

## Scalable model of pediatric inguinal hernia surgery in remote Nepal: prospective study to change practice

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**Abstract**

**Introduction:** Inguinal hernia is the common surgical problem in children. Most of the inguinal hernia in children are congenital due to patent processes vaginalis. Due to inadequate numbers of surgeons in remote Nepal, most of the childhood hernia are referred or left untreated. The study evaluates the outcomes of pediatric hernia surgery performed by General Practitioners (GPs) after training GPs in remote setting by pediatric and general surgeons.

**Method:** It is a prospective study of pediatric hernia surgeries performed by general practitioners after targeted inguinal hernia surgery workshops and hands on training by group of general and pediatric surgeons at Charikot Hospital and Tsho-Rolpa General Hospital at Dolakha district of rural Nepal from 1<sup>st</sup> December 2019 to November 30<sup>th</sup> 2023 and a year of follow up for the age group of 3-18 years. Data was collected through Electronic Health Record (EHR) system and surgery register.

**Result:** During study period, 204 children underwent herniotomy, out of which 131 (65.2%) were boys while 73(35.8%) were girls. Among them, 151(74%) had unilateral inguinal hernia, 31(15.2%) had bilateral and remaining 22(10.8%) had unilateral hydrocele. Among 151 children, 98(65%) had right sided inguinal hernia. Among 204 cases, 9 (4.4%) had scrotal edema, 6(2.9%) had wound infection and 2(1%) had recurrence in 1-year post surgery follow up.

**Conclusion:** This prospective study highlights the feasibility of implementing a scalable, community-based surgical model for pediatric inguinal hernia repair in remote areas of Nepal. GPs can be trained to perform inguinal herniotomy to improve surgery access in remote setting.

**Keywords:** General Practitioners, Herniotomy, Hydrocele, Inguinal Hernia

## INTRODUCTION

Inguinal hernia is the common surgical problem in children and over 99% of those hernia is indirect type.<sup>1</sup> Most of the childhood hernia are congenital as they result from a patent processes vaginalis.<sup>2</sup> The incidence of inguinal hernia in term and preterm babies are 3.5- 5% and 44-55% respectively.<sup>3</sup> The small intestines are the commonest content in boys and the ovaries are in females however bowel becomes more common after one year of age.<sup>4</sup> Hydrocele is the accumulation of fluid within the sac surrounding testicle.<sup>5</sup> The surgical correction of both pediatric inguinal hernia and hydrocele is herniotomy.

Access to surgical care in rural Nepal is poor due to inadequate numbers of surgeons, greater concentration of available surgeons in urban setting and lack of motivation to work in rural areas.<sup>6</sup> However, general practitioners (GPs) are mostly available in district hospitals providing holistic health care as per the need of rural communities where access to specialists are limited.<sup>7</sup>

Inguinal hernia surgery is generally performed by general surgeon or pediatric surgeon.<sup>8</sup> Most of the childhood hernia are referred or left untreated in remote hospitals of Nepal. This study describes how GPs can be upskilled to treat pediatric inguinal hernia and evaluate outcomes of hernia surgery in resource limited setting after planned workshops and hands on training by group of pediatric surgeons and general surgeons.

## METHOD

**Patient's Characteristics:** This study was carried out prospectively from 1<sup>st</sup> Dec 2019 to 30<sup>th</sup> Nov 2021 at Charikot Hospital (Name changed - Pashupati Chaulagain Memorial Provincial Government Hospital) and from 1<sup>st</sup> Dec 2021 to Nov 30<sup>th</sup> 2023 at Tsho-Rolpa General Hospital, located at Dolakha district of Himalayan region of eastern Nepal. Ethical consideration was taken from hospital review board. Inclusion criteria were cooperative and clinically fit child of age group 3-18 years with diagnosed cases of inguinal hernia or congenital hydrocele, emergency and elective both. However, children who were very sick, associated with other congenital anomalies and age less than 3 years were excluded. Consent for children up to age 16 years were taken from their parents by filling assent form. All children who met inclusion criteria were taken as sample with convenience sampling technique.

**Pediatric Inguinal Hernia Surgery Training:** In Jun 2019 and Feb 2020, the workshops and hands on program was conducted for general practitioners (MDGPs) who are working in remote Nepal at Charikot Hospital and review workshop was conducted in 2023 April at Tsho-Rolpa General Hospital, Dolakha, Nepal. The sessions were delivered by Nepali surgeons and UK pediatric surgeons working with HPN UK (Health Partnership Nepal) which is a charity organization to strengthen rural health care of

Nepal. The training program consisted of medical education sessions, theoretical and live operative demonstrations for 2 weeks for consecutive 2 years. Pediatric trainers provided further support and advice remotely as required. Fund raising of the training program was supported by Royal College of Surgeons, England.

