in our study required any rescue block or had any complications associated with

the block. The amount of local anesthetic used can be reduced by ultrasound guidance and proper visualization of the cords which is an added advantage. A study by Wong *et al.* in 40 patients undergoing elective forearm and hand surgeries found that the minimum effective local anesthetic volume of 0.5% ropivacaine was found to be 20.9 mL. Furthermore, there are only very few literatures available for this infraclavicular approaches.[10]

There are few limitations in our study. First, the sample size is limited. Surgeon satisfaction score was not assessed at the end of the procedure which could have guided better in comparing both the approaches. More studies are encouraged in the near future to provide a comprehensive data for analysis leaving the fear of complications of pneumothorax while performing infraclavicular brachial plexus block which can be avoided under ultrasound guidance. Furthermore, there are few literatures available with regard to infraclavicular approach.

CONCLUSION

Costoclavicular approach is easy to perform in terms of block performance as cords are clustered at a single anatomical location as compared to lateral sagittal approach with maximum success rate and minimum complications.

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