**Inguinal Hernia Surgery Method and follow up:** All children undergone open hernia repair surgery. A 2-3 cm transverse incision was given at the lowest part of inguinal crease. Prophylactic antibiotic (Cefazolin 1gm IV) was given before surgery. Operations were carried out by trained general practitioners under intravenous anesthesia (Ketamine 1mg/kg) with facemasks without intubations. Vicryl 3-0 was used to tie hernia sac proximally and distal sac was left open. All children were discharged after 1 day of surgery with oral paracetamol (15mg/kg). All children were followed up at 3<sup>rd</sup> and 7<sup>th</sup> day. Dressing was removed on day 7<sup>th</sup> and infected wounds were managed by regular dressing and antibiotics as required. All children were advised to follow up at 1<sup>st</sup>, 3<sup>rd</sup>, 6<sup>th</sup> and 12<sup>th</sup> months. Complications were recorded on bleeding, scrotal edema, wound infection, and recurrence.

**Data Analysis:** Children's data was collected from Electronic Health Record (EHR) system and surgery register of the hospital. Categorical variables were reported in frequency and percentage.

## RESULT

The clinical characteristics of 204 children are shown in Table 1. Inguinal hernia and congenital hydrocele were diagnosed by taking history and followed by careful examinations and investigations if required. Among 204 children, two thirds were boys and remaining one third were girls as shown in Table 1. Almost more than one third of the children were in age group of 6-10 years and only 29(14%) were in 6-18 years' group.

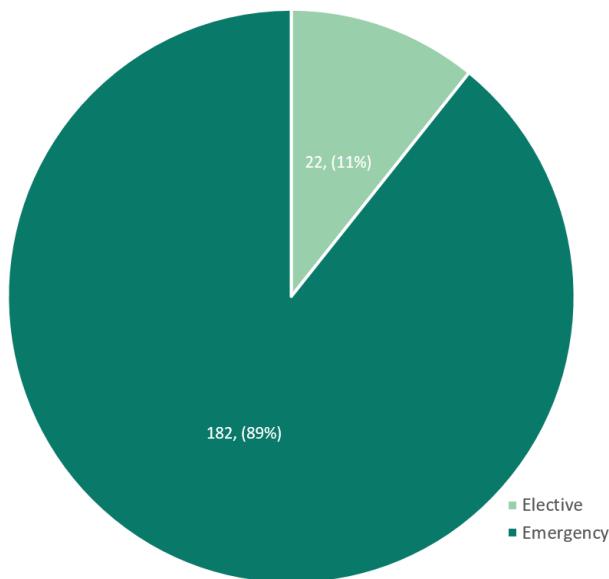
**Table 1. Clinical characteristics of children with inguinal hernia and congenital hydrocele, (N=204)**

Characteristics	N(%)
<b>Sex</b>	
Boys	131(65.2%)
Girls	73 (35.8%)
<b>Age (Year)</b>	
3-5 Years	54(26.5%)
6-10 Years	78 (38.2%)
11-15 years	43 (21%)
16-18 years	29 (14.2%)
<b>Inguinal Hernia and Hydrocele</b>	
Right-sided hernia	98(48%)
Left-sided hernia	53 (28.4%)
Bilateral hernia	31 (15.2%)
Congenital Hydrocele	22 (10.8%)

Interestingly, right sided inguinal hernia was most common among 98 (48%) and 31 (15.2%) had bilateral inguinal hernia however only 22 (10.8%) had congenital hydrocele.

Predominantly, 182(89.2%) children underwent elective

surgery however 22(11.8%) children underwent emergency surgery for obstructive features shown in Figure 1.



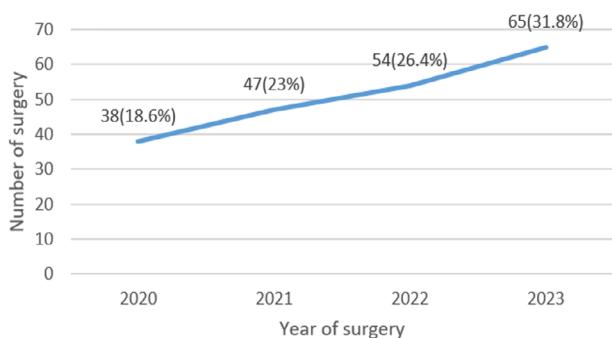
**Figure 1. Pie chart showing nature of pediatric inguinal surgery**

Hernia content was reduced in most of the children but ovary was the content found in 7(9.5%) among 73 girls and 34(16.6%) had small bowel as content which was causing obstruction in emergency cases shown in Table 2.

**Table 2. Content of the hernia**

Contents of hernia	N(%)
Small bowel	34(16.6%)
Ovary	7(3.4%)
Omentum	9(4.5%)
Reduced	151(74%)

Almost 2/3<sup>rd</sup> of the surgery was performed in 2023 and 38(18.6%) children were operated in the year 2020 shown in Figure 2.



**Figure 2. Trend of total pediatric inguinal surgery**

Scrotal edema was the major complications noted after the inguinal hernia surgery in 9 (4.4%) children which was resolved spontaneously, 6(3%) has wound infection detected on 7<sup>th</sup> day of surgery and was resolved after dressing and oral antibiotics and 2(1%) cases of children had recurrence of hernia at 10<sup>th</sup> month of follow up shown in Table 3.

**Table 3. Complications after pediatric inguinal hernia surgery**

Complications	No. of Patients	ATAC
Scrotal edema	9(4.4%)	7 <sup>th</sup> Day
Wound Infection	6(3%)	7 <sup>th</sup> Day
Recurrence	2(1%)	10 <sup>th</sup> Month

Note: ATAC: Average time after complication

## DISCUSSION

Inguinal hernia and congenital hydrocele are the common surgical problem encountered in children. During process of growth of children, 0.8% to 4.4% will develop inguinal hernia.<sup>9</sup> Normally, processus vaginalis descends with the testis into the scrotum, failure to obliterate processus vaginalis leads to inguinal hernia.<sup>2</sup>

Surgery is the only option to inguinal hernia and the modern principles of hernia repair includes high ligation of the sac, narrowing of the internal ring and tensionless repair.<sup>10</sup> Inguinal hernias should be repaired promptly as it can lead intestinal obstruction, testicular atrophy and infertility once incarcerated.<sup>11</sup>

65% of our children were male whereas study done in Patan Hospital in Nepal had 90% male among 90 children.<sup>12</sup> Commonest age group in our case was 6-10 years in 38.2%, below 5 years of age was more dominant (48%) in study done in Western Regional Hospital, Pokhara, Nepal.<sup>13</sup>

Our study shows 48% has right sided inguinal hernia and literature review of Rowe, et al.<sup>14</sup> and Grossfeld et al<sup>15</sup> shows predominance on right side with reported incidence of 55-60%. Direct hernia was not reported in our study, however, study done by Ravikumar et al had 4% of direct inguinal hernia in children.<sup>16</sup> In total 22(11.8%) cases underwent emergency surgery without significant post-operative morbidities for obstructive symptoms as reduction failed. However, Rowe et al<sup>14</sup> recommends elective surgery after a reduction since it has lower rate of complications (1.7% Vs 22.2%).

Complications wise, scrotal edema was present in 4% of the total cases along with recurrence of 1% which is similar to the rates reported by Aihole et al.<sup>17</sup> Most of our cases (74%) had contents reduced during the time of surgery and 34 cases (16.6%) had small bowel and 7(3.4%) cases had ovary as content respectively however study done by Osifo et al had ovary as content in 145 cases (82.4%) to 3.8% inguinal hernia containing normal ovary in study done by Ein, et al.

Globally, the pediatric inguinal hernia surgery is done by general surgeons or pediatric surgeons<sup>8</sup> but in our case the surgery is performed by trained GPs in two institutions of remote Nepal after scheduled workshops, live demonstration and hands on sessions. Initial report of inguinal hernia surgery was published in the Journal of General Practice and Emergency Medicine of Nepal.<sup>20</sup>

The utilization of anesthesia assistants in all cases reduced the need for sophisticated anesthesia equipment, which is often scarce in rural settings. The average surgical time was 45 minutes per patient, and the hospital stay postoperatively was minimal, with 90% of children discharged within 24 hours. The low complication rate and high follow-up compliance indicate that the model could be expanded to other parts of Nepal and similar low-resource countries.

This study was done in a small sample size. Details of congenital malformations associated with inguinal hernia, age less than 3 years and critical patients were excluded from the study. Follow up was limited to 1 year only as we could not review testicular atrophy and infertility in future. Consideration of surgery was only done for trained GPs. Well-designed larger studies can be done to verify our findings. Government can initiate training GPs in remote setting to scale up inguinal hernia surgery project where there are less or no access to pediatric surgery.

## CONCLUSION

This prospective study highlights the feasibility of implementing a scalable, community-based surgical model for pediatric inguinal hernia repair in remote areas of Nepal. The success of this approach demonstrates its potential for replication in other rural and resource-poor settings globally. Future studies should assess the long-term sustainability and cost-effectiveness of this model, as well as its impact on improving healthcare infrastructure and training in rural communities. GPs can be trained to perform inguinal herniotomy to improve surgery access in remote setting.

## DECLARATIONS

### Acknowledgement

We would like to thank hospital staff, HPN UK and Royal College of Surgeons for the support.

### Conflict of Interest

None

### Funding

This study was supported by Royal College of Surgeons, England and Health Partnership Nepal, UK to conduct training program. These organizations helped to run training programs at rural Nepal including resources need for the overall training.

### Ethical Clearance

Ethical consideration was obtained from the hospital review board of Tsho-Rolpa General Hospital, Charikot, Dolakha, Nepal.

